Instrument for Pre-accession Assistance
of the European Union
Operational Programme for Regional Development 2007-2013

Preparation of necessary documents for establishing of an Integrated and Financially Self-sustainable Waste Management System in Pelagonija, Southwest, Vardar and Skopje Regions

Regional Waste Management Plan Southwest Region

(19/11/2016)

EuropeAid/136347/IH/SER/MK

This project is funded by the European Union

A project implemented by ENVIROPLAN SA and its consortium partners

ENVIROPLAN S.A. (Leader) – LOUIS BERGER – BiPRO GmbH – EPEM S.A. – SLR Consulting Limited
23 Perikleous Str.
15344 Gerakas/Athens - Greece
Tel: +30 210 6105127 / 8
Fax: +30 210 6105138
Email: fl@enviroplan.gr

Project:	**"Preparation of necessary documents for establishing of an Integrated and Financially Self-sustainable Waste Management System in Pelagonija, Southwest, Vardar and Skopje Regions"**
Reference No:	EuropeAid/136347/IH/SER/MK

Document title:	Southwest Region – Regional Waste Management Plan
Status:	Draft
Date:	19th of November 2016
Client:	Ministry of Finance-CFCD
Drafted by:	Christos Tsompanidis, Team Leader
Checked by:	Christos Tsompanidis, Team Leader
Approved by:	Theofanis Lolos, Project Director

Table of Contents

1. EXECUTIVE SUMMARY

The overall objective of the component 1 of the project '*Preparation of necessary documents for establishing of an Integrated and Financially Self sustainable Waste Management System in Pelagonija, Southwest, Vardar and Skopje Region*' (EuropeAid/136347/IH/SER/MK) is the selection of the most preferable option for an integrated regional waste management system after the elaboration of calculations regarding legislative targets, financial indexes and GHG emissions. The RWMP was drafted on the basis of: a) EU and national waste legislation and strategies, which may include objectives, set out in specific areas; and b) the analysis and evaluation of the current situation, which was the outcome of the elaborated Assessment Report. Apart from the EU and national waste legislation and strategy, there is a number of significant parameters which influence the regional planning and were taken into account: (1) Waste quantity and composition, (2) Geographic origin of the waste and (3) Current situation regarding waste collection and treatment, including waste tariffs and affordability.

A waste qualitative and quantitative survey had been performed during the elaboration of the Assessment Report. According to the waste qualitative survey the total biodegradable waste in this region has been estimated in 45.14%, the total recyclables 34.73%. The fractions textile-leather-wood-other special waste streams (elastic tyres) have a share of 9.29%, diapers 6.60% construction and demolition waste 1.18%, WEEE and hazardous materials (medical waste) 1.41% and fine fraction 1.65%. According to the waste quantitative survey, in Southwest Region, the total collected waste for year 2016 was 46.826 t and the total generated waste was estimated to 56.224 t. The collection coverage has been calculated to 83%. The waste generation rate for Southwest Region has been calculated to 251 kg/ca/year.

In order to calculate the waste generation forecast (2017-2046) for the region the following steps have been followed: (1) the forecasting of the population (permanent and seasonal) has been implemented for years 2017-2046 taking into consideration data regarding the average annual change of permanent population from World Bank and data concerning the average annual change of seasonal population from National Tourism Strategy 2009-2013, (2) four scenarios regarding the forecasting of waste generation rate from permanent population have been quantified and compared (the chosen scenarios have been proposed in NWMP) and scenario 2 was eventually preferred, (3) the assumption that the waste generation rate of seasonal population will be 1.2 kg/bednight has been used, (4) multiplying each population with the corresponding waste generation rate the generated waste has been estimated for years 2017-2046. The waste generation for Southwest Region has been calculated to 51.178 t in 2017 and 61.450 t in 2046 (average 2021-2046 62.961 t/y).

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

- Total recycling of packaging waste: min 55% - max 80% to be achieved by 2020
- Recycling of materials of packaging waste: (1) glass 60% to be achieved by 2020, (2) Paper and cardboard 60% to be achieved by 2020, (3) Metals 50% to be achieved by 2020, (4) Plastic 22.5% to be achieved by 2018 and wood 15% to be achieved by 2020
- Reduction of the quantity of Biodegradable municipal waste (BMW) landfilled expressed as a percentage reduction of the BMW generated in 1995: (1) at least 25% until 2017, (2) at least 50% until 2020 and (3) at least 65% until 2027

To fulfill the objectives of waste management, four main alternative waste management scenarios which include sub-scenarios have been examined and presented via flow diagrams. All proposed waste management scenarios include some common elements like (i) green points that will be a collection point for recyclables and wood packaging fraction, (ii) separate collection of hazardous municipal waste, (iii) separate collection of construction and demolition waste, (iv) separate collection of WEEE and (v) separate collection of other special waste streams (elastic-tires). Also all alternative scenarios include separate collection of garden waste and sorting at source of recyclables or packaging waste. Finally the alternative scenarios include a collection system with the use of either 1 or 2 or 3 bins. Obviously, based on the collection system, the proposed treatment facilities (including home composting), are also differentiated, accordingly by the way some sub-scenarios (a, b, c) are also developed, which are involving different technologies to treat waste that are collected with the same concept (1 bin, 2 bin or 3 bin system). A brief description of the examined scenarios is presented below.

Scenario 1a (Sc.1a): Collection of mixed waste in one bin that is transferred to Mechanical Biological treatment plant with aerobic composting process (recovery of glass, paper, plastics, Fe, Al, RDF, production of CLO). This sub-scenario also includes separate collection of green waste that is treated through windrow composting process (production of compost), home composting actions (compost production), green points (collection of small amounts of recyclables and wood), separate collection of construction and demolition waste, hazardous fraction of waste, WEEE and other special waste streams like elastic-tires and sorting at source for packaging waste from collective schemes.

Scenario 1b (Sc.1b): Collection of mixed waste in one bin that is transferred to Mechanical Biological treatment plant with anaerobic digestion process (electricity production from biogas) and aerobic composting of digestate (recovery of glass, paper, plastics, Fe, Al, RDF, production of CLO). This sub-scenario also includes separate collection of green waste that is treated through windrow composting process (production of compost), home composting actions (compost production), green points (collection of small amounts of recyclables and wood), separate collection of construction and demolition waste, hazardous fraction of waste, WEEE and other special waste streams like elastic-tires and sorting at source for packaging waste from collective schemes.

Scenario 1c (Sc.1c): Collection of mixed waste in one bin that is transferred to a thermal treatment unit. This scenario also includes separate collection of green waste that is transferred also to an incineration plant (or alternatively can be treated through windrow composting process-compost production), home composting actions (compost production), green points (collection of small amounts of recyclables and wood), separate collection of construction and demolition waste, hazardous fraction of waste, WEEE and other special waste streams-elastic, tires and sorting at source for packaging waste from collective schemes.

Scenario 2 (Sc.2): Collection of mixed waste in one bin that is transferred to a Mechanical Recovery Facility (recovery of glass, paper, plastics, Fe, Al, RDF) and collection of organic waste in another bin (organic waste bin) that is transferred to an aerobic composting plant (production of compost). This scenario also includes separate collection of green waste that is treated to the same aerobic composting plant with organic waste derived from organic waste bin and produce compost, green points (collection of small amounts of recyclables and wood), separate collection of construction and demolition waste, hazardous fraction of waste, WEEE and other special waste streams-elastic, tires and sorting at source for packaging waste from collective schemes.

Scenario 3a (Sc.3a): Collection of recyclable waste in one bin that is transferred to a Material Recycling Facility (recovery of glass, paper, plastics, Fe, Al) and collection of residual waste in another bin (mixed waste bin) that is transferred to a mechanical biological treatment plant with aerobic composting and recovery of recyclables (glass, paper, plastics, Fe, Al, RDF and production of CLO). This scenarios also includes separate collection of green waste that is treated through windrow composting process (compost production), home composting actions (compost production), and green points (collection of small amounts of recyclables and wood), separate collection of construction and demolition waste, hazardous fraction of waste, WEEE and other special waste streams-elastic, tires.

Scenario 3b (Sc.3b): Collection of recyclable waste in one bin that is transferred to a Material Recycling Facility (recovery of glass, paper, plastics, Fe, Al) and collection of residual waste in another bin (mixed waste bin) that is transferred to a mechanical biological treatment plant with anaerobic digestion (biogas production/electricity production) followed by aerobic composting of digestate and recovery of recyclables (glass, paper, plastics, Fe, Al, RDF and production of CLO). This sub-scenario also includes separate collection of green waste that is treated to a windrow composting process (compost production), home composting actions (compost production), and green points (collection of small amounts of recyclables and wood), separate collection of construction and demolition waste, hazardous fraction of waste, WEEE and other special waste streams-elastic, tires.

Scenario 3c (Sc.3c): Collection of recyclable waste in one bin that is transferred to a Material Recycling Facility (recovery of glass, paper, plastics, Fe, Al) and collection of residual waste in another bin (mixed waste bin) that is transferred to a Mechanical Biological Stabilization plant (recovery of Fe, Al and production of CLO). This sub-scenario also includes separate collection of green waste that is treated through windrow composting process (production of compost), home composting actions (production of compost), and green points (collection of small amounts of recyclables and wood), separate collection of construction and demolition waste, hazardous fraction of waste, WEEE and other special waste streams-elastic, tires.

Scenario 4 (Sc.4): Collection of recyclable waste in one bin that is transferred to a Material Recycling Facility (recovery of glass, paper, plastics, Fe, Al), collection of organic waste in another bin (organic waste bin) that is transferred to an aerobic composting plant (production of compost) and collection of residual waste in a third waste bin (residual waste bin) that is transferred directly to the landfill. This scenario also includes separate collection of green waste that is treated to the same aerobic composting plant with organic waste (from organic waste bin) and produce compost, and green points (collection of small amounts of recyclables and wood), separate collection of construction and demolition waste, hazardous fraction of waste, WEEE and other special waste streams-elastic, tires.

Except the sub-scenario 1c, all the above examined scenarios fulfill the legislative targets concerning recycling of packaging waste. Regarding the legislative target of reduction of Biodegradable municipal waste which will be diverted to landfill, only Scenario 4 does not fulfill the target of reduction of biodegradable municipal waste which will be landfilled for year 2021.

Apart from the quantification of targets for each examined scenario concerning recycling of packaging waste and reduction of biodegradable municipal waste landfilled, GHG calculations have been made for each scenario (SWM-GHG Calculator) and estimations of investment cost, operational cost, revenues, net operational cost and dynamic prime cost have been done.

The next step was the use of a Multi-Criteria Analysis (MCA), PROMETHEE, in order to simultaneously analyze the characteristics of the various alternative scenarios through the evaluation and rating of all the different criteria for the extraction of the optimal solution. The criteria that have been selected are classified into four major groups incorporating financial, technical, environmental and social-institutional parameters.

Considering all the elements which have been presented in various chapters of the plan, the recommended waste management system for Pelagonija region is scenario Sc. 3b. The total investment cost of the recommended scenario is approximately 26 mil € (without contingencies and VAT), the revenues are approximately 2.1 mil €/y (average 2021-2046), the net operational cost is approximately 1.6 mil €/y (average 2021-2046) and the levelized unit cost have been calculated to 64.24 €/t.

Regarding the quantification of targets of recycling of packaging waste and reduction of biodegradable municipal waste which will be landfilled in years 2021 and 2027 (expressed as a percentage of biodegradable municipal waste produced in 1995) for the selected scenario 3b the following figures have been calculated: (i) total % of recycling of packaging waste 69.77%, (ii) % glass packaging recycling 68.28%, (iii) % plastic packaging recycling 68.59%, (iv) % paper packaging recycling 70.98%, (v) % Fe packaging recycling 88.83%, (vi) % Al packaging recycling 88.83%, (vii) % Wood packaging recycling 15.00%, (viii) Reduction of biodegradable municipal waste landfilled in 2021 91.52% and Reduction of biodegradable municipal waste landfilled in 2027 91.29%.

In Southwest Region were identified 10 non-compliant municipal landfill sites (active and closed) and 87 (uncontrolled) dumpsites. There are applied 3 models of landfill remediation and the total cost (indicative) for the rehabilitation of these landfills has been estimated.

Having set the regional targets and objectives as well as the measures via which these targets will be achieved in the previous paragraphs, an action plan for the proposed interventions is prepared. This plan focuses on the priority measures and the respective main infrastructure investments, but it also gives an indication of all future activities (reinvestment or other activities) that will need to be implemented. The Action Plan may be divided into the following periods: (1) Priority measures for a period of up to three years (2018-2020), (2) Short-term measures for a period of up to five years (-2022), (3) Medium-term measures for a period of six to ten years (-2027) and (4) Long term measures for a period longer than ten years (-2046).

Table of Contents

List of tables

List of figures

2. DESCRIPTION OF WASTE MANAGEMENT REGION

2.1 Geographical Location

The Southwest Region is located in the western part of the country and it borders Albania. Internally, it borders the Polog, Skopje, Vardar and Pelagonija regions. Southwest Region is divided into nine (9) municipalities:

1. Vevchani
2. Debar
3. Debarca
4. Kichevo
5. Makedonski Brod
6. Ohrid
7. Plasnica
8. Struga
9. Centar Zhupa

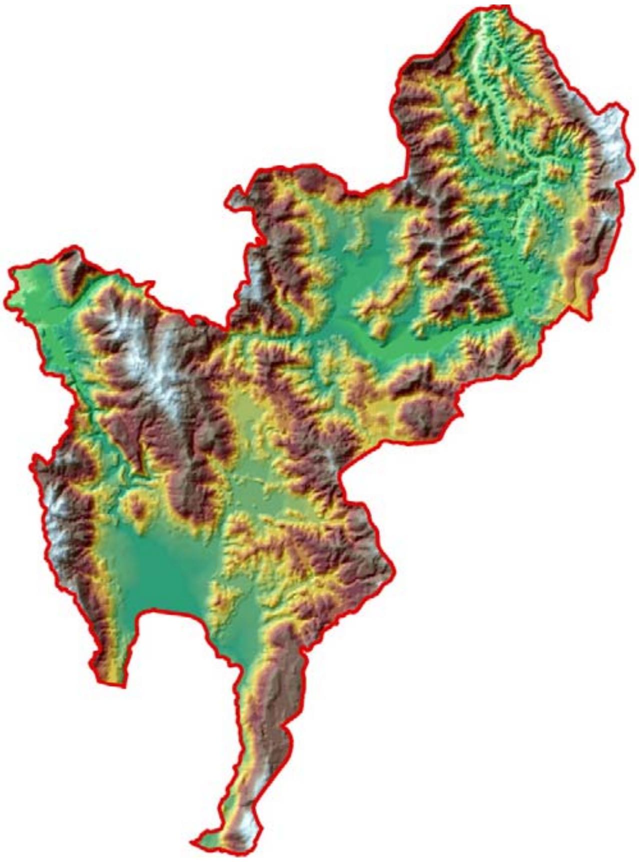
Figure 2-1: Municipalities of Southwest region

2.2 Topography

Wider region, and the current area, belongs to Western Republic of Macedonian zone as geotectonic unit. In the area of mountains, terrain runs by hilly - mountainous field, passes through flat terrain and mild, slightly hilly and hilly terrain.

The terrain is characterized by alternately switching the high hills and deeply incised valleys and gullies with elevations on hills with very steep sides toward streams and gullies. Most of the route is represented by a flat - hilly terrain with occasional valleys and ravines.

Figure 2-2: Terrain model of Southwest Region



2.3 Climate

As a continental country, the most important climatic factors in the country are: geographical position, relief, proximity to the surrounding seas and atmospheric currents.

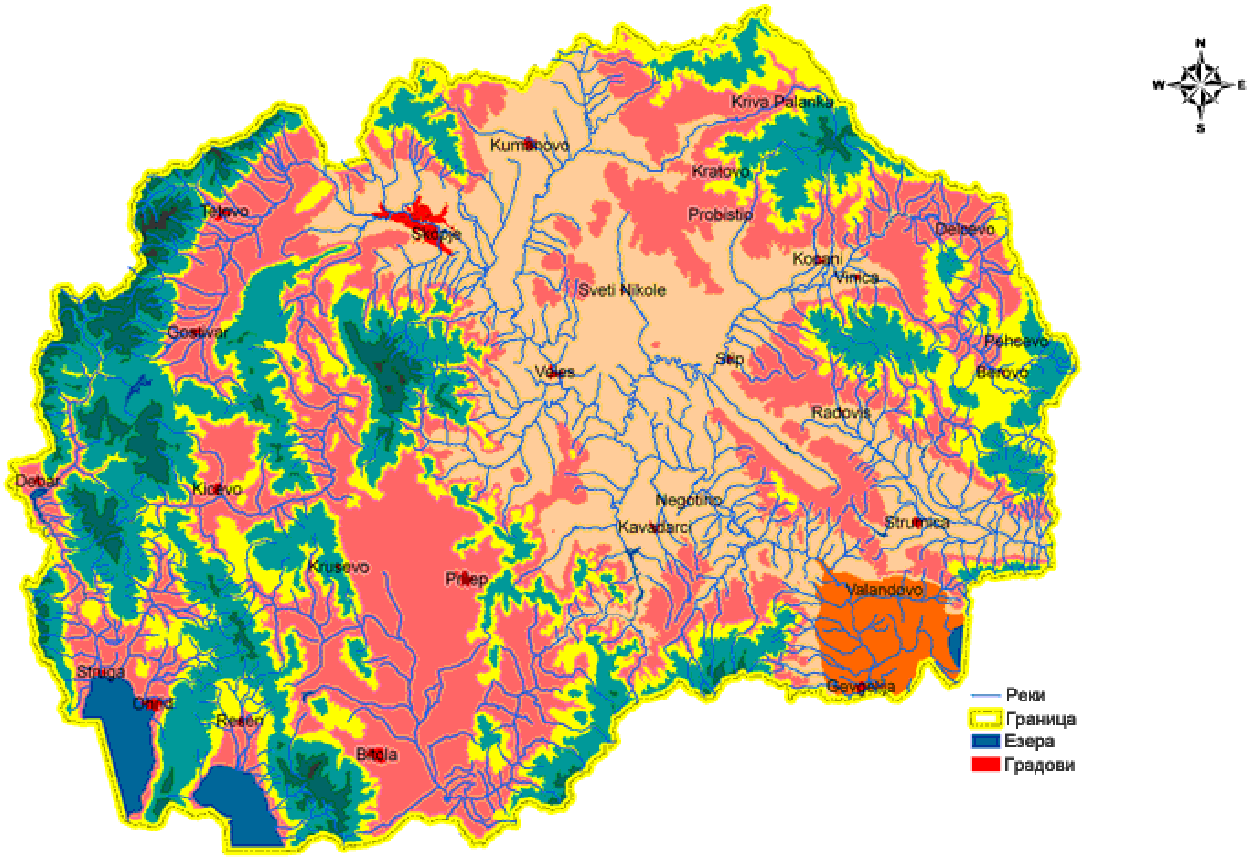
Republic of Macedonia lies in the temperate heat zone and is closer to the equator than to the North Pole. So there is enough heat for the development of flora and fauna in the majority of the year. Due to the geographic location, a four seasons are clearly expressed. Summer lasts from June 22 to September 23, and winter from 22 December to 21 March.

The proximity of the Aegean Sea of just 60 km and the Adriatic Sea of 80 km has a profound effect on the climate in the Republic of Macedonia. This is especially evident in the valley of the river Vardar, Strumica, and less of Crn Drim where penetrating hot and humid air masses. Apart from the seas, the climate of the country is affected from Atlantic Ocean from where come humid air masses especially in spring and autumn.

Relief with his height and direction of extension has a significant impact on the climate of our state. High mountains in the western and southern part of the Republic of Macedonia prevent hot and humid marine influences to penetrate deeper inside. Their penetration is only possible through the valleys of the Vardar, Strumica and Drim Rivers. On the other hand, moderate mountains and broad valleys in the north allow infiltration of cold air masses from the north. Therefore, even in winter, the southern parts of the country could have very low temperatures. Besides mountains, climate is significantly influence with valleys disposition. Some of the valleys are surrounded by mountains on all sides and in the winter low parts can be very cold. Some valleys are filled with the lakes that do not allow the surrounding air to heat much in the summer or to cool much in winter.

Temperate continental climate with quite weak Mediterranean influences stretches along the valley of the Vardar, Demir Kapija to the south, to Skopje and Kumanovo to the north, then along Bregalnitsa to the east of Kocani and along the river Crna and Mariovo to the west. There, winter ice is more common. The lowest temperatures are lowered below -20° C, and in the summer they climb to 45° C. Average amount of rainfall is around 600-900 mm/yr. Mountain areas are characterized by severe mountain climate, cold winters and summers, average annual temperatures around 0° C and rainfall around 1000-1200 mm, through the winter in the form of snow. The snow usually stays from November to May, and in the highest sides till August.

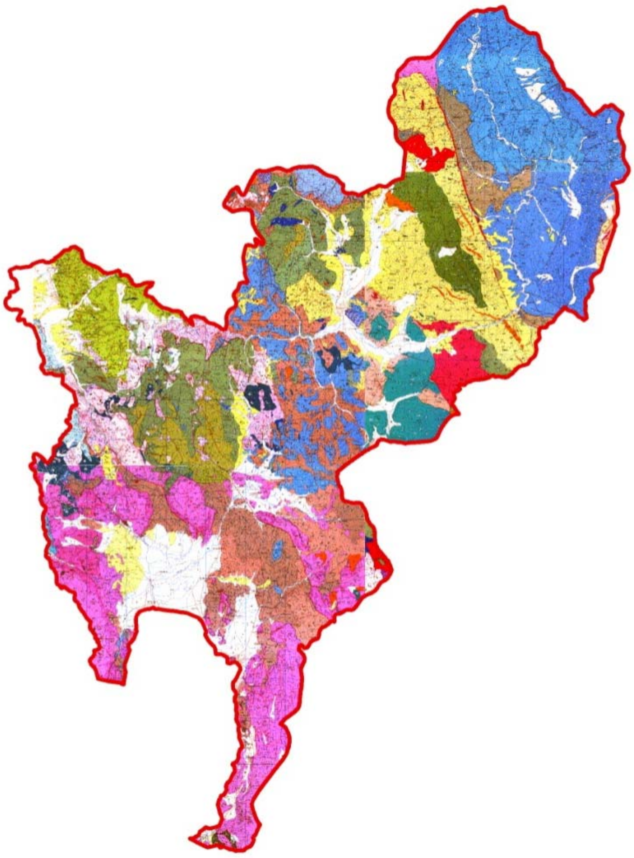
Figure 2-3: Republic of Macedonia climate map



2.4 Geology

Southwest region belongs to West Republic of Macedonian geotectonic unit which is characterized with its own specific lithological composition, tectonic structure and degree of metamorphism.

Figure 2-4: Southwest Region General Geological map



General geological map analysis indicates presence of the following rock formations;

PALEOZOIC

Phylite schists (Sqse): These schists have dominant place in the Devonian rocks. On the terrain are seen on several places, but much present are under the Triassic sediments. In the upper part contains carbonate schists or gradually transform in marbleized limestones. According the mineral composition, wthin the phylite schists appear quartz - sericite - clayey schists, quartz - sericite and quartz - sericite - graphite schists.

Meta - sandstones and meta - conglomerates (Sq): Meta - sandstones are almost the most present lithological member. They appear in different horizons of the stratigraphic column and alternately replace with phylite schists. Their color is grey to dark grey, fine to coarse granular and composed mainly of quartz, and poorly sericite and pieces of meta - quartzites.

Meta - conglomerates lie above the marbleized limestones and have reddish color and schistose texture. They are composed of perfectly sorted pieces of quartz and meta - quartzites.

Phylitoide (FD): In this group are included mainly phylite, and less present are slates, sandstones, sericite - quartz schists etc. These rocks alternately replace each other, horizontally and vertically. Phylites are rocks with grey to black color, on some places light brown and yellowish, and have schistose texture. Main minerals in their composition are sericite or muscovite, quartz and chlorite, and as secondary appear magnetite, tourmaline, zircon and pyrite which are limonitized. Slates have grey to black color and schistose texture. Main minerals in their composition are quartz, sericite, muscovite, chlorite and clay

matter. Sandstones are rocks with schistose texture and light to dark grey color. Mainly are composed of quartz and less content of feldspar.
Conglomerates and sandstones (D): Conglomerates are built of pieces of quartz, meta - sandstones, meta - quartzites and small grains of potassium feldspars and plagioclases. Pieces are well sorted and large to 25 cm. these rocks appear in the lower part of Devonian. Sandstones are composed of quartz and feldspar grains. The texture is schistose and the structure is psammite. Their color is light to dark grey, and sometimes with greenish tone.
Marble series (MD): In this series are present several types of marbles: plated, massive, and dolomite marbles. Plated marbles are composed of calcite and have white to grey color. The structure is granoblastic. Massive marbles are white to dark grey with granoblastic structure and composed of calcite. They are massive and appear as stratified in thick beds only in the basement. Dolomite marbles are characterized with white to ruddy color. In their composition, beside calcite, appears dolomite.
Metamorphosed diabase and spilite (ββ): These rocks are characterized with dark green color, rare with yellowish - greenish color. They have massive to schistose texture, ophitic structure and are very strong and compact. Their primery composition is totally altered and transformed in secondary products.

MESOZOIC
Triassic sediments ($T_2^{1,2}$): Triassic sediments are represented with different members on different places. In the surrounding of Ohrid Triassic is presented with clastic and carbonate rocks which are separated in two facies: clastic - carbonate facies with outburst of rhyolite and diabase and carbonate - chert facies. The first facies has variable thickness from 3 to 100 m and it is represented with conglomerates, sandstones and siltstones, slates, limestones, dolomites and cherts. In the upper parts are present outbursts of rhyolite and diabase. The second facies is thick 500 - 550 m composed of dolomite, plated limestone with cherts and massive limestone.

Triassic sediments ($T_{2,3}$): On the part of Kicevo, Triassic sediments are represented with a) facies of clastic sediments represent by conglomerates and sandstones, slates and cherts; b) facies of carbonate sediments (plated limestone, massive and stratified in thick beds limestone and dolomite limestone).
Upper Cretaceous sediments ($K_2^{2,3}$): These sediments are present on mountains Jablanica, Stogovo and Deshat, along the valley of the rivers Radika, Mala Reka and Garska Reka. They are represented with flysch sediments in which are separated layers of plated limestones, rudists (rudistae) limestones, gypsum and anhydrite. On several places are determined submarine outbursts of diabase.

CENOZOIC
Pliocene ($Pl_{2,3}$): Pliocene sediments are developed on large area within the Prespa, Ohrid, Piskupshtina and Debarca basin and partially are covered with Quaternary sediments. Middle Pliocene sediments are developed in well stratified sediments represented with gravel, sand, different clays and marls. Upper Pliocene is developed in poorly stratified material represent by clays, gravels and sands. Upper Pliocene sediments have larger spreading related to middle Pliocene sediments.

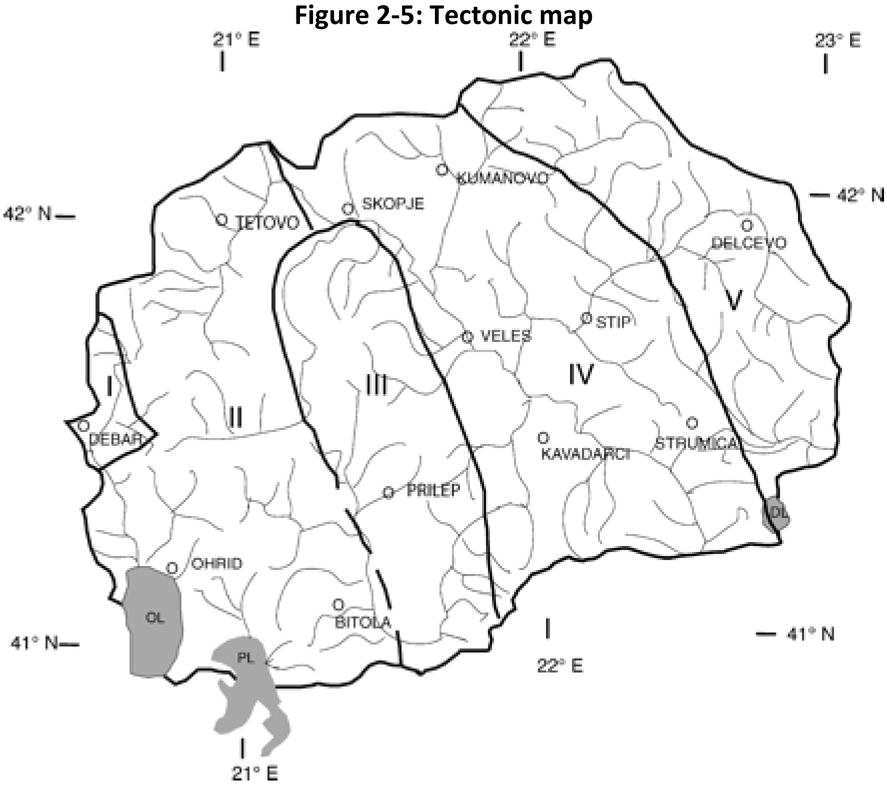
QUATERNARY
Moraine sediments (gl): During the glaciation, large part of the terrain was covered with glaciers. Today, remarkable traces of these processes are present only on the area of Jablanica manifested with moraines and glacier lakes.
Terra Rosa (ts): It is developed in karstified areas with Triassic limestones. Developed is on Galicica and Petrina.
Proluvium (pr): Proluvial sediments are much developed on the edge parts of Ohrid and Struga Field, Debarca and Prespa. They are represented with coarse clastic unsorted material, partially processed or unprocessed, composed of the rocks that builts the surrounding.
Slope breccia (d): The most present are on the western slopes of the mountains Galicica and Petrina. They are built of sharp angle pieces and blocks from Triassic limestones cemented with carbonate matter.

Alluvium (a):Alluvial sediments are spread along the riverbeds of the larger rivers. In larger masses are developed along the rivers Crni Drim, Sateska, Koselska, Openichka, Cherava and Bolnska. These sediments are represented with coarse clastic material composed of gravel, sand and sandy clay.

Tectonics

Within the country, above the basement tectonic units, there are two main groups of sedimentary basins that formed in late Eocene to Recent time and reflect two major periods of extensional deformation separated by a short period of shortening. Most of the basins are related to extensional faulting and some are clearly ridges, but others are more complex and there is a wide range of basin types.
The interconnected Tikves and Ovchepole basins in central country are an exception and contain both marine and non-marine strata that interfinger with volcanic rocks to the east. These strata lie in a for-arc position relative to a coeval volcanic arc to the east and a convergence zone to the west in central Albania where the Apulian plate moved east relative to the country.

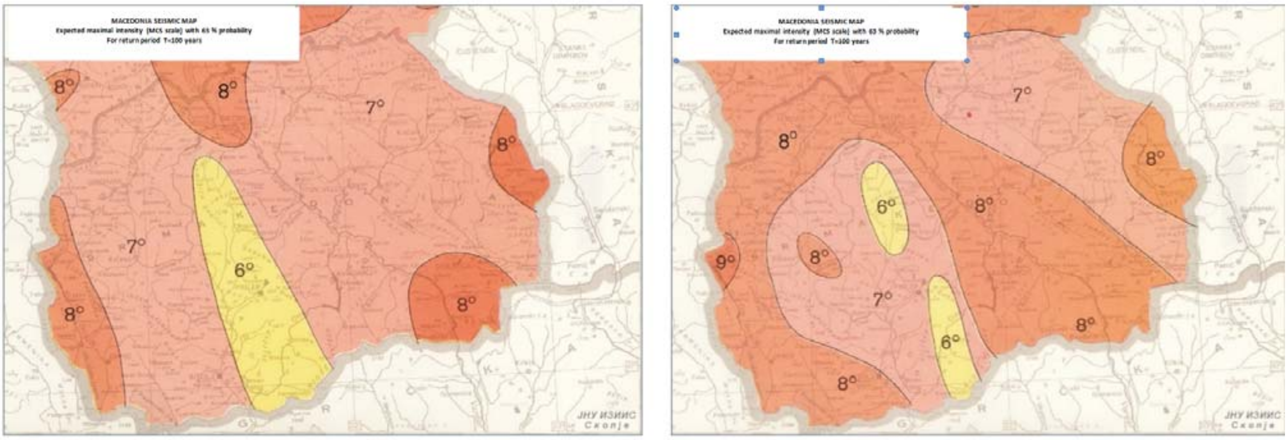
Figure 2-5: Tectonic map



Seismic Hazards

Seismic activity of the area is especially important for any construction structural stability and therefore it is a basis for any risk analysis procedure, as the strong earthquakes can have catastrophic consequences in very large areas. Southwest Region under consideration is not area marked with high seismic hazard, according to the country's seismic hazards maps (source: IZIIS, UKIM Skopje).

Figure 2-6: Republic of Macedonia seismic hazard maps for return period of 100 and 200 years (source: IZIIS – UKIM Skopje)



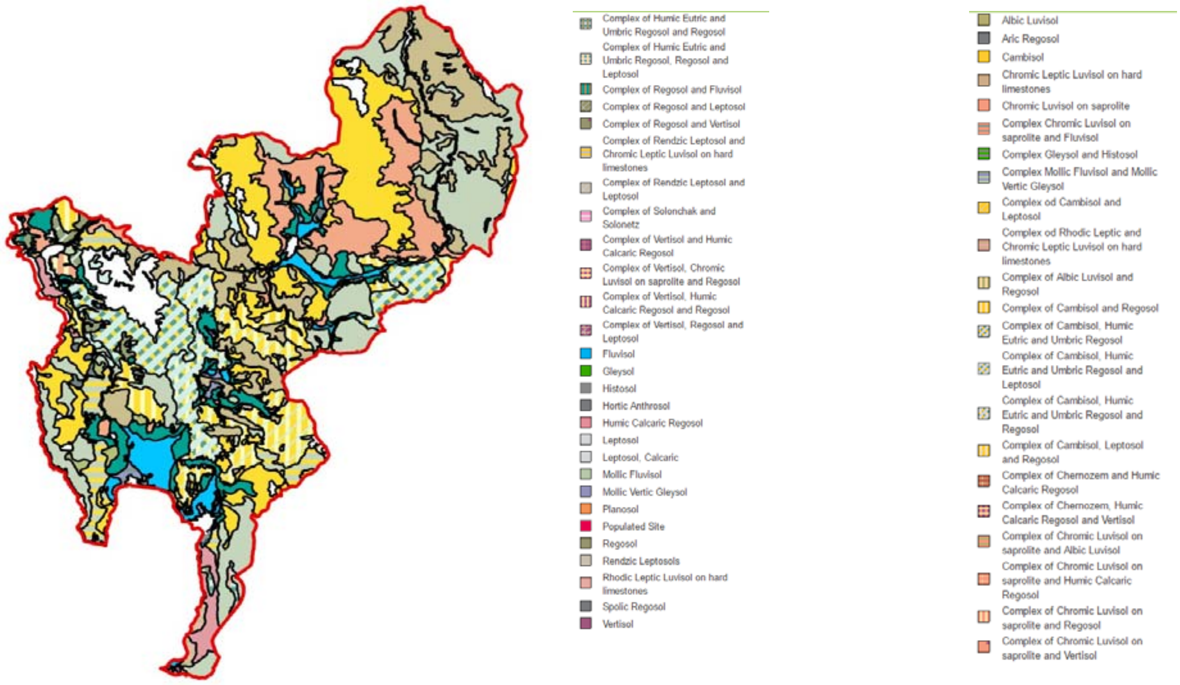
Soils

Land cover in Southwest region includes lager number different soil types, mostly dominated by complexes of Rendzic Leptosol, Cambisol, Chromic leptic luvisol on hard limestones and Chromic luvisol on saprolite.

Cambisol are sandy - clay soils which are the most spread in the mountain regions on the height of 600 m above sea level. They are rich in humus - to 12 %, but humus matter is not very good quality. Reaction is weakly acidic - pH is 5.5 - 6. Usually, there is mountain vegetation and rare is used for agriculture. They are present in the lower part of the middle forest vegetation belt. The vegetation is formed entirely under the influence of woody vegetation. Most common are the oak, then beech, black and white pine and fir tree. Dark cambisol is characteristic for the northern and near expositions. They are characterized with large thickness of the profile, and good expressed humus - accumulative horizon. They have large reserves of nutrients and high-capacity of active moisture. It made them, in most cases, soils with high forest vegetation properties, where successfully grow crops of beech, firtree, white pine and others. Light cambisols are characteristic for the south and near expositions. They are with thin profile, with decreased humus horizon and many skeletal elements. Mainly are covered with white pine. Pine and firtree have poor growth and low productivity. The average humus content in the A horizon is 7%. The solum is not calcareous. The pH in water is close to neutral (average 6.5). The cation exchange capacity is high (for the A horizon, on average, 39eqmmol/100g soil). The sum of exchangeable bases (S) is high (33eqmmol/100g soil in the A horizon) and the base saturation percentage (V) is also high, at around 84%. The humus composition has the following characteristics: there is a low percentage of insoluble residue (32-33%) and a fairly high percentage of humic (29%) and especially fulvic acids (38%). The ratio of these acids is fairly narrow (0.77 in the A and 0.67 in (B).

They form on compact quartz rocks, as well as on a number of compact acid, neutral basic and ultrabasic silicate eruptive and metamorphic rocks and, over small areas, on carbonate-free silicate sediments.

Figure 2-7: Southwest Region soil map (source: www.maksoil.ukim.mk)



Regosol occur in basins, mainly on undulating terrain, over paleogenic, neogenic and diluvial sediments. Depending on the substratum over which they are formed, these soils are very heterogeneous in mechanical composition. The Regosol formed over residuum from acid rocks contain on average: 27% coarse fragments, 3% clay, 13% silt and 17% clay + silt. Sandy soils prevail, covering 83% of the area. Calcaric Regosol over tertiary sediments contain on average: 8-9% coarse fragments, 17% clay, silt 28% and 45% clay + silt. The physical properties of carbonate Regosol are: porosity 50%, water capacity 38%, air capacity 11%, wilting point 15% and available water 23%. The chemical properties also show heterogeneity. The Regosol formed over residuum from acid rocks are without carbonate and contain around 2% humus. pH in water is on average 6.2, cation exchange capacity is 11.5, S = 4.5eqmmol in 100g soil and V = 38.7%. Silicate carbonate Regosol over Tertiary sediments contains more than 2% humus and 16% $CaCO_3$ on average. Their reaction in water is averages pH 7.7.

Some of the Regosol are under xerophilic hilly pastures. The rest are used intensively for agricultural purposes. Vertisol are identified as intrazonal, lithogenic topogenic soils. They are found together with other types of soil; depending on the parent material, with Regosol, rendzinas, chernozems and cinnamonic forest soils, and on basic compact rock with lithosols and vertic rankers. The texture of Vertisol is characterized by the following features: low coarse fraction (4% on average); the clay fraction dominates (clay + silt = 60%); clay is the dominant soil separate (40%) in the fine earth; there is little coarse sand in the Vertisol (9%), more silt (21%) and fine sand (30%); clay textures prevail and there is no texture differentiation.

There are very small areas of arenosol, formed on sand from the Vardar River that has been transmitted and deposited with the help of strong winds in the Vardar valley.

Coarser macro aggregates dominate (above 3mm and especially above 5mm). The air capacity is low (2.7 to 6.5%, with an average of 4.2%). Aeration is low in wet conditions. Vertisol are characterised by high plasticity: the upper limit is 79%, the lower 38%, and the plasticity number is 41%. The A horizon contains an average of 3.5% humus and an average of 5.3% CaCO3 (calcareous Vertisol). The mean pH value for all

Vertisol is 7.2. The exchange capacity is high and amounts on average to 38eqmmol/100g soil. Mean values of exchangeable alkaline cations are: Ca=56%, Mg=27%, H + Al=15%, K=1.0%, and Na=0.7%.

Exchangeable Mg cations dominate in the Vertisol on serpentinite and gabbro. These soils are characterised by a high percentage of humic acids, among which few are free. They contain little fulvic acids. The ratio between the humic and fulvic acids is high (1,75, and varies from 1,1 to 2,6). These soils contain a high percentage of insoluble organic remains.

Vertisol have large significance for agricultural production. They covered large areas in valleys.

Chromic leptic luvisol on hard limestones are found only in the limestone and dolomitic mountains, at an altitude of 600 – 1600m. The average depth of the solum is 56cm. The texture has the following characteristics on average: 12% skeletal material; physical clay (clay + silt) prevails (60%). The textural differentiation is clear. The (B) horizon contains 1,37 times more clay than the A horizon.

As far as the climate is concerned, these soils can be found in four vertical climatic zones: cold continental, piedmont-continental-mountain, mountain-continental, and sub alpic. These soils are found under a number of associations in the oak, beech and subalpic regions. The texture of the soils is heterogeneous: sandy loams, loams, and clay loams prevail .The skeletal content is quite high (average 25%) in the A and (B) horizons. The clay content averages 9% in the A and 12% in (B) and textural differentiation is low. On average, the (B) horizon contains 1,28 times more clay than the A horizon; argilogenesis is low and there is 1,24 times more clay in the (B) horizon than in the C. The sand content (coarse + fine sand) accounts for 2/3 of all the particle-size fractions. Coarse aggregates dominate in these soils (46% of the aggregates are larger than 3mm).

The macro aggregates show high stability (82,5% in the A horizon and 77,7% in the (B) horizon. The soils are characterised by high porosity (54% in the A, 41% in the (B) horizon on average). They have moderate water retention capacity (37% in A, 33% in (B)). The aeration is very high (17%) in the A and 13% in the (B). The chemical properties vary within broad limits, depending on the parent material, altitude, climatic-vegetation zones.

The organic horizon contains approximately 19% humus. The mineral soils are also rich in humus: 6.6% on average in the Ahorizon. The soils are non calcareous, with pH averaging 5.6 in the A horizon and 5,5 in the (B). Acid and moderately acid soils thus dominate. The cation exchange capacity in the A horizon is an average of 25 and in the (B) horizon an average of 20eqmmol/100g soil. The sum of exchangeable bases (S) is low: 13,5 in the A horizon, 9.9eqmmol/100g soil in the (B) horizon (B, so that V is around 50%, but it varies depending on the subtypes The humus has a distinctly different composition in different horizons. The insoluble residue is the most dominant followed by the fulvic acids, while the humic acids come third (the ratio is 1:0.48:0.41); the ratio between the quantity of the humic acids and the fulvic acids is below 1 (in the A horizon 0.87 and in the (B) horizon 0.51).

Fluvisols (alluvial soils) cover approximately two thirds of the flood plain surface and are among the best-known soils in these parts. They are characterized by their highly heterogeneous texture. The dominance of loamy soils (86%) indicates their favourable texture. The average texture is as follows: fine sand 51%, silt 30%, clay 10%, and coarse sand 9%. There are few coarse fragments (4%). In the surface horizon, these soils contain an average of 2% humus.

Of the entire area of alluvial soils, non-carbonate soils make up 62%, and carbonate soils 38%. The average CEC of the soils is 19 in the top layer, while the S is 16eqmmol/100g of soil; consequently, the average V is 82%. Salt content is low (below 0,2%), with predominance of Ca and Mg bicarbonates.

Alluvial soil can be found in the middle part of the valley that stretches to 100 m above sea level and are present downstream of Vardar. They are formed with deposition of fine material brought from rivers from the higher areas in the plains. They are water permeable, i.e. have a good capacity for the water permeability.

Colluvial (diluvial) soils are intensively used in the agriculture. They have very heterogeneous texture. On average, these soils contain: 10% coarse fragments, 10% clay, 20% silt and thus sand dominates (70%). The average value for porosity is 44%, for water capacity 34%, for air capacity 10%, for wilting point 11% and for available water 23%.

They are also heterogeneous in their chemical properties. Lithosols contain on average 2% humus. The reaction of the surface soils in this group is as follows: neutral (44,7%), acid (42,7%), with a small number alkaline (12.6%). Dystric colluvial soils have a low cation exchange capacity (less clay, with more illite and kaolinite), which is on average 17eqmmol in 100g of soil, and the base saturation is 78%.

Diluvial soils are formed with erosion and transportation of mother rocks and soils from the higher (mountain and hilly) terrains with heavy water flow and surface water and the recent accumulation of eroded material in the bases of these fields.

Diluvial soil can become another kind of soil as a result of the impact of shallow groundwater or the influence of pedogenetic processes over the long term. They show great heterogeneity in horizontal and vertical direction. Diluvial soils compared with alluvial soils that are contiguous, are characterized by significantly lower productivity. They are poorly sorted, no flat terrain, poorly provided with water, have a worse chemical properties and contain fewer nutrients.

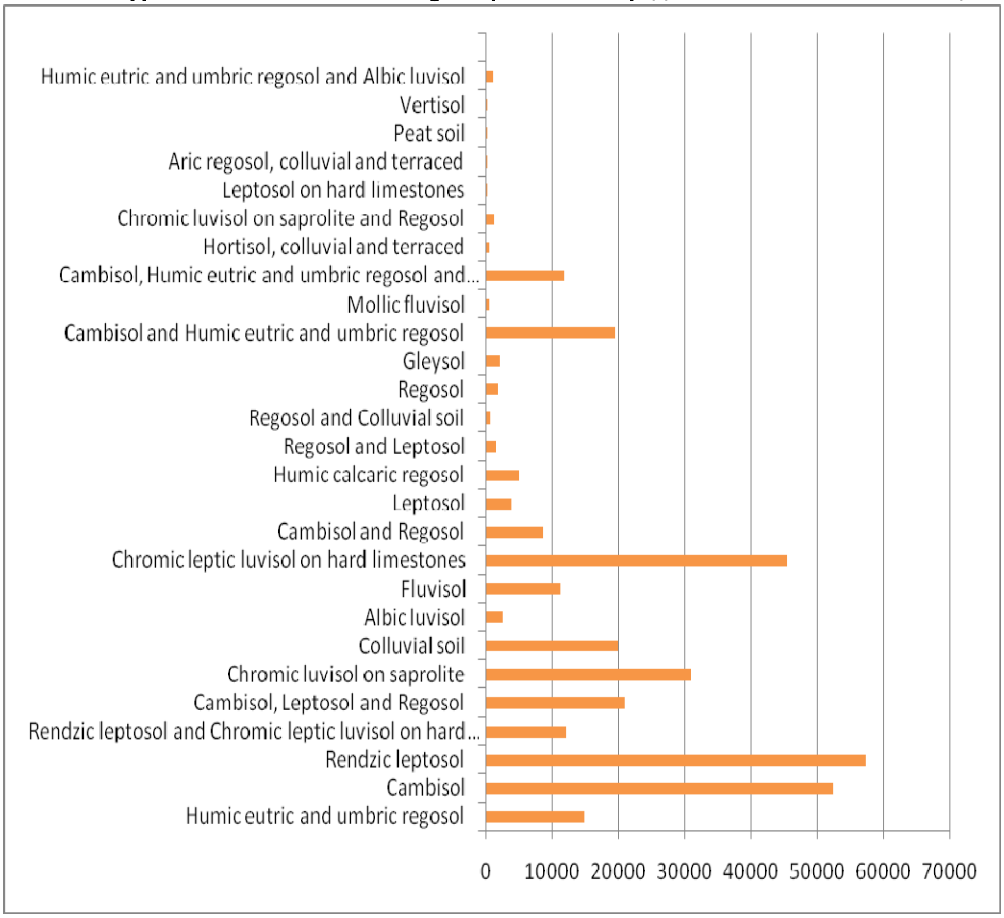
Agrogene soils are distributed in the agricultural area. It is those types of soils that are formed under the influence of man and serve for agricultural production.

Aric regosols are soil that is formed by human intervention in grape seedlings (vinesols) and orchards.

Hortizoles are anthropogenic soil type used in floriculture and gardening created from various soils.

Rizosols are anthropogenic hipidromorphic soils. Rizosols are formed by colluvial and alluvial soils with prevalence of alluvial soils. They are found in the river valleys i.e. in the flat-bottomed valleys.

Table 2-1: Soil types in the Southwest region (source: http://www.maksoil.ukim.mk/masis/)



2.5 Hydrogeological features

In Southwest region, from hydrogeological point of view, there are terrains with different water permeability. According the geological structure, there are types of wells with free level formed in the environment with inter-grain porosity, i.e. in Quaternary and Pliocene sediments. In the Eocene sediments, materials are hydrogeological complexes with individual layers with a collector and isolation hydrogeological function.

In depth, these rock masses are more compact and have function of hydrogeological collector, and in depth are hydrogeological isolators. As relatively waterless areas, the investigated terrain includes tightly bound semi - petrified rock masses represented by Eocene sediments. Within the allocated types of wells, in terms of the groundwater regime (feeding, movement of groundwater, discharge and groundwater level), it can be concluded that, based on the geological structure of the field, a major factor for the formation of wells are persistent and occasional river flows and streams and atmospheric precipitation (rain, snow), which represent the main source of wells nourishment.

In the group of hydrogeological collectors are included proluvial - alluvial formations. Characteristic for them is typical super - capillary porosity. Proluvial sediments, depending of percentage of clay, could be relatively hydrogeological collectors.

In the group of hydrogeological insulators are classified gneisses (Gm) and micaschists (Smg), characterized by tight cracks and almost always are filled with dusty sandy clay.

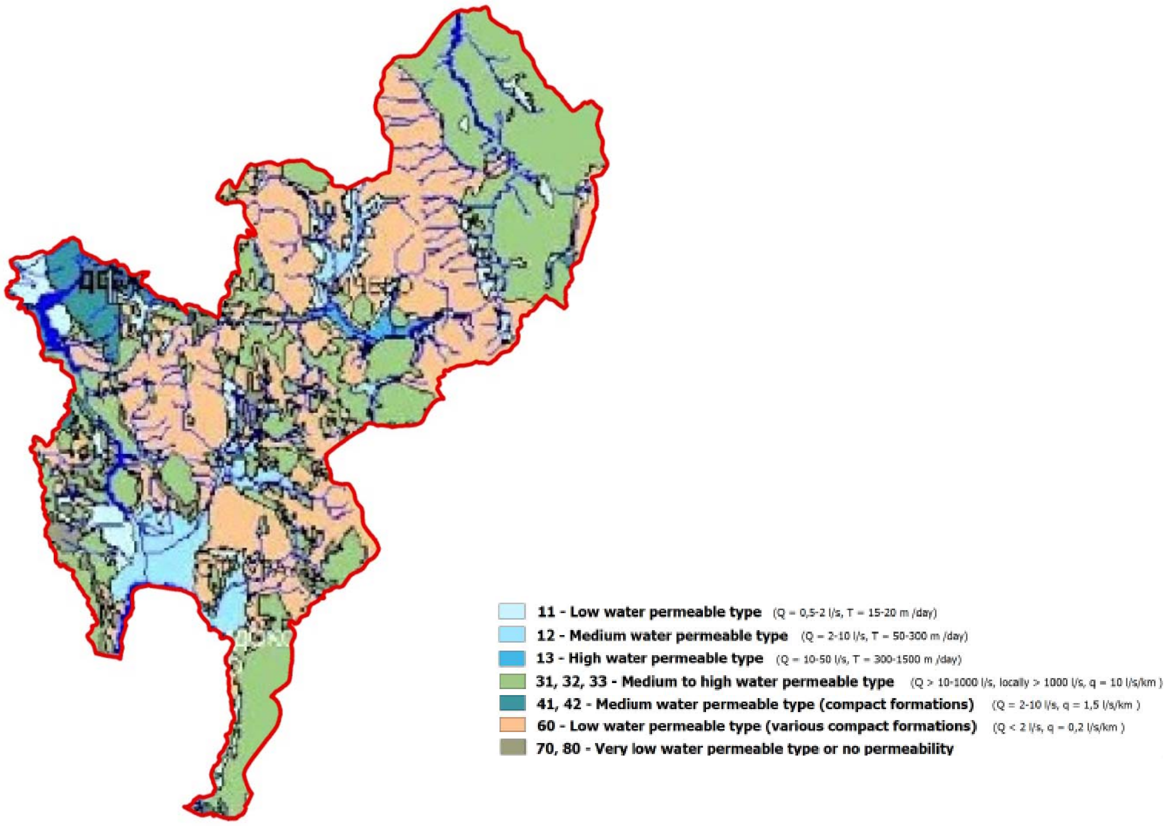
Eocene sediments, flysch series, represent hydrogeological complexes. Vertically changed hydrogeological isolators represented by marls and slates and relatively hydrogeological collectors - sandstones. Generally, they are waterless terrains.

The main hydrological occurrence of this area is the river Vardar and its tributaries. In the dry year period, it is possible their waterways to reduce the flow of water, but not to dried.

This shows that, along the flow of the river Vardar and its tributaries on the terrain, there are characteristic geological pre-conditions for formation of well zone. Namely, it is expected that the well zone is formed in very wide belt along the flow of the river Vardar. In that part, it is of boundary type, with free level, which is in hydraulic connection with the level of the water in the rivers.

According hydrogeological function, represented rock masses (soil materials) represent the most typical hydrogeological complexes and hydrogeological insulators and less to hydrogeological collectors. As hydrogeological collectors appear sandy - gravel sediments. Because of the large presence of hydrogeological complexes and hydrogeological insulators, along the trace, atmospheric precipitations practically, are not infiltrated in the ground, but part of them evaporate, and other part, through the dry ravines, is infiltrated in the river flows, and certain amounts of surface water with the influence of groundwater, formed wet zones, i.e. zones of occasionally flooding of the terrain, as modern geological phenomena and processes that need to undertake appropriate measures for drainage of groundwater.

Figure 2-8: Hydrogeological characteristics and water permeability types (source: MOEPP)



According to hydrogeological function, the present rock masses (soil materials) represent the most typical hydrogeological complexes composed mostly of hydrogeological insulators. Sandy - gravel sediments appear as only hydrogeological collectors. Because of the large presence of hydrogeological complexes (mostly hydrogeological insulators), along the trace, atmospheric precipitations practically, are not infiltrated in the ground. Part of them evaporates, and other part, through the dry ravines, is infiltrated in the river flows. Certain amounts of surface water with the influence of groundwater, form wet zones, i.e. zones of occasional flooding, as modern geological phenomena that require appropriate drainage measure. According the structure type of porosity of the rocks that appear, four types of wells are separated:

- Boundary spring;
- Fissure type of wells;
- Karst type of wells;
- Terrains with low yield and waterless terrains.

Boundary springs–are type of wells formed in the rock masses with capillary porosity. Water masses of these wells is compressed, because the pores are directly next to each other and multiply connected. Boundary springs are formed in: diluvial, proluvial, alluvial and lake sediments and river teraces.

Fissure type of wells - are formed within masses with fissure porosity. Water is spread along the cracks as a set of "water veins", which are connected only where cracks crosses. Among the water veins there are waterproof rock masses, i.e. monolites. Fissure types of wells from the catchment area of the Crna river are formed in clastic, igneous and metamorphic rocks with Paleozoic and Mesozoic age.

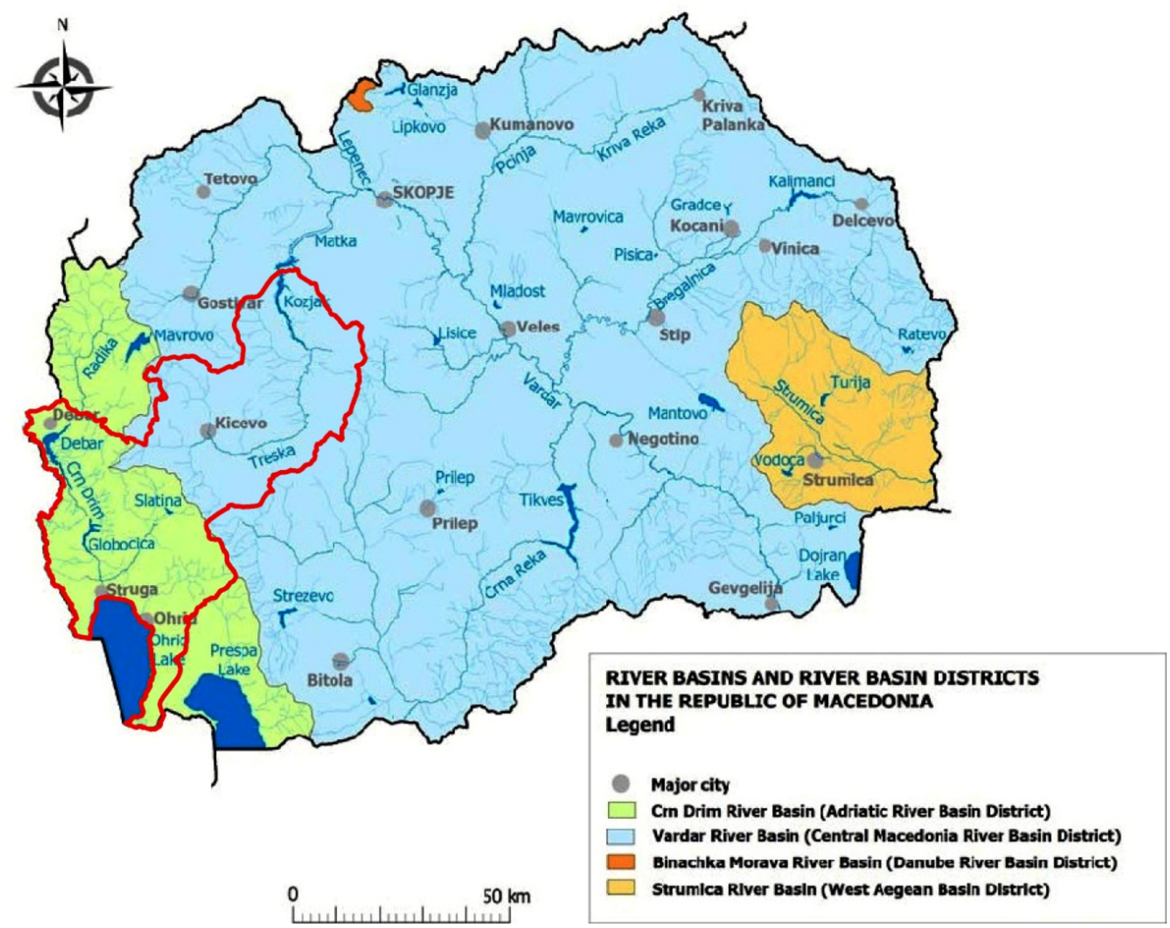
Karst type of wells - are formed in carbonate rocks and layers. This specific type of wells occurs in terrains with karst porosity (channels and caverns). They can have free level and level under the pressure. Large dimensions of the karst pores, their connection and high level of water permeability make possible fast wells charging and discharge. Karst types of wells are feed directly with infiltration of atmospheric and surface waters along the channels and pores. Karst types of wells have large fluctuation of the groundwater level and large velocity, therefore they can be easily polluted and their natural purification is difficult.

Waterless terrains are presented with Jurassic, Cretaceous and Eocene flysch. Flysch sediments (which, in term of hydrogeology, are waterproof) present waterless terrain, with rare occurrences of fissure springs which are characterized with small yield (0.10 l/s).

2.6 Hydrology

Hydrographic network in the Southwest region belongs to two basins: Vardar and basin of Ohrid Lake (basin of Crni Drim).

Figure 2-9: River basins in the Republic of Macedonia



Vardar basin

The main river which flows in Southwest region in Vardar basin is the river Treska. The basin of the river Treska in the Southwest region is 1610 km^2 to accumulation Kozjak.

Larger tributaries of the river Treska which are in the Southwest region are:

- River Zajaska
- River Mala

Basins of these rivers are full in Southwest region.

Basin of Ohrid Lake (basin of Crni Drim)

Basin of the Ohrid Lake belongs to the basin of the river Crni Drim. From the Ohrid Lake rises Crni Drim and inflows in the Adriatic Sea.

Larger rivers that inflow in Ohrid Lake are the rivers Sateska and Koselska. On the river Crni Drim there are built two large hydro-energetic accumulations Globocica and Shpilje. The river Radika inflows in Crni Drim near the accumulation Shpilje.

Some of the rivers in Southwest region

Crn Drim rises in Ohrid Lake on 695 m a.s.l. and exits the country near the town Debar on 467 m a.s.l. On the territory of the country, Crn Drm is 56 km long. But the river is as usual only less than half of that length, from Struga up to the village Tashmarunishta. Leaving the village on north, river enters the gorge and immediately thereafter formed lake thanks to 82 meters high dam located 10 km to the north on the other side of the lake. The dam forms the accumulation "Globochica" created by the waters of the Crn Drim. After the hydro - electric plant Globochica, water of Crn Drim creates another lake with help of the dam high 102 m near the town Debar. This lake is the richest water lake in the Republic of Macedonia. Lake accumulates 520 million cubic meters of water.

The catchment area of the river Crn Drim is 4340 km^2, length is 125 km and average decline of 23.7 ‰.

River Mala is the largest tributary of the river Radika. It is formed on 966 m from the waters of the rivers Garska and Tresonechka. River Mala is the name of the all rivers from the area of mountains Bistra and Stogovo. It rises on mountain Bistra on height of 1728 m. its catchment area is 184 km^2, the length is 23,4 and average decline is 29,1 ‰.

Sateska River rises in the mountaineous part of the area Debarca. Flowing through the valley Debarca collects water from several tributaries: Slatina, Mramorechka river, etc., and then passing through a ravine Botunska entering the Struga field, where flowing until its confluence in the Crn Drim or Lake Ohrid. River Sateska naturally flows into the Crn Drim, between the villages Draslajca, Moroista and Vranishta and artificially through the channel since the late XX century flows in the Ohrid Lake. Sateska River belongs to the Adriatic basin. Near the village Pesocani, on Sateska River was built dam with a small hydroelectric plant. In most of the water from the river is used for irrigation of agricultural lands of the villages in the east end of the Ohrid-Struga valley.

The catchment area of the river Sateska 432 km^2,has a length of 41,4 km and average decline of 19,6 ‰.

Koselska River rises on the western slopes of Plakenska Mountain on height of 1070 m and inflows in Ohrid Lake on 693 m a.s.l. near Ohrid.

The catchment area of the river Koselska is 214 km^2,has a length of 32,3 km and average decline of 17,9 ‰.

Figure 2-10: Springs of Crn Drim near St. Naum

Figure 2-11:River Mala

Table 2-2: Catchment area, length, average decline and reforestation of rivers

River	Catchment area (km^2)	Length (km)	Average decline	Reforestation (%)
Vardarski Sliv				
Zajaska River	318	26,8	16,2 ‰	70
Mala River	184	23,4	29,1 ‰	70
Treska River-Zdunje	1610	106	24,2 ‰	-
Sliv na Crn Drim				
Sateska River	432	41,4	19,6 ‰	60
Koselska River	214	32,3	17,9 ‰	60
Radika River	876	67	27,3 ‰	60
Crn Drim River	4340	125	23,7 ‰	-

Table 2-3: Average flows on the water meter profiles

River	Profile	Basin (km^2)	Characteristic average flows (m^3/s)		
			Q_{sr}	Q_{max}	Q_{min}
Crn Drim River	Lazani	2780	24,7	173	3.4
Sateska River	Botun	432	6,35	44,7	0,02

Legend: Qsr - average annual flow; Qmin - absolute minimal flow; Qmax - absolute maximal flow

Table 2-4:Review of minimal, average monthly and maximal flows of water for the period 1961 - 2005 of the river Treska with basin of 1610 km^2, hydrological station Zdunje, 393.61 m asl.

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Qann (m^3/s)
Q_{min}	5,45	6,50	7,67	7,38	8,25	3,78	3,41	2,34	2,34	2,61	1,80	3,96	1,80
Q_{sr}	20,3	25,6	30,6	36,5	33,9	18,4	9,0	5,7	6,1	7,9	14,8	19,6	19,0
Q_{max}	218	197	173	94	187	71	37	19	52	100	334	152	334

Table 2-5:Review of minimal, average monthly and maximal flows of water for the period 1961 - 2005 of the river Sateska with basin of 368 km^2, hydrological station Botun, 743.18 m asl.

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Qann (m^3/s)
Q_{min}	1,21	1,85	2,94	4,46	3,38	1,66	0,02	0,84	0,78	1,23	1,83	1,11	0,02
Q_{sr}	7,20	8,93	10,82	13,32	10,75	4,59	2,21	1,64	1,96	2,74	5,25	6,75	6,35
Q_{max}	44,70	44,50	31,30	30,30	29,50	12,10	5,17	3,09	4,39	6,07	24,50	20,90	44,70

Table 2-6:Review of minimal, average monthly and maximal flows of water for the period 1961 - 2005 of the river Crn Drim with basin of 2780 km^2, hydrological station Lazani, 693.17 m asl.

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Qann (m^3/s)
Q_{min}	10,0	11,8	12,1	11,0	11,2	13,6	11,0	10,2	8,1	6,9	3,4	8,7	3,4
Q_{sr}	24,6	26,1	28,3	31,6	33,1	26,8	21,3	19,8	19,6	19,9	22,3	22,8	24,7
Q_{max}	78,1	73,7	84,0	87,6	68,7	52,0	46,0	37,0	116,4	46,8	173,0	53,3	173,0

2.7 Land Use

Land cover and land usage in the Southwest region are presented according to CORINE Land COVER for period 2006 – 2012 period. According to CORINE methodology, geophysical cover of the Earth's surface is approached from two different angles:

- Land cover, which essentially concerns the nature of features (forests, crops, water bodies, bare rocks, etc.).
- Land usage, which is concerned with the socio-economic function (agriculture, habitat, environmental protection) of basic surfaces.

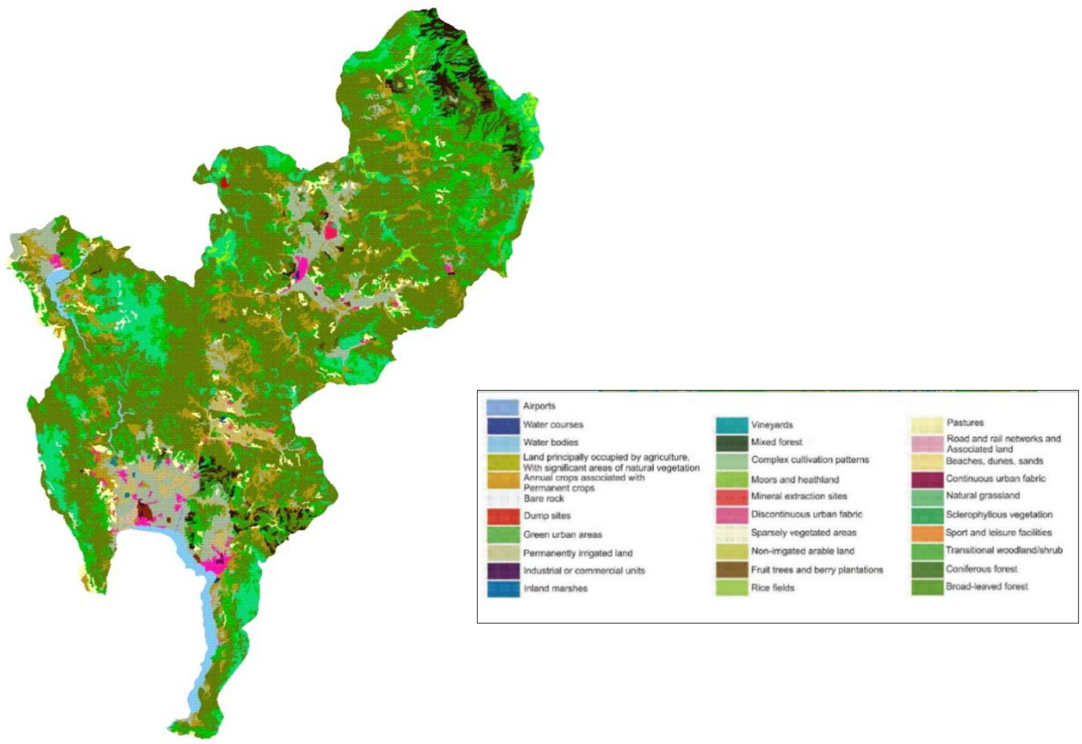
According to this nomenclature, in Southwest region, 189438 km^2 of the total surface is forest areas. The category agricultural areas take up 136574 km^2 of the total area. The rest of the surface is covered with semi natural or artificial areas. According to CORINE Land COVER, major changes between 2006 and 2012 can be noted in artificial areas and forests and semi-natural areas, accompanied by decreased agricultural areas and water areas.

The statistical data on agricultural area in the Republic of Macedonia, by regions, show that in 2014 the largest part of agricultural area was concentrated in the Pelagonija Region, covering 20,8% of the total area. The same year, the lowest production of wheat, 15021t, was registered in the Southwest Region.

Land usage indicator shows the basic land structure, i.e. how much of the land is used as agricultural land and how large is the area under forest or used for other purpose. According to the CORINE methodology, agricultural land usage includes cultivated land and pastures. Cultivated land is additionally classified as arable land and gardens, orchards, vineyards and meadows.

Numerical data for agricultural land usage and production rates (crops, fruits, grapes) as much as data about forests by species, ownership and usage are compiled from latest statistical reports available (www.stat.gov.mk) and include the year 2014 if not otherwise indicated. It must be noted that analysis of last three consecutive years (2012, 2013 and 2014) indicates stability, as no significant differences from year to year occurred.

Figure 2-12: Land cover in Southwest region (CORINE)

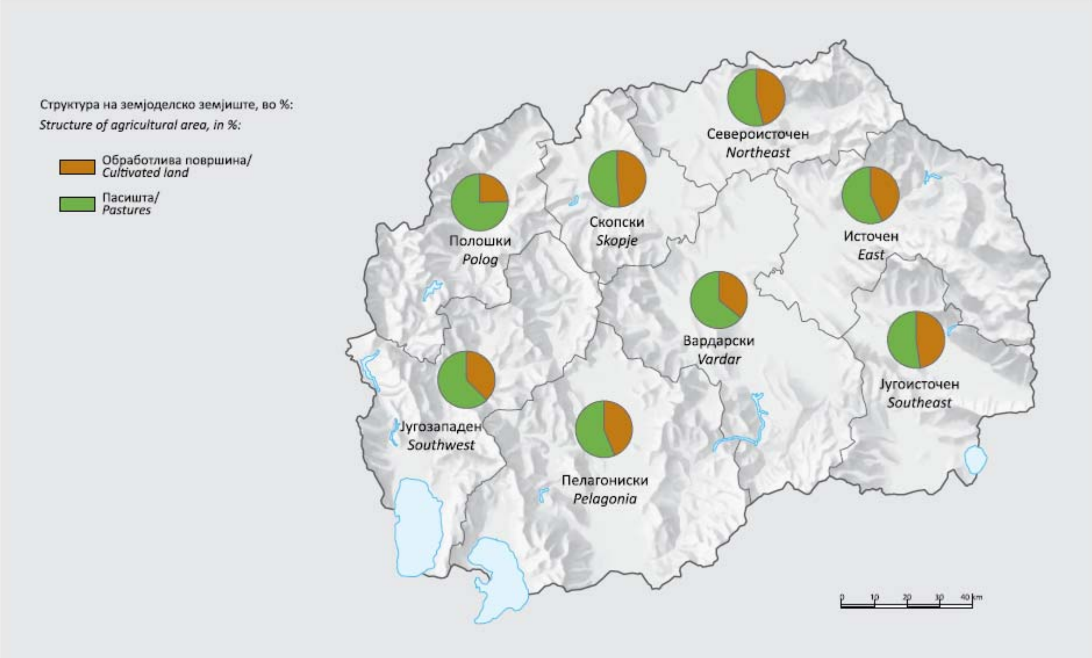


Numerical data about Southwest region land usage are given in the tables bellow:

Table 2-7: Land surface by category of use as per 2014 (source: www.stat.gov.mk)

Land usage in hectares (ha)	Republic of Macedonia	Southwest Region
Agricultural area	1267869	136574
Cultivated land – total	510407	50012
Arable land and gardens	414075	39795
Orchards	14622	2175
Vineyards	21269	618
Meadows	60441	7424
Pastures	756558	86557

Figure 2-13: Structure of agricultural area in Southwest region as per 2014 (source: www.stat.gov.mk)



The Agricultural land includes areas used for the production: arable land and pastures.

The data for the area of agricultural land in the period encompassed 2014 of substantial evidence indicates stability, without significant differences from year to year. Pasture land is used for pasturing. They make up the majority of the Agricultural land and covered mountainous and lowland pastures. The total area under forests is 189438 ha.

Table 2-8: Production of some crops as per 2014 (source: www.stat.gov.mk)

Crops in tons	Republic of Macedonia	Southwest Region
Wheat	287954	15021
Maize	136930	12512
Tobacco	27578	117
Potatoes	198943	18409
Onions	59974	411
Tomatoes	160530	637
Peppers	175867	735
Cucumbers	48334	57
Clover	17203	1114
Alfalfa	130768	7036

Table 2-9: Production of fruits as per 2014 (source: www.stat.gov.mk)

Fruits in tons	Republic of Macedonia	Southwest Region
Cherries	6324	1492
Sour cherries	8042	957
Apricots	4619	132
Apples	95684	15615
Pears	6195	683
Plums	33101	5312
Peaches	11558	535
Walnuts	4649	589
Almonds	520	0

Table 2-10: Production of grape wines, production of grapes as per 2014 (source: www.stat.gov.mk)

	Republic of Macedonia	Southwest Region
Harvested area (ha)	22726	600
Total number of vines	85986	1685
Number of bearing vines	84481	1685
Production (t)	195888	1950

Figure 2-14: Areas with vineyards as per 2014 (source: www.stat.gov.mk)

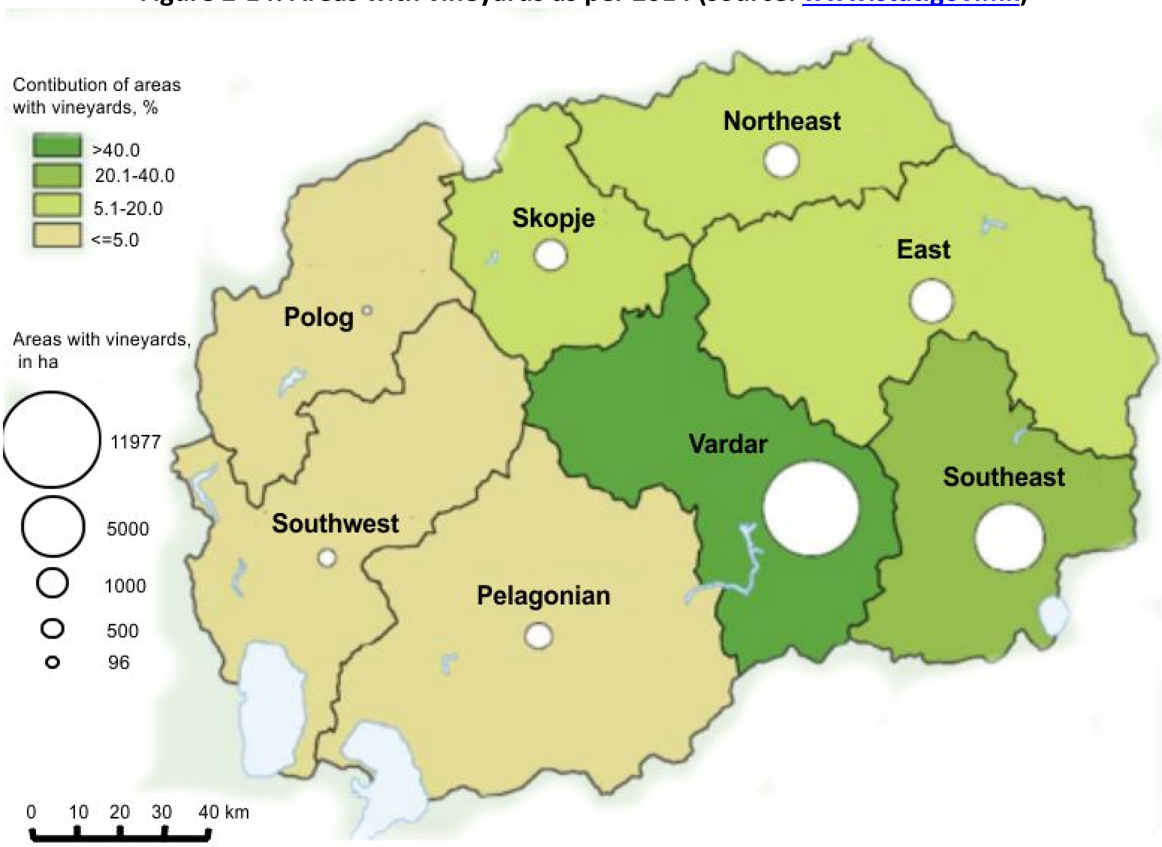


Figure 2-15: Forest area as per 2014 (source: www.state.gov.mk)

Table 2-11: Forests by species as per 2014 (source: www.state.gov.mk)

	Republic of Macedonia	Southwest region
Total forest area	983388	189438
Broad-leaved species	600847	126346
Beech	232243	52171
Oaks (all)	308058	69067
Chestnuts	2754	647
Other hard broad-leaved species	54502	4400
Other soft broad-leaved species	3290	61
Coniferous species	68670	10557
Spruce	1152	139
Fir	5847	2356
Black pine	45360	6306
Scots pine	8459	440
Macedonian pine	4270	-
Other conifers	3582	1316
Mixed forests	270525	36924
Degraded forests	43346	15611

Table 2-12: Afforestation in and outside forests in 2014 (source: www.stat.gov.mk)

	Total	Afforestation in forest (ha)		Afforestation outside forest (ha)		
		Cleared areas	Bare land	Rocky and bare land	Eroded land	Agricultural and other types of land
Republic of Macedonia	1 064	446	166	180	172	100
Southwest Region	61	19	39	3	-	-

Table 2-13: Afforestation by species in 2014 (source: www.stat.gov.mk)

Hectares (ha)	Republic of Macedonia	Southwest Region
Total	1064	61
Coniferous	721	60
Spruce	20	3
Fir	154	3
Black pine	324	39
Scots pine	92	6
Other coniferous species	131	9
Broad-leaved	343	1
Beech	31	-
Oaks, all species	269	-
Acacia	19	1
Other hard wood	1	-
Other soft wood	23	-

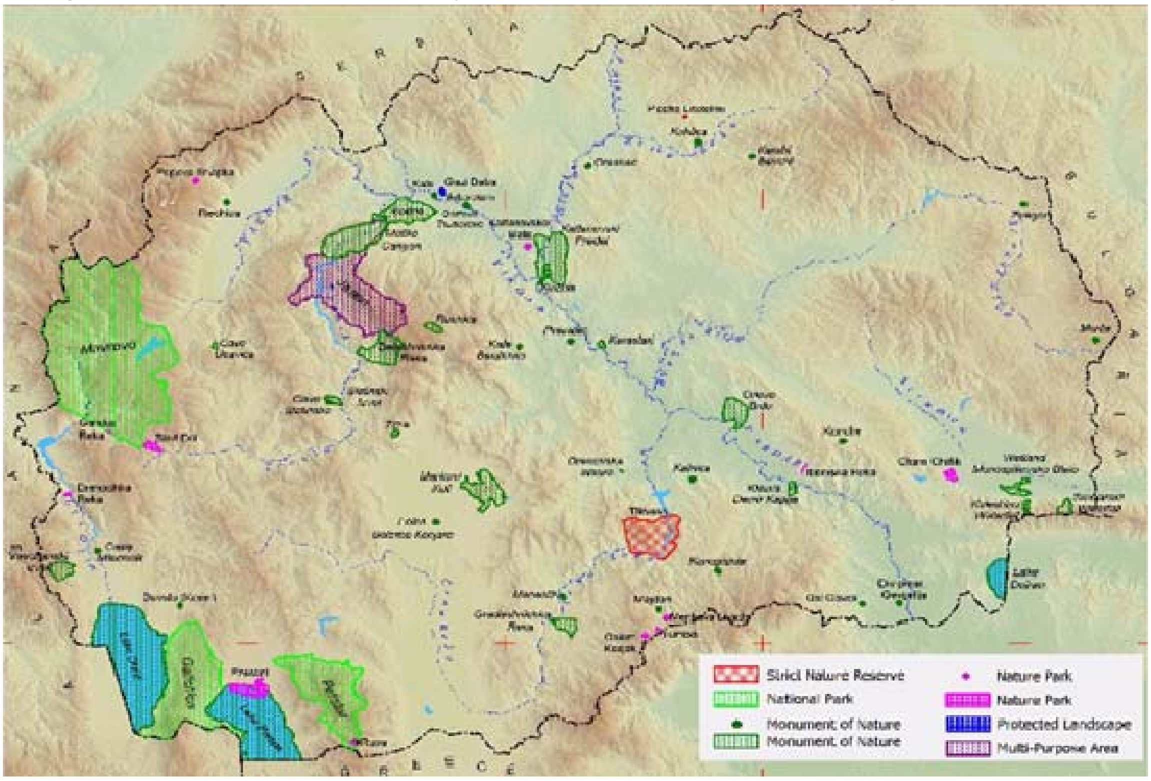
2.8 Protected Areas

Under the 2004 Law on Nature Protection, new categorization of designated area is introduced, aligned with the International Union for Conservation of Nature (IUCN), enabling inclusion of the national designated areas in the world network of designated areas. The Law stipulates a responsibility that, within 6 years, all designated areas (nominated before 2004) to be re-evaluated and designated accordance with the new categorization. Because of the current transitional period, the network of designated areas (areas designated according to the new categorization redesignated areas) the analysis (regarding the number and area they occupy) includes all designated areas in the Republic of Macedonia, designated under the old and also the new categorization. In doing so, the areas designated in accordance with the old categorization have been processed according to the appropriate/corresponding IUCN category. The analysis of the area of the designated areas has been made by rendering the borders of the areas in GIS (according to the data from the acts of designation or redesignation of areas, the Spatial Plan of the Republic of Macedonia, and where precise data in the Spatial Plan were missing, the area of the designated areas was rendered in accordance with the experts opinion)[1].

In the analyzed period, the area of designated areas has grown, i.e. the share of designated areas in the overall area of the Republic of Macedonia in 1990 was 7,14% and in 2015 it grew to 8,94%. Also, the number of designated areas recorded increase from 67 in 1990 to 86 areas in 2015, most of which – 67 areas – belong to natural monuments, followed by nature park with 12 areas. Thus, currently the designated area network comprises 86 areas, with total area of 229900ha or 8,94% of the territory of the country. Most of it falls into the category national parks with around 4,47 %, then natural monuments with 3,07 % and the multipurpose area Jasen with 0,97 % of the national territory.

[1] *The analysis of the number and area of designated areas, i.e. the rendering of the borders in GIS has been done during 2010-2011, within the UNDP and GEF project „Strenghtening the environmental, institutional and financial sustainability of the system of designated areas in the Republic of Macedonia “.*

Figure 2-16: Protected areas in Republic of Macedonia under the categorization of IUCN



The establishment of the National Emerald Network consists of 4 phase process which was implemented in the Republic of Macedonia from 2002 to 2008 to identify the areas of special conservation interest (ASCI) and finally establish the Emerald Network. This network is established on the territory of the countries Parties to the Bern Convention and important part in the preparation of candidate countries for EU membership for the implementation of the EU Birds and/or Habitats Directives, or an additional tool in the process of establishing the coherent European Environmental Network Natura 2000.

The locations that have been identified in the National Emerald network are 35. Under the first project, implemented in 2002-2003, three areas have been identified: SNR Ezerani, NP Galicica and SR Dojran Lake, with a total area of 27660 ha (3,6%). In 2004 a second project was implemented, identifying another three areas: SNR Tikves, NP Pelister, SR Demir Kapija, with a total area of 28000 ha (3,8%). Under the third project implemented in 2005-2006, ten areas with a total area of 144,783 ha (19,1%) were identified, while with the fourth project (implemented in 2008), another 19 areas were identified with a total area of 556447 ha (73,5%). The National Emerald Network of the Republic of Macedonia identifies 35 areas covering an area of 752,223 ha or around 29 % of its territory.

Figure 2-17. Map of the Emerald Network of Areas Special Conservation Interest in Republic of Macedonia (source: MOEPP)

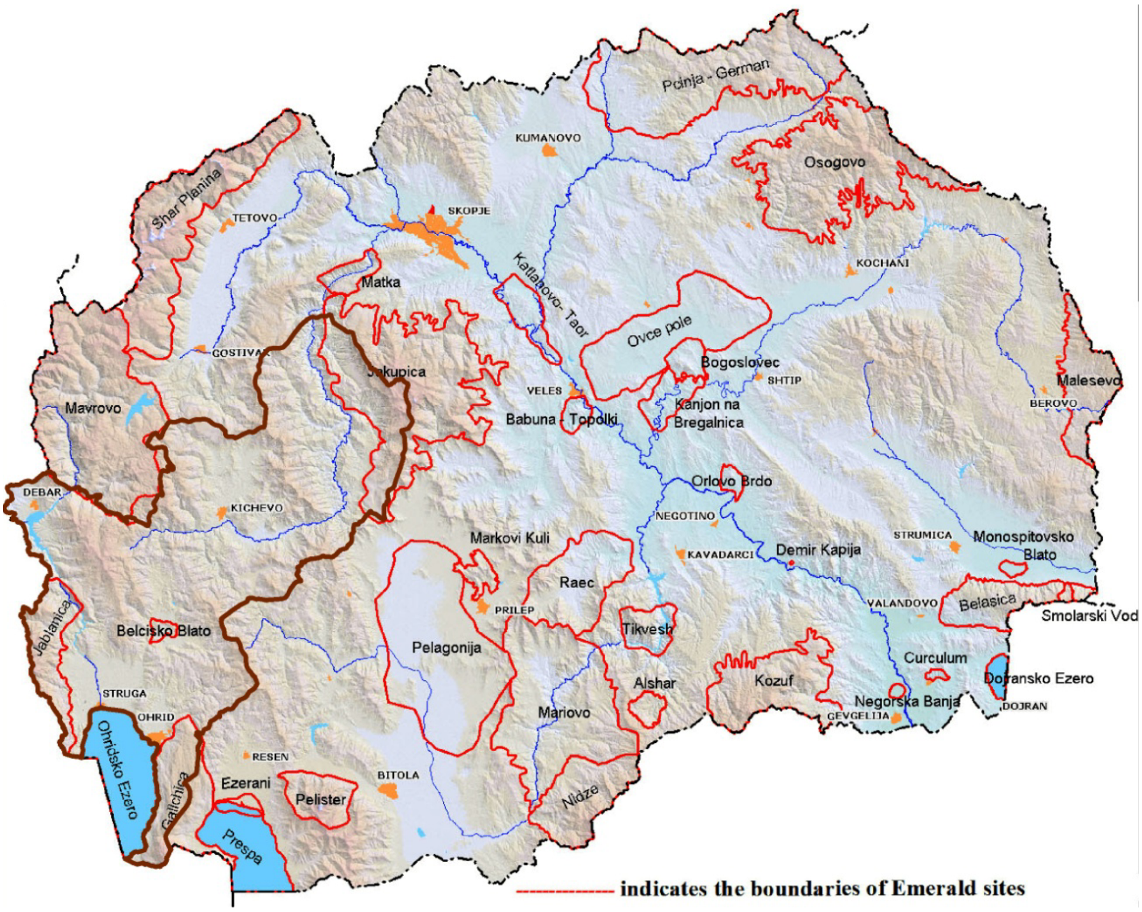


Table 2-14: Protected areas in Southwest Region

Protected area	
MK02 Galichica	**National Park**
MK03 Slatinski Izvor	**Natural Monument**
MK03 Vevchanski izvori	
MK98 Mavrovo	**Designated area not yet reviewed**
MK98 Ohridsko Ezero	
MK98 Drenachka Reka	
MK98 Suvi Dol	
MK98 Gorna Slatinska Peshtera	
MK98 Peshtera Mlechnik	
MK98 Beleshnicka Reka	
MK98 Zrze	
MK98 Duvalo (Kosel)	
MK98 Platan s. Kalishte, Struga	
MK98 Platan-chinar, Ohrid	

Protected area	
MK98 Platanovi Stebla, Ohrid	
MK98 Peshtera Ubavica	
MK0000014 Belchishko Blato	**Emerald sites**
MK0000020 Jablanica	
MK0000001 Galichica	
MK0000024 Ohridsko Ezero	
MK0000007 Mavrovo	
MK0000017 Jakupica	

2.9 Transportation infrastructure

ROAD NETWORK

The Republic of Macedonia has a well-developed road network of 14,199[2] km that includes motorways, national roads, regional and local roads. According to the Public Enterprise for State Roads, the main two Pan-European corridors that intersect the country are Corridor VIII (east-west) and Corridor X (north-south).

The regional roads provide access to the main road transport corridors and the national roads network and, together with the local roads, are greatly important for the local economy development, attracting of new investments, small businesses and agricultural activities throughout the country. According to the current legislation, the Public Enterprise for State Roads is the authority responsible for managing, construction, reconstruction, maintenance and protection of the state roads in the Republic of Macedonia.[3]

Road network of the Republic of Macedonia consists of motorways, national, regional and local roads, as shown in the figure below.

[2] State Statistical Office of the Republic of Macedonia, Transport and other services, 2014
[3] Public Enterprise for State Roads http://roads.org.mk/255/road-network

Figure 2-18: Road network of the Republic of Macedonia

(Source: Public Enterprise for State Roads)

Figure 2-19: National roads map (source: Nations Online Project)

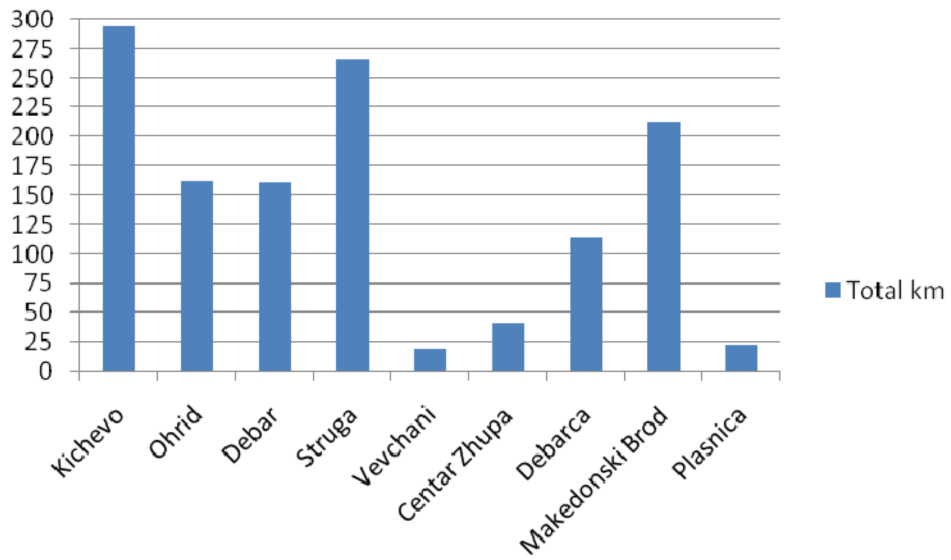
According to the Development Programme of Southwest region (2010-2015), the region is relatively well covered by national, regional and local roads. The road network is relatively well developed in terms of the length of local roads. Main roads, linking this region with other regions are the state road A2 Skopje Gostivar - Kicevo - Struga - Albania border and the state road A3, connected to A2 - Ohrid - Resen. Regarding the quality of the road network in the region, the Development programme states that extremely poor conditions are prevailing, especially for the road A2.
Several sections of the main roads in the Southwest Region were built up to 30 and 40 years ago and they are in extremely poor condition and inadequately maintained and reconstructed in time. Such are the sections Straza - Kicevo - Podmolje (M-4), Ohrid - beech (M-5) and Gradsko - Prilep; Bitola - Resen - Ohrid (R-106 M-5).[4]

The length of the local road network in the Southwest region is 1363 km of the roads in the Republic of Macedonia.

Table 2-15: Roads by type within Skopje region as per 2014 (source: www.stat.gov.mk)

Roads	Republic of Macedonia	Southwest Region
Highway	259	no data
Local, km	9513	1296
Trunk, km	908	no data
Regional, km	3771	no data
Railways, km	682	no data

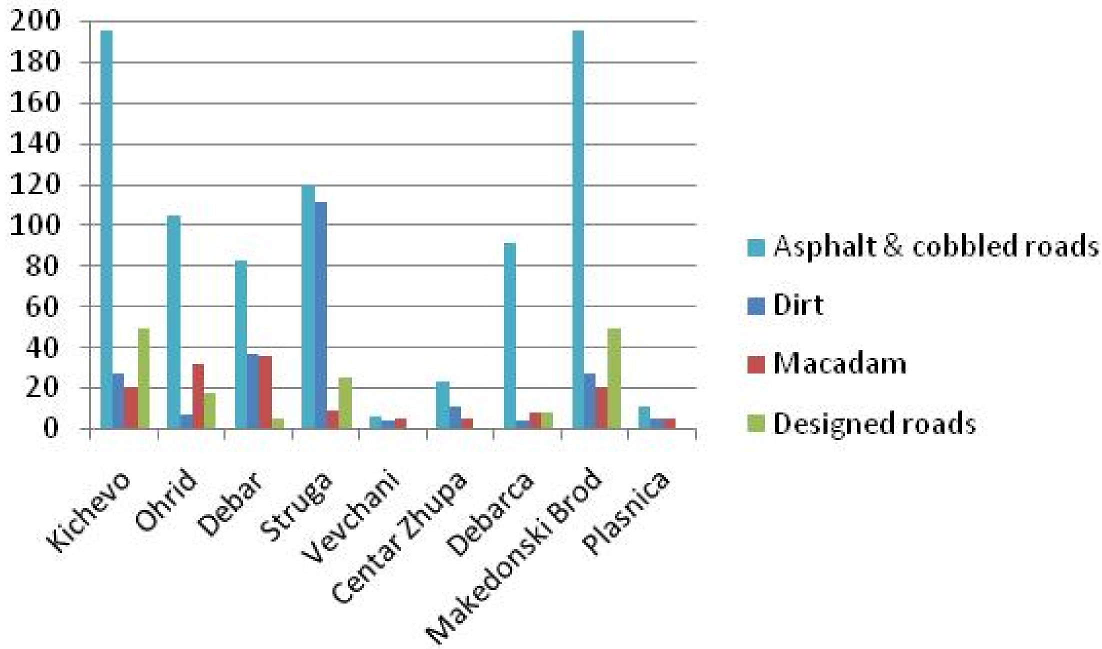
Figure 2-20: Local road network by municipality, km (2014)



Source: State Statistical Office, Transport and other Services, 2014 (situation 31.12.2014)

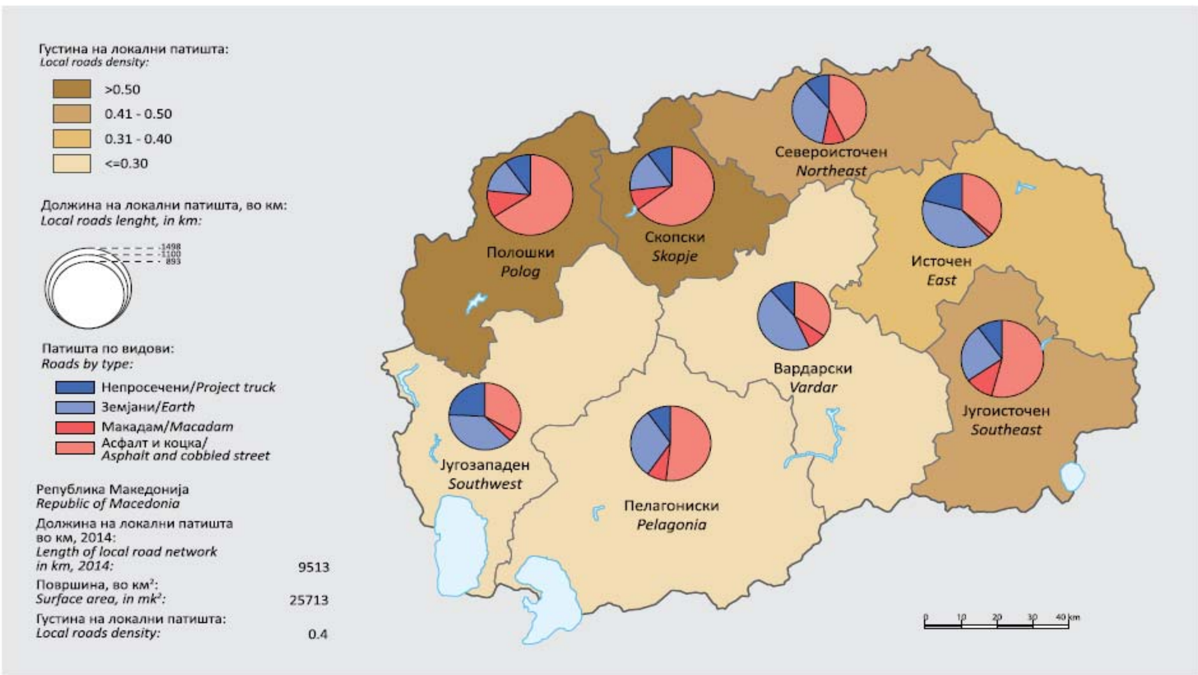
[4] Strategy For Regional Development Of The Republic Of Macedonia 2009-2019

Figure 2-21: Local road network by municipality and category, km (2014)



Source: State Statistical Office, Transport and other Services, 2014 (situation 31.12.2014)

Figure 2-22: Local roads density as per 2014 (source: www.stat.gov.mk)

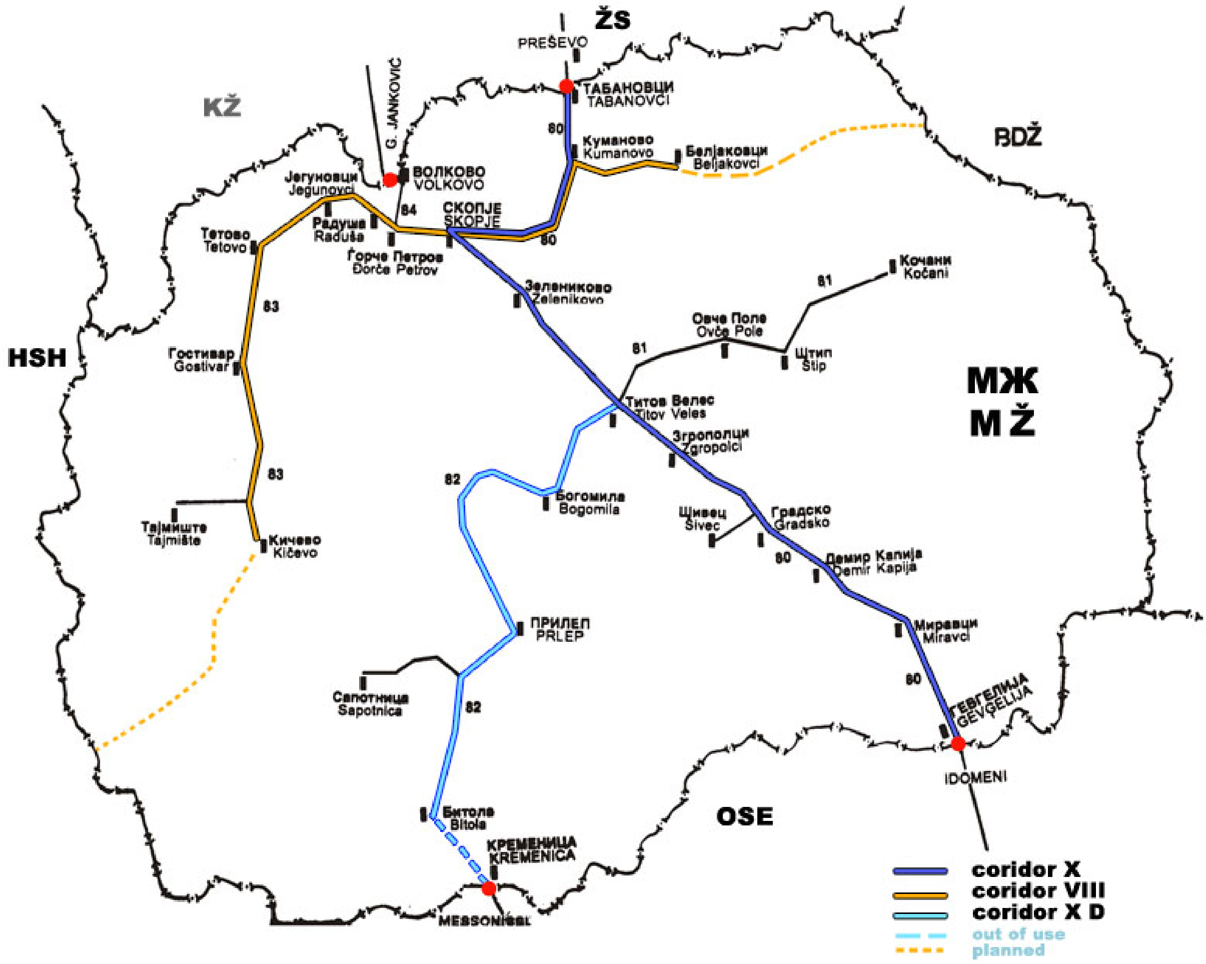


RAILWAY NETWORK

The development of the railway network in the country was assessed by the Strategy for Regional Development of the Republic of Macedonia 2009-2019 as insufficient. Services provided by Macedonian Railways are limited and regions not well served by this kind of transport. Existing railway infrastructure mainly located on Corridor 10. The service of the regions by rail transportation is uneven, ie Skopje, Vardar, Pelagonija, East and Polog region are better served by this kind of services, while many of the urban centers in other regions - Southwest (Ohrid, Struga, Debar), Northeast (Kriva Palanka) and part of the South (Radovis and Strumica) were not served by rail service.

The development of the railway network in the Southwest region can be assessed as low. Part of the Corridor 8 runs across the Region, which ends in Kichevo. The total length of the route of Corridor 8 in the country is approximately 309 km, of which 157 kilometers are designed or under construction.

Figure 2-23: Railway infrastructure in the Republic of Macedonia



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

WATER TRANSPORT

Water transport in the Southwest region regards lake transport performed on Lake Ohrid. According to the State Statistical Office, data sources for lake transport statistics are the regular annual surveys of business entities whose main activity according to the National Classification of Activities is lake transport. The transport of passengers mainly refers to the transport of tourists to particular tourist locations.

Table 2-16: Lake Transport

	2011	2012	2013	2014
Passenger vessels, number	2	3	4	4
Passenger seats	260	380	530	530
Passengers carried,	28440	17690	31660	36620

	2011	2012	2013	2014
number				
National Transport				35770
International Transport				850

Source: State Statistical Office, Transport and other Services, 2014

AIR TRANSPORT

Air traffic in the Southwest region is via the Airport - St. Paul the Apostle, located in the Debarca Municipality, 9 km from Ohrid. According to the State Statistical Office, data on air transport refer to the operations of the airports Alexander the Great and St. Paul the Apostle. Regular transport includes aircraft flights on regular lines. Charter transport covers flights that are performed outside of regularly scheduled services. In charter flights, the entire aircraft is rented for a particular line. The number of arrived and departed passengers and goods covers domestic and international transport. The number of passengers also includes children, although they don't use a seat in the aircraft.

Table 2-17: Air Transport

	2012	2013	2014
International companies			
International transport - total	668	854	576
International transport - regular	80	620	407
departed	40	310	205
arrived	40	310	202
International transport - charter	588	234	169
departed	294	117	84
arrived	294	117	85
Other operations	136	178	245
departed	68	89	122
arrived	68	89	123
Domestic companies			
Other operations	62	40	40
departed	31	20	20
arrived	31	20	20

2.10 Water supply network

In all urban centers in the region there is a system for urban water supply. Rural areas are supplied with drinking water from local water supplies or wells. In the municipality of Ohrid settlements which are supplied by water are Ohrid, settlements Orman, Raca, Stephen, Dolno Konjsko Lagadin, and tourist sites along the lake. In Debar, 80% of the population covered by water supply systems, mainly in urban

population. In the most rural areas, often there is a lack of water supply systems. Although urban population in the biggest municipalities are connected to the water supply system, it is important to mention that the systems are in pretty poor condition.
Almost all villages are facing the problem of shortage of drinking water that results the highest average consumption per capita and the state of supply systems water characterized by high water losses (average over 50%), primarily due to their age (mostly older than 15 years), insufficient volumes of tanks treatment plants and other facilities.

2.11 installations and facilities for waste handling

The waste management system is based mainly on waste collection and disposal. The waste collection, transportation and disposal service is provided by Public Utility Enterprises (PUEs). Waste disposal is provided by the PUEs at the regional municipal landfill sites. The sites are operated on a controlled basis, but they are not compliant with EU requirements. Furthermore, according to the field investigations, there are uncontrolled dumpsites, especially in rural areas not covered by the waste collection system.

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

Table 2-18: Companies with licenses for storage and transport of waste in Southwest Region

REGISTER OF LICENCES ISSUED FOR STORAGE AND TREATMENT OF WASTE (Metal, paper, plastic, wood, rubber, etc.).	
Southwest Region	
Municipality	**Collective scheme**
Kicevo	Emandra-S uvoz izvoz
Kicevo	Elez labi uvoz-izvoz v.Strelci - Oslomej
Ohrid	AKUMA TREJD uvoz-izvoz
Kicevo	I.B.F TREJD Eksport-import
Ohrid	OTPAD
Ohrid	K&D PALETI v.Leskoec
Ohrid	PETREP uvoz-izvoz
Struga	TEHNOMETAL S.R.L. uvoz-izvoz
Debarca	VIBEL EKSPORT v.Belcista
Kicevo	KRCO TREJD eksport-import
Struga	F.B. METAL GRUP 2012 v.Dolna Belica
Struga	SNA LAB v.Labuniste
Kicevo	LUDI LAS KOMPANI
Debar	RA MEDINA HM
	Total 14

2.12 Installations And Facilities For Wastewater Treatment

Public companies in the region are responsible for wastewater utilities, manage a total of 263,3 km collector drainage in the cities network mostly, located in the urban centers of the municipalities. The coverage of the population with sewage network in urban areas vary from 70% in Debar to 100% in Struga, while in rural areas, the coverage of the population with systems for wastewater services extremely low. In many rural settlements there are no sewage systems. In Ohrid is under construction a secondary sewage network with a length of about 108 km, including the Ohrid settlements D.Konjsko and Lagadin. The percentage of connectivity to users in the sewage system in Ohrid is 92%. Station for wastewater treatment for cities of Ohrid and Struga and other Settlements is located on the Ohrid coast about 4 km from Struga. The station provides mechanical and biological wastewater treatment. The capacity of the plant is about 120000 population equivalents, and purified water discharged in the Black Drin. In the town of Debar there is a system of drainage and wastewater treatment and it serves 70% urban population, while about 40% of the dwellings in the municipality are not connected. The degree of coverage of the population with wastewater treatment plants at the level of the Region is extremely high (43,8%) and is above the average in national level, which is 12,5%. It is certainly important in terms of protection of the lake and the rivers of the Adriatic Basin - Black Drin River to adopt wastewater treatment measures.

2.13 Hospitals and centres for public health

Health care is provided through an extensive network of health care organizations, on three levels: primary, secondary, and tertiary. Hospital health care is delivered by public hospitals, specialized hospitals, institutes, and specialized departments (clinics) in the Skopje Clinical Center, as well as by private hospitals[5].
Hospital care in the Southwest Region is organized through a network of general, specialized hospitals, health centers and institutes. The annual Report on DRG (Diagnosis Related Groups) provides a list of health institutes located in Southwest Region, their capacity and the utilization of beds for 2011, as presented in the following table:

Table 2-19: Health care institutes and Hospital beds utilisation in Southwest Region, 2011

Health Institution	Number of beds	Maximum number of bed / days	Utilization of hospital beds %
General Hospitals			
General Hospital Struga	84	30660	92,27
General Hospital Kichevo	78	28470	38,61
General Hospital Debar	90	32850	29,54
General Hospital Ohrid	226	82490	17,62
Special Hospitals			
Special Hospital For Orthopedics And Traumatology ST. Erasmus Ohrid	261	95265	22,24
Office For Prevention, Treatment And Rehabilitation Of Cardio. Ohrid Diseases	99	36135	11,37
Institute Of Nephrology In Struga	95	34675	9,27

* Psychiatric hospitals and private hospitals not included.
(Source: Annual Report on DRG, 2011[6])

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

2.14 Industrial sector

The main centers of industrial activities in Southwest Region are the Municipalities of Ohrid, Struga and Kichevo.

[5] The World Bank - IEG Public Sector Evaluation (2013). PROJECT PERFORMANCE ASSESSMENT REPORT - FORMER YUGOSLAV REPUBLIC OF MACEDONIA - HEALTH SECTOR MANAGEMENT PROJECT (P086670) [pdf]. http://goo.gl/bAfErH
[6] Annex of the Annual Report on DRG, 2011 "Usage of Hospital Capacities for cute patients" Health Insurance Fund of Republic of Macedonia

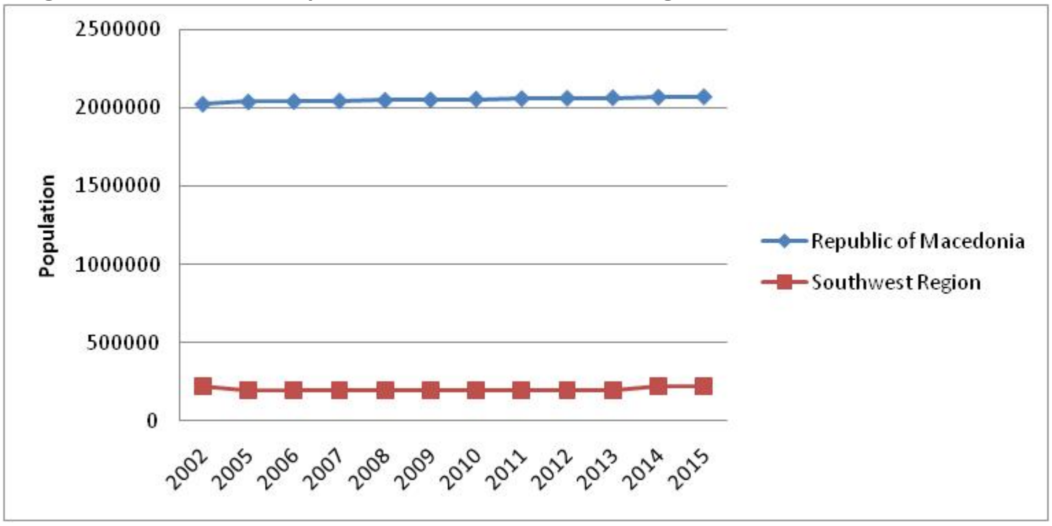
- **In the municipality of Ohrid** the highest percentage of active business entities (companies) in the region appears (2663 out of 70139 in the whole country). The main industrial sectors of activity are "wholesale and retail trade - repair of motor vehicles and motorcycles" and "manufacturing", followed by a relatively high percentage of the "construction" sector as well as the "transportation and storage" sector. Ohrid's Industrial zone is placed at the north part of the town and plenty of active business entities, especially from the wholesale and retail trade sector (textiles), are present. Regarding the mining and quarrying sector, there is no active business entities within the whole municipality.
- **Struga municipality** has a remarkable high percentage of active business entities (companies) in the country (2073 out of 70139 in the whole country). The most important industrial activity in the area belongs to "wholesale and retail trade - repair of motor vehicles and motorcycles", followed by a relatively high percentage of the "construction", the "manufacturing" as well as the "transportation and storage" sector. Regarding the mining and quarrying sector, there are 4 active business entities within the whole municipality.
- **In the municipality of Kichevo** a relatively high amount of 1419 business entities (companies) are active and is considered to be an industrial area. The most significant industrial sector of activity is the "wholesale and retail trade - repair of motor vehicles and motorcycles" sector, numbering 563 entities out of 1419 within the whole municipality. The three business sectors of "construction", "manufacturing" and "transportation and storage", also have a significant total share of almost 30% in the active business entities contribution of the municipality.
- **In the municipality of Debar** 465 business entities are active and the most important industrial activity also belongs to the "wholesale and retail trade - repair of motor vehicles and motorcycles sector" (193 active entities). "Construction" sector together with "manufacturing" sector, are also present in the active business entities contribution of the area and share the same percentage of 35 active entities out of 465 in the whole municipality.
- **In the municipality of Makedonski Brod** there are 161 active business entities and the most important industrial activity belongs to the "wholesale and retail trade - repair of motor vehicles and motorcycles sector" with a share of 55 business entities). "Manufacturing" sector together with "transportation and storage" sector, are also present in the active business entities contribution of the area and have a share of almost 15% in the whole municipality.
- **In Vevchani municipality** there are 107 active business entities and the most important industrial activity belongs to the "construction sector" with a share of 39 business entities). The second sector with a relatively significant share in the active business entities contribution of the area is the "wholesale and retail trade - repair of motor vehicles and motorcycles sector" with a number of 17 business entities.
- Similar to Vevchani, **in the municipality of Debarca** there is also a small number of legal entities (companies) which are active (only 106 out of 70139 active business entities within the whole country). The most important industrial activity in that area belongs also to the ""wholesale and retail trade - repair of motor vehicles and motorcycles" sector (30 active entities), while the sectors of "manufacturing" and "construction" have a significant number of 18 and 11 business entities respectively out of 106 within the whole municipality.
- **In the municipality of Centar Zhupa**, there is a small number of legal entities (companies) which are active (only 78 out of 70139 active business entities within the whole country). Among these active business entities of the area, the biggest number comes from the "wholesale and retail trade - repair of motor vehicles and motorcycles" sector (20 active entities out of 78), while very few fall within the sectors of "manufacturing" and "construction".
- Similar to Centar Zhupa municipality, **in the municipality of Plasnica** there is also a small number of legal entities (companies) which are active (only 55 out of 70139 active business entities within the whole country). The most important industrial activity in that area belongs also to the ""wholesale

and retail trade - repair of motor vehicles and motorcycles"" sector (17 active entities), while the sector of "transportation and storage", is also present in the active business entities contribution of the area with a number of 10 active business entities out of 55 within the whole municipality.

2.15 Population – Basic demographic data

According to the data from the last Census of Population, Households and Dwellings in 2002, the Southwest Region had 221,546 inhabitants. According to the sixth edition of "Regions of the Republic of Macedonia, 2016" population estimates from the State Statistical Office, the overall population of Southwest Region has decreased (219,891 inhabitants), while the overall population of the country has slightly increased.

Figure 1: Permanent Population 2002-2015, according to the State Statistical Office



**Note: State Statistical Office did not provide data for years 2003 and 2004*

Population changes are usually a result of the direct influence of natural changes (births and deaths) and mechanical changes (migration). The following table presents basic demographic date for the Region. According to the 2015 population estimates, 10,6% of the total population in the country lived in this region. It takes up 13,4% of the total area of the country and has a population density of 65,8 citizens per km^2.

Table 20: Basic demographic data, Southwest Region, 2015

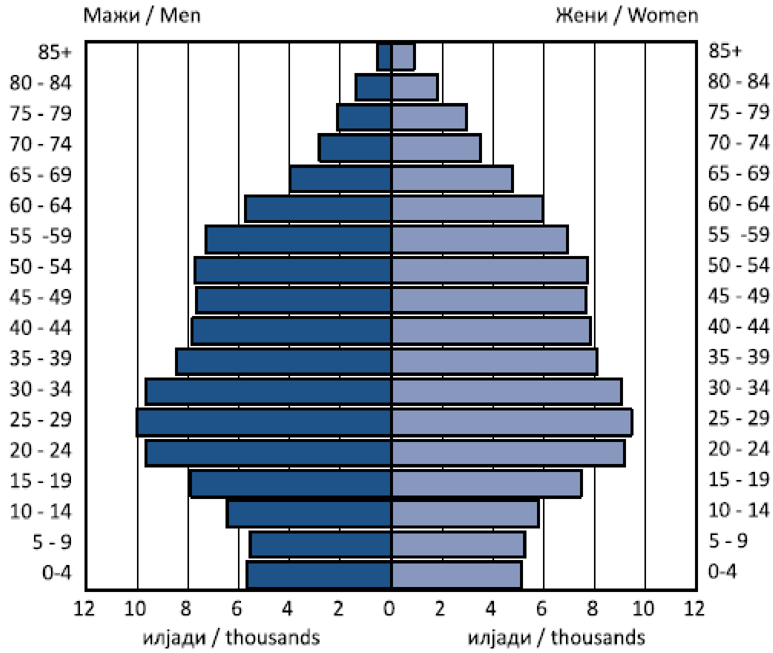
Number of municipalities	9
Number of settlements	286
Total population, Population Census, 2002	221,546
Estimated population, 2015	219,891
Population density, 2015	65.8
Number of dwellings, Population Census, 2002	84,627
Average number of persons per household, Population Census, 2002	3.8
Live births, 2015	2,165
Deaths, 2015	1,981
Natural increase, 2015	184
Immigrants from abroad, 2015	512
Emigrants to abroad, 2015	455
Number of beds, 2015	41,917
Number of tourists, 2015	298,057
Number of nights spent, 2015	1,201,927

(Source: State Statistical Office (2016) (Regional Yearbook 2016, ISSN 1857-6141)

Tourism has great importance for the development of this region, mostly owing to the natural characteristics of Ohrid Lake. In 2014, the largest percentage of domestic tourists was registered in the Southwest Region (40,38%) and the second high percentage for foreign tourists after Skopje Region (33,91%). Regarding tourist nights spent, Southwest region had the highest percentage for both domestic (54,52%) and foreign (43,49%) nights spent in the country.

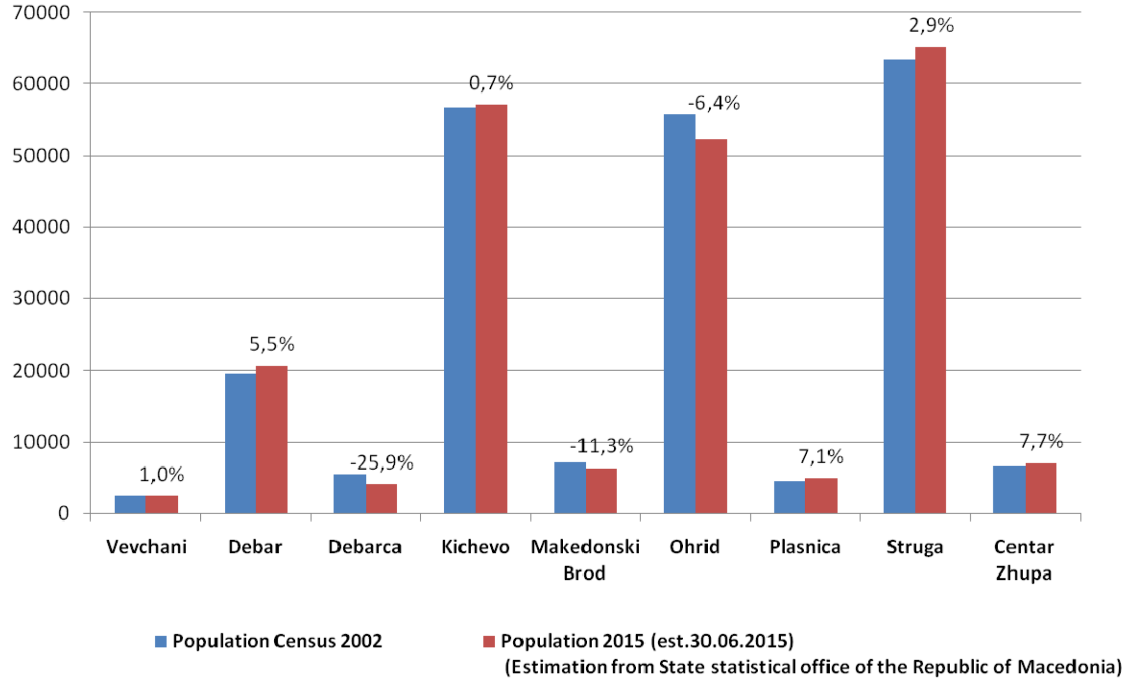
Regarding the age structure of the population, the young population (0-14) has a share of 15,4% and the population aged 65+ has a share of 11,3%. Both values are lower than the national average (indicators as at 30.06.2015).

Figure 2-24: Estimation of population in the Southwest Region as at 30.06.2015, according to gender and five-year age groups, NUTS 3[7]



[7]State Statistical Office (2016) (Regional Yearbook 2016, ISSN 1857-6141)

Figure 2-25: Population of Southwest Region Municipalities (Census 2002 and estimations according to State Statistical Office for 2015)



2.16 Conclusion

The Southwest Region is located in the western part of the country and it borders Albania. Internally, it borders the Polog, Skopje, Vardar and Pelagonija regions. Southwest Region is divided into nine (9) municipalities.
Wider region, and the current area, belongs to Western Macedonian zone as geotectonic unit. In the area of mountains, terrain runs by hilly - mountainous field, passes through flat terrain and mild, slightly hilly and hilly terrain.
As a continental country, the most important climatic factors in the country are: geographical position, relief, proximity to the surrounding seas and atmospheric currents.
Republic of Macedonia lies in the temperate heat zone and is closer to the equator than to the North Pole. So there is enough heat for the development of flora and fauna in the majority of the year. Due to the geographic location, a four seasons are clearly expressed. Summer lasts from June 22 to September 23, and winter from 22 December to 21 March.
Southwest region belongs to West Macedonian geotectonic unit which is characterized with its own specific lithological composition, tectonic structure and degree of metamorphism. General geological map analysis indicates presence of following rock formations; PALEOZOIC, MESOZOIC, CENOZOIC, QUATERNARY.
In Southwest region, from hydrogeological point of view, there are terrains with different water permeability. According the geological structure, there are types of wells with free level formed in the environment with inter-grain porosity, i.e. in Quaternary and Pliocene sediments. In the Eocene sediments, materials are hydrogeological complexes with individual layers with a collector and isolation hydrogeological function.
In depth, these rock masses are more compact and have function of hydrogeological collector, and in depth are hydrogeological isolators. As relatively waterless areas, the investigated terrain includes tightly bound semi - petrified rock masses represented by Eocene sediments. Within the allocated types of wells, in terms of the groundwater regime (feeding, movement of groundwater, discharge and groundwater level), it can be concluded that, based on the geological structure of the field, a major factor for the formation of wells are persistent and occasional river flows and streams and atmospheric precipitation (rain, snow), which represent the main source of wells nourishment.

In the group of hydrogeological collectors are included proluvial - alluvial formations. Characteristic for them is typical super - capillary porosity. Proluvial sediments, depending of percentage of clay, could be relatively hydrogeological collectors.
Hydrographic network in the Southwest region belongs to two basins: Vardar and basin of Ohrid Lake (basin of Crni Drim). The main river which flows in Southwest region in Vardar basin is the river Treska. The basin of the river Treska in the Southwest region is 1610 km^2 to accumulation Kozjak. Larger tributaries of the river Treska which are in the Southwest region are River Zajaska and River Mala.
According to CORINE methodology, geophysical cover of the Earth's surface is approached from two different angles:

- Land cover, which essentially concerns the nature of features (forests, crops, water bodies, bare rocks, etc.).
- Land usage, which is concerned with the socio-economic function (agriculture, habitat, environmental protection) of basic surfaces.

According to this nomenclature, in Southwest region, 189,438 km^2 of the total surface is forest areas. The category agricultural areas take up 136,574 km^2 of the total area. The rest of the surface is covered with semi natural or artificial areas. According to CORINE Land COVER, major changes between 2006 and 2012 can be noted in artificial areas and forests and semi-natural areas, accompanied by decreased agricultural areas and water areas.
The total length of local roads in Southwest Region is 1,296 km (State Statistical Office 2014) and they can be categorised in to asphalt and cobbled, Macadam, Dirt roads and also in designed roads. In all urban

centers in the region there is a system for urban water supply. Rural areas are supplied with drinking water from local water supplies or wells.

Public companies in the region are responsible for wastewater utilities, manage a total of 263,3 km collector drainage in the cities network mostly, located in the urban centers of the municipalities. The coverage of the population with sewage network in urban areas vary from 70% in Debar to 100% in Struga, while in rural areas, the coverage of the population with systems for wastewater services extremely low. In many rural settlements there are no sewage systems. The companies have licenses for storage and transport of waste in Southwest Region are 14 in total.

Hospital care in the Southwest Region is organized through a network of general, specialized hospitals, health centers and institutes. The annual Report on DRG (Diagnosis Related Groups) provides a list of health institutes located in Southwest Region, their capacity and the utilization of beds for 2011, as presented above (table 2-19). There is a number of 4 general hospitals and 3 special hospitals.
According to the data from the last Census of Population, Households and Dwellings in 2002, the Southwest Region had 221,546 inhabitants. According to the sixth edition of "Regions of the Republic of Macedonia, 2016" population estimates from the State Statistical Office for the year 2015, the overall population of Southwest Region has decreased (219,891 inhabitants), while the overall population of the country has slightly increased.

The main centers of industrial activities in Southwest Region are the Municipalities of Ohrid, Struga and Kichevo. In the municipality of Ohrid there are 2,663 active business entities (companies), in Struga municipality 2,073 business entities and in the municipality of Kichevo 1,419, out of 70,139 in the country.

Table of Contents

Annexes:
Annex I – Population and Waste Generation Forecast
Annex II – Financial Analysis of each scenario
Annex III - Detailed presentation of multi-criteria analysis for comparison of alternative scenarios
Annex IV - Maps

List of tables

List of figures

3. DATA ON THE REGIONAL PLAN

3.1 BACKGROUND FOR THE GENERATION OF WASTE

3.1.1 Permanent population in urban and rural areas

According to the data from the last Census of Population, Households and Dwellings in 2002, the Southwest Region had 221,546 inhabitants. According to the sixth edition of "Regions of the Republic of Macedonia, 2016" for the year 2015 population estimates from the State Statistical Office, the overall population of Southwest Region has decreased (219,891 inhabitants), while the overall population of the country has slightly increased.

Table 3-1: Population of Southwest Region per municipality (Census 2002 and estimation according to State Statistical Office for 2015)

	Population Census 2002	Population 2015 (Estimation from State statistical office of the Republic of Macedonia)
Vevchani	2,433	2,458
Debar	19,542	20,613
Debarca	5,507	4,082
Kichevo	56,734	57,107
Makedonski Brod	7,141	6,331
Ohrid	55,749	52,204
Plasnica	4,545	4,866
Struga	63,376	65,208
Centar Zhupa	6,519	7,022
Total	**221,546**	**219,891**

Table 3-2: Households statistics, Southwest region, Census 2002 & Estimation 2016

	Total number of individual households (According to Census 2002)	Total number of household members (According to Census 2002)	Average size of household (Census 2002)	Total number of individual households (According to estimation 2016)*
Vevchani	593	2,433	4.1	597
Debar	3,916	19,538	5	4,126
Debarca	1,995	5,507	2.8	1,452
Kichevo	8,330	30,138	3.6	15,858
Makedonski Brod	2,391	7,138	3	2,109
Ohrid	16,010	55,705	3.5	14,931
Plasnica	1,125	4,545	4	1,212
Struga	14,485	63,376	4.4	14,819
Centar Zhupa	1,444	6,519	4.5	1,555
TOTAL	**50,289**	**194,899**	**3.9**	**56,659**

**Source: Project team estimations, Census 2002*

Table 3-3: Share (in %) of the urban and rural population at the regional level, 2015 estimation

Municipalities (Southwest Region)	2015	
	Percentage of Urban Population	Percentage of Rural Population
Vevchani	0.0%	100.0%
Debar	74.5%	25.5%
Debarca	0.0%	100.0%
Kichevo	56.0%	44.0%
Makedonski Brod	52.4%	47.6%
Ohrid	77.7%	22.3%
Plasnica	0.0%	100.0%
Struga	59.8%	40.2%
Centar Zhupa	0.0%	100.0%
Total	**59.2%**	**40.8%**

Table 3-4: Household (HH) revenues (MKD/HH)

Household revenues/ Covered Households	MKD/HH 2014	MKD/HH 2015
Kichevo	2,242	2,162
Ohrid	4,455	4,504
Debar	1,231	1,058
Struga	1,757	2,094
Debarca	2,403	2,584
Makedonski Brod	0	51
Plasnica	1,209	2,103
Centar Zhupa	0	0
Vevchani	2,113	1,889

3.1.2 Seasonal population

Besides permanent, seasonal population should also be taken into consideration for the purpose of this project. For the calculation of the seasonal population of Southwest Region, the following data have been used:

- Data regarding Number of Nights Spent per Municipality of Skopje Region (2014, 2015) have been taken from MAKstat Data Base
- Data regarding Number of Nights Spent in total Skopje Region (2014, 2015) have been taken from MAKstat Data Base

According to the State Statistical office of RM, some of the above data are confidential and were not published. Those data are marked with the symbol (-) in the following table. The number of nights spent in the Region of Southwest according to the State Statistical Office for the year 2015 is 1,576,112.

Table 3-5: Number of nights spent in Southwest Region (State Statistical Office)

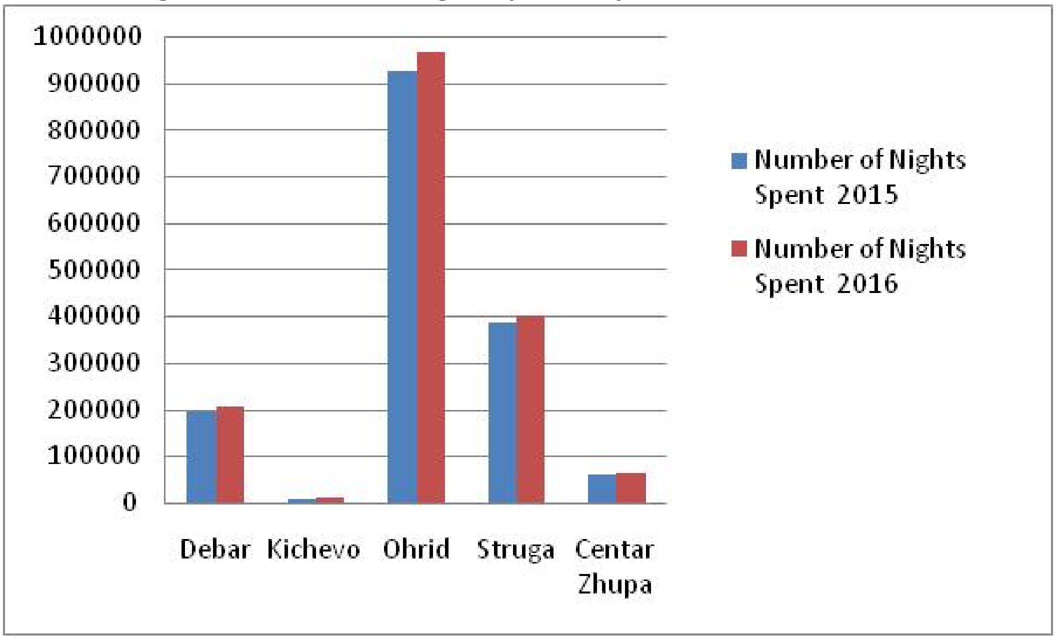
Municipalities (Southwest Region)	**Number of Nights Spent 2015** ***(Source State Statistical office of the RM)***
Vevchani	-
Debar	196,618
Debarca	-
Kichevo	9,141
Makedonski Brod	-
Ohrid	926,396
Plasnica	-
Struga	383,957
Centar Zhupa	60,000
Total	**1,576,112**

Data for equivalent seasonal population are given below:

Table 3-6: Equivalent seasonal population

Municipalities (Southwest Region)	**Seasonal Population 2015** ***(Project team)***	**Seasonal Population 2016** ***(Project team)***
Vevchani		
Debar	539	562
Debarca		
Kichevo	25	26
Makedonski Brod		
Ohrid	2,538	2,650
Plasnica		
Struga	1,052	1,098
Centar Zhupa	164	172
Total	**4,318**	**4,508**

Figure 3-1: Number of Nights Spent for years 2015 and 2016

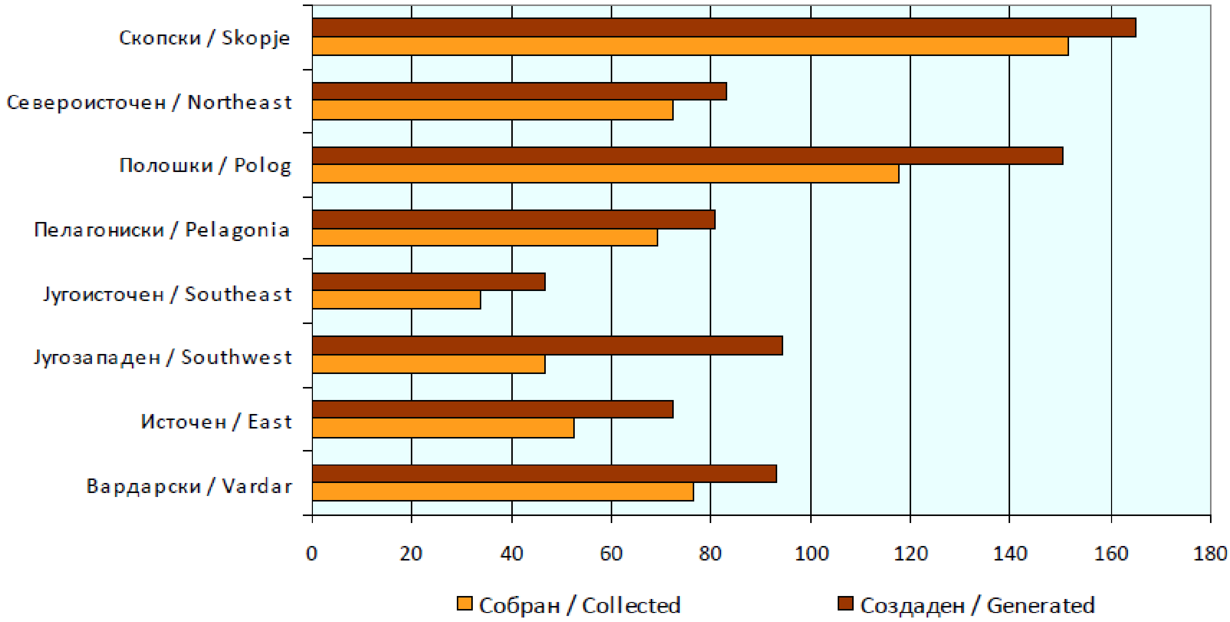


3.1.3 Existing data on municipal waste generation

Statistical Data

The following chart presents the collected and generated municipal waste by regions for 2015.

Figure 3-2: Collected and generated municipal waste by regions, 2015, tons (000)



Source: State Statistical Office (News release, Municipal Waste 2015, No: 5.1.16.08)

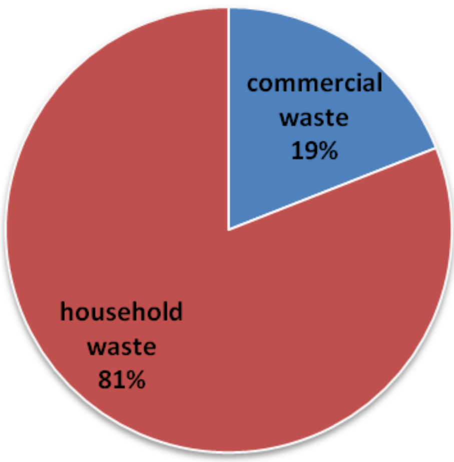
Publication Environmental statistics 2015 provides the data presented in the following table (data derived from State Statistical office of the Republic of Macedonia).

Table 3-7: Collected and generated municipal waste for Southwest region, 2014

	Population 2014 (Permanent and seasonal population)	Annual waste collection (t)	Annual waste production (t)	Collection coverage %	Waste generation rate (kg/ca/yr)
Southwest Region	223,135	56,138	96,249	58%	431

Regarding the collected municipal waste, according to data of the State Statistical Office, the total amount of collected municipal waste in the Republic of Macedonia in 2015 was 620,328 tons. Compared to 2014, the total amount of collected municipal waste increased by 8.9%. The highest amount of collected municipal waste was registered in the Skopje Region - 151,592 t, or 24.4% of the total collected amount in the Republic of Macedonia. Of the total amount of collected municipal waste, 499,658 tons, or 81%, were collected from households, and the remaining 19% from legal and natural persons (commercial waste). The total amount of generated municipal waste in the Republic of Macedonia in 2015 was 786,182 tons. The annual amount of generated municipal waste per person in 2015 was 380 kg per person, which is 2.7% higher than the same amount in 2014.

Figure 3-3: Collected municipal waste by site of generation, 2015



Source: State Statistical Office (News release, Municipal Waste 2015, No: 5.1.16.08)

Waste Measurements

For the quantitative determination of wastes that end up in municipal landfills, waste measurements were implemented during the period of May 2016. The data delivered from waste measurements in combination with information from questionnaires, are presented in the following table.

Table 3-8: Collected and generated municipal waste for Southwest region, 2016 (waste measurements)

	Population 2016 (Permanent and seasonal population)	**Annual waste collection (t)**	**Annual waste production (t)**	**Collection coverage %**	**Waste generation rate (kg/ca/yr)**
Southwest Region	224,371	46,826	56,224	83%	251

3.1.4 Medical Waste

Medical waste is waste generated in medical and health institutions (dispensaries, hospitals, polyclinics and clinics, dental clinics, veterinary associations, etc.) as the product of used items and materials for the diagnosis, prevention and treatment of diseases in humans and animals. Waste and by-products cover a diverse range of materials, like pathological (anatomical) waste, infectious waste, waste from sharp objects, pharmaceutical and chemical waste.

Health care in the Beneficiary country is provided through an extensive network of health care organizations, on three levels: primary, secondary, and tertiary.

According to current regulations in the area of medical waste management, health institutions that produce medical waste are obliged to submit an annual report on waste treatment to the Ministry of Environment and Special Planning. According to the data provided by health institutions in the Beneficiary country, the amount of the reported medical waste generated in 2015, within the whole country, was 704.6 tons.

European Waste Catalogue (EWC) codes are used to categorize all types of waste and are applicable to all types of clinical waste. The following table and figure present the generated quantities (in tons), within the whole country, according to the types of medical waste[1].

Table 3-9: Generated medical waste reported in 2015 in the Beneficiary country, according to EWC code

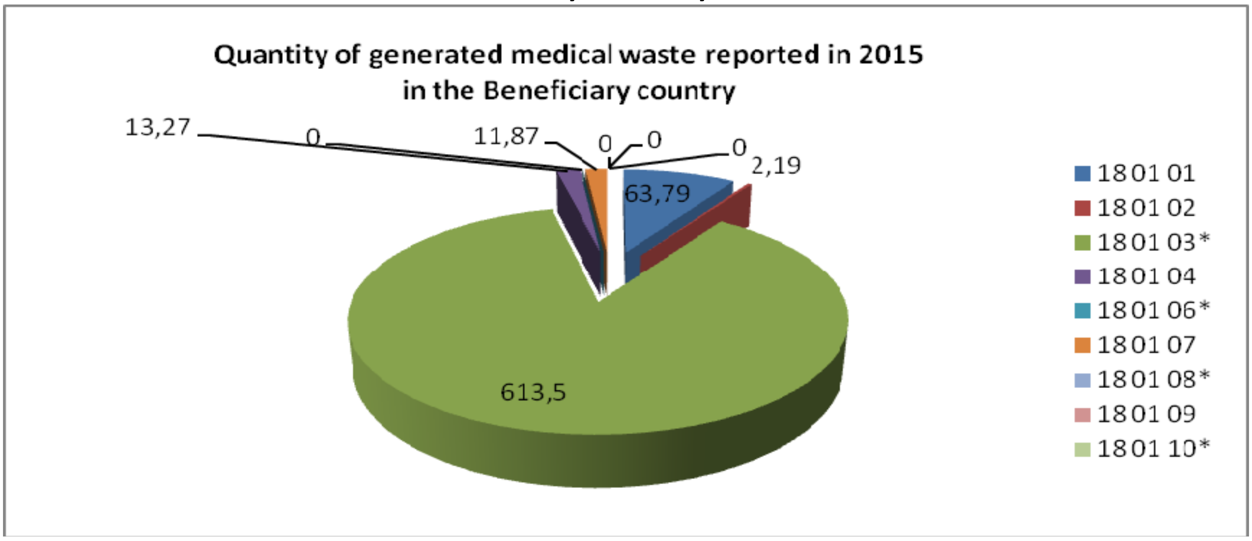
Code of Waste	**Description**	**Quantity in tons**
18 01	***Wastes from natal care, diagnosis, treatment or prevention of diseases in humans***	***704,6***
18 01 01	Sharps, but not including those included in code 18-01-03*	63,8
18 01 02	Body parts and organs including blood bags and blood preserves (excluding those in category 18 01 03*)	2,2
18 01 03*	Wastes whose collection and disposal is subject to special requirements in order to prevent infection	613,5
18 01 04	Wastes whose collection and disposal is not subject to special requirements in order to prevent infection	13,3
18 01 06*	Chemicals consisting of dangerous substances	0,00
18 01 07	Chemicals not mentioned in 18-01-06	11,8

[1] Macedonian Environmental Information Center - MEIC (2016). Quality of the Environment – Annual Report 2015

Code of Waste	Description	Quantity in tons
18 01 08*	Cytotoxic and cytostatic medicines	0,00
18 01 09	Medicines other than those mentioned in 18 01 08*	0,00
18 01 10*	Amalgam waste from dental care	0,00

*hazardous waste

Figure 3-4: Quantity of generated medical waste from health facilities reported in 2015 in the Beneficiary country - Quantity in tons

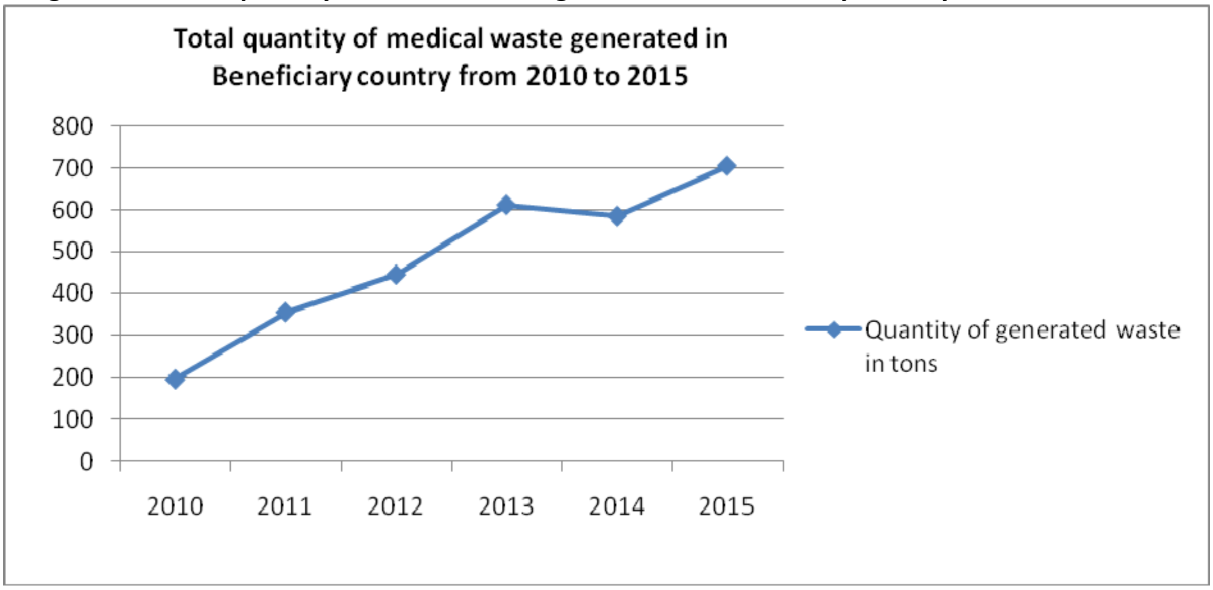


According to the Annual Report 2015 for Quality of the Environment of Macedonian Environmental Information Center (MEIC), the growth of generated waste in the Beneficiary country over the last six years is shown at the following table and figure.

Table 3-10 Amount of generated medical waste reported per year in the Beneficiary country

Year	Quantity of generated waste in tons
2010	195.6
2011	355.9
2012	444. 8
2013	611.3
2014	584.9
2015	704.9

Figure 3-5: Total quantity of medical waste generated in Beneficiary country from 2010 to 2015



As seen from the figure, it can be concluded that the amount of medical waste generated within the whole country, gradually increased, during the last six years.

Hospital care in Southwest Region is organized through a network of general, specialized hospitals, health centers and institutes. The Annual Report on DRG (Diagnosis Related Groups) provides a list of health institutes located in Southwest Region (*psychiatric hospitals and private hospitals not included)[2], their capacity and the utilization of beds for 2011, as presented in par. 2.13 of Chapter 2. According to this, the number of hospitalized patients per year in the whole country is 3239 patients, while the number of hospitalized patients per year in Southwest Region is 252 patients. The following table and figure present the generated quantities (in tons) per type of medical waste according to the European Waste Catalogue (EWC), within Southwest Region.

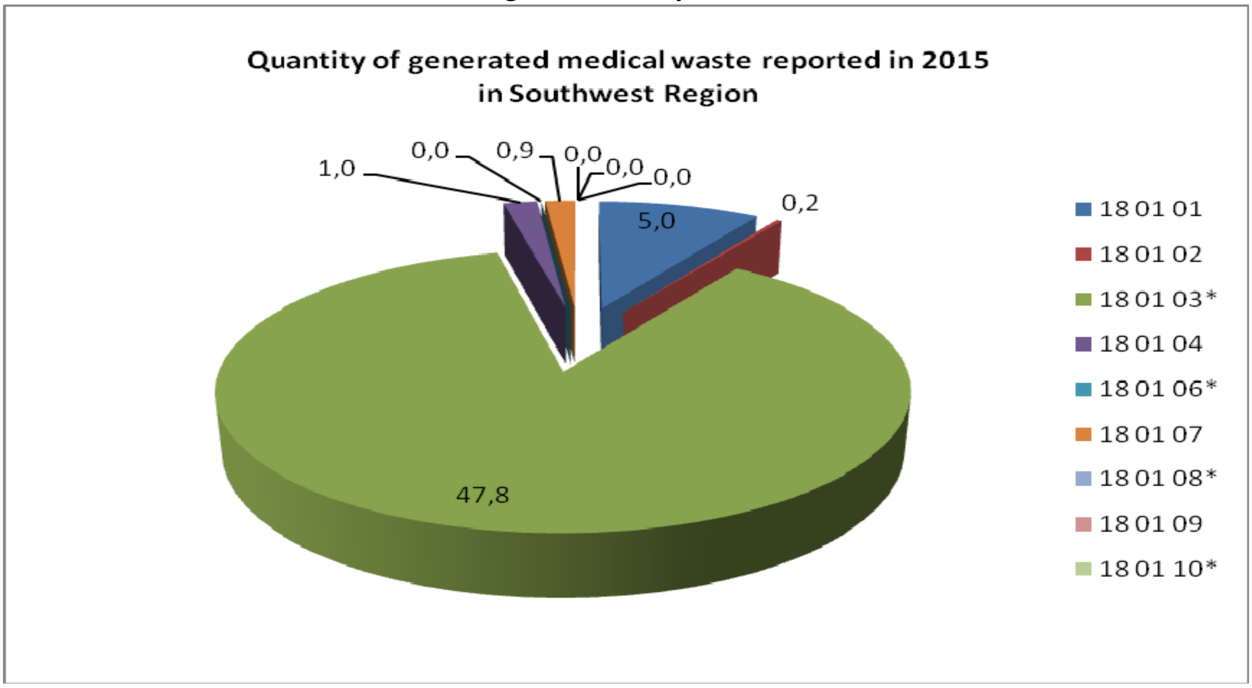
[2] Annex of the Annual Report on DRG, 2011 "Usage of Hospital Capacities for cute patients" Health Insurance Fund of Republic of Macedonia

Table 3-11: Generated medical waste reported in 2015 in Southwest Region, according to EWC code

Code of Waste	Description	Quantity in tons
18 01	***Wastes from natal care, diagnosis, treatment or prevention of diseases in humans***	***54.8***
18 01 01	Sharps, but not including those included in code 18-01-03*	5.0
18 01 02	Body parts and organs including blood bags and blood preserves (excluding those in category 18 01 03*)	0.2
18 01 03*	Wastes whose collection and disposal is subject to special requirements in order to prevent infection	47.8
18 01 04	Wastes whose collection and disposal is not subject to special requirements in order to prevent infection	1.0
18 01 06*	Chemicals consisting of dangerous substances	0.0
18 01 07	Chemicals not mentioned in 18-01-06	0.9
18 01 08*	Cytotoxic and cytostatic medicines	0.0
18 01 09	Medicines other than those mentioned in 18 01 08*	0.0
18 01 10*	Amalgam waste from dental care	0.0

*hazardous waste

Figure 3-6: Quantity of generated medical waste from health facilities reported in 2015 in Southwest Region - Quantity in tons



3.1.5 Packaging Waste

According to the annual reports submitted to the Ministry of Environment and Physical Planning[3] for 2013 and 2014, it can be seen that the total amount of packaging placed on the country's market amounted to 56043,7 tons and 59572,8 tons, respectively. By type of material, the amount of packaging placed on the market for 2013 and 2014 is the following:

Table 3-12: Packaging placed on the country's market (tons) in 2013 and 2014, by material

Type of material	Placed on the market 2013	Placed on the market in 2014
Glass	10390.2	10642.5
Plastic	16896.8	17375.3
Paper and cardboard	19113.4	20525.8
Metal	1952.3	2320.0
Wood	4952.0	5501.6
Composite materials	2739.0	3207.6
Other/ packaging not selected by type	-	0.1
Total	56043.7	59572.8

Packaging placed on the market in 2013, as already mentioned above, amounts to 56043,7 tons. The total amount of collected packaging waste was 12799,6 tons. In 2014, likewise, packaging placed on the market, by type, amounts to 59572,8 tons. There was 0,1 tons of packaging, which was not reported by its type. The total amount of collected packaging waste was 16366,2 tons.

In 2013, the amounts of recycled packaging waste, by type, were 1525,5 tons of glass, 4928,8 tons of plastic, 6277,6 tons of paper and cardboard, 2,4 tons of metal, 65,4 tons of wood. In total, 1280,0 tons were recycled, which corresponds to 22,8% of the packaging placed on the market. Specifically, by type of material, the recycling of glass packaging, in relation to the glass packaging placed on the market, is equal to 14,7%; the recycling of plastic packaging, in relation to the plastic packaging placed on the market, is equal to 29,2%; the recycling of paper and cardboard packaging, in relation to paper and cardboard placed on the market, is equal to 32,8%; and the recycling of metal packaging, in relation to the amount of metal packaging placed on the market, is equal to 0,1%; the recycling of wood packaging, in relation to the wood packaging placed on the market, is equal to 1,3%.

In 2014, the amounts of recycled packaging waste, by type, were 828,7 tons of glass, 6100,7 tons of plastic and 9201,1 tons of paper and cardboard. In total, 16130,5 tons were recycled, which corresponds to 27,1% of the packaging placed on the market. Specifically, by type of material, the recycling of glass packaging, in relation to the glass packaging placed on the market, is equal to 7,8%; the recycling of plastic packaging, in relation to the plastic packaging placed on the market, is equal to 35,1%; the recycling of paper and cardboard packaging, in relation to paper and cardboard placed on the market, is equal to 44,8%.

Table 3-13: Data for the total amount of collected packaging waste

Year	Collected amount (tons)
2013	12799.6
2014	16366.2

[3] Macedonian Environmental Information Center - MEIC (2016). Quality of the Environment – Annual Report 2015

Table 3-14: Recycled packaging waste in 2013, by material

Type of material	Recycled material	% Recycled material
Glass	1525.5	14.7
Plastic	4928.8	29.2
Paper and cardboard	6277.6	32.8
Metal	2.4	0.1
Wood	65.4	1.3
Composite materials	0.0	0.0
Other	0.0	0.0
Total	12799.7	22.8

Table 3-15: Recycled packaging waste in 2014, by material

Type of material	Recycled material	% of Recycled material
Glass	828.7	7.8
Plastic	6100.7	35.1
Paper and cardboard	9201.1	44.8
Metal	0.0	0.0
Wood	0.0	0.0
Composite materials	0.0	0.0
Other	0.0	0.0
Total	16130.5	27.1

It can also be said that the number of manufacturers who fulfill the legal obligations has increased, and many manufacturers have transferred this commitment to a legal entity for handling packaging waste. According to the Law on packaging and packaging waste, the National targets described in the Article 35 for the treatment of packaging waste, include that within the territory of the Republic of Macedonia the following quantities of packaging and packaging waste should be collected and processed in the following timeframe:

- By the end of 2020, at least 60% by weight of packaging waste created in the Republic of Macedonia should be processed by operations or recovery operations with energy recovery.

- By the end of 2020, a minimum of 55% and a maximum of 80% by weight of packaging waste created in the Republic of Macedonia should be recycled.

- By the end of 2020, the following amounts of materials, that are produced packaging, should be recycled:

- 60% glass,
- 60% of paper and cardboard
- 50% metals and
- 15% wood, and,

additionally, by the end of 2018, 22,5% plastic, taking into account only such materials that are recycled into plastic.

In the beneficiary country there are four legal entities which have permissions for treatment of packaging waste (collective handlers)[4], according to article 21 of the Law on managing packaging and packaging waste (Official Gazette of the Republic of Macedonia no. 161/09, 17/11, 41/11, 136/11, 6/12 and 39/12):

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

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

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

Table 3-16: Data on the collective handlers of packaging waste at country level- 2012

General Data	PAKOMAK	EURO ECO PACK	EKOSAJKL	EKO-PAK HIT
Number of companies that are members of the system	583	no data	42	48
Number of companies reporting to waste system	468	no data	42	16
Total reported quantities of waste (in tons)	40557	8263	1120	682
Total reported amount of collected and recovered packaging waste (in tons)	7595	9.2	211	132
Percentage of recycled waste compared to the reported (in accordance with Article 35 paragraph (1)	18.7%	0.1%	18.8%	19.4%
Percentage of waste recycled compared to the reported (in accordance with Article 35 paragraph (1)	/	/	/	/

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

Table 3-17: Collected packaging waste in 2013 by Pakomak at country level

Month/tn	*Paper*	*Plastic*	*Glass*	*Metal*	*Wood*	*Composites*	Total (tn)
January	259.8	259.8					**519.6**
February	259.4	351.3			0.2		**610.9**
March	426.9	438.6			5.1		**870.5**
April	562.9	299.7		2.3	22.5		**887.4**
May	575.2	582.5	24.5		9.7		**1191.9**
June	608.7	639.2	256.1	0.2	7.9		**1512.1**
July	496.6	462.9	555.3		9.9		**1524.7**
August	439.2	233.0	412.2		6.0		**1090.5**
September	166.5	195.7			1.1		**363.3**
October	192.4	48.5	79.4		0.4		**320.7**
November	170.4	25.8	26.6		0.7		**223.6**
December	145.0	32.1	33.2		1.7		**212.1**
to 31.12.2013	**4303.2**	**3569.1**	**1387.3**	**2.4**	**65.1**	**0.0**	**9327.1**
% Share	**46.1%**	**38.3%**	**14.9%**	**0.0%**	**0.7%**	**0.0%**	**100.0%**

3.1.6 Waste Batteries and accumulators

The definitions from the Law on Batteries and Accumulators and Waste Batteries and Accumulators (Official Gazette of the Republic of Macedonia No. 140/10, 47/11 and 148/11) will be used5:

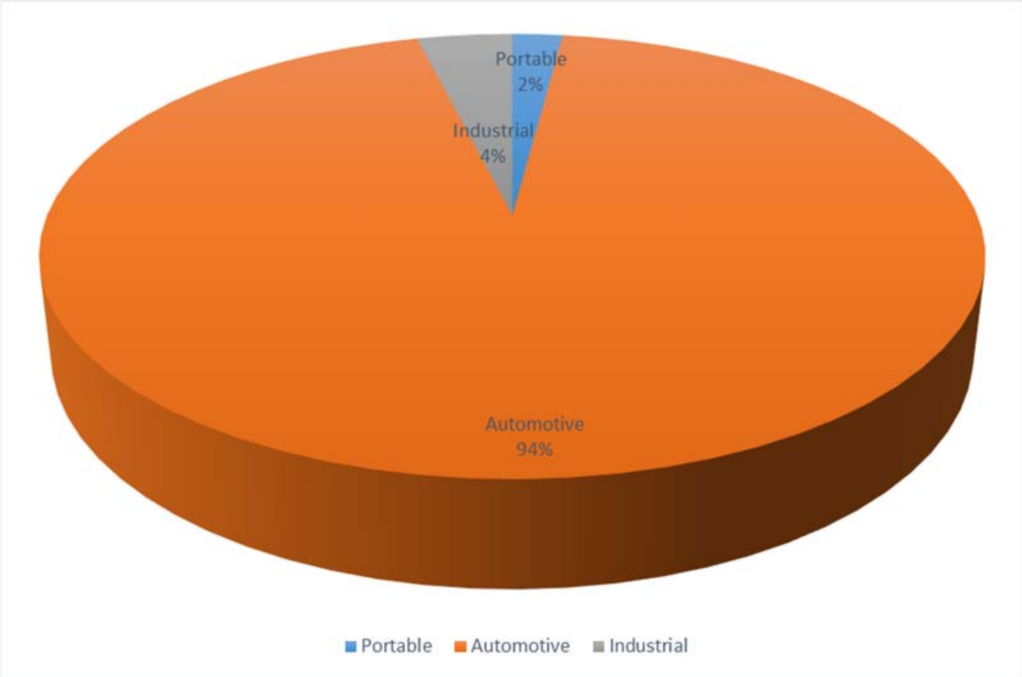
- Battery or accumulator means any source of electrical energy generated by direct conversion of chemical energy and consisting of one or more battery cells (non-rechargeable), or consisting of one or more secondary battery cells (rechargeable);
- Battery pack means any set of batteries or accumulators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

The Law on Management of Batteries and Accumulators and Waste Batteries and Accumulators, prescribed requirements concerning environmental protection, which must meet batteries and accumulators in their production and placing on the market of the Republic of Macedonia. Also, treatment of waste batteries and accumulators, which covers, obligations and responsibilities of economic operators and other entities participating in the production and marketing of batteries and batteries, limiting the use of batteries and accumulators containing hazardous substances, the rules for the collection, processing, recycling and disposal of waste batteries and accumulators, as well as other conditions for handling waste batteries and accumulators, information and economic instruments to achieve national targets for the collection and processing of waste batteries and accumulators.

According to the submitted annual reports to the Ministry of Environment and Spatial Planning for 2014, can be seen that the total amount of batteries and accumulators placed on the market in the Republic of Macedonia is 2486725,90 kg (portable is 51087,49 kg, automotive batteries is 2339205,20 kg, industrial 96433,21 kg). Automotive batteries and accumulators have the largest share in the total quantity of 94%.

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

Figure 3-7: Quantity of batteries and accumulators placed on the market at country level, in kg



According to the reported annual reports for 2014 (figure 3-13) the quantity of collected portable is 6073,40 kg, automotive 2599819,50 kg and industrial 5052,50 kg. The largest share have collected waste automobile batteries and accumulators with 99,5%. The amount of treated and recycled portable waste batteries is 2933 kg, automotive 2494736,98 kg and industrial is 6348,02 kg. Quantity of exported automotive waste batteries for treatment and recycling is 108684 kg.

Table 3-18: Waste batteries and accumulators collected, recycled and treated or exported for treatment (kg) at country level (2014)

	Waste batteries and accumulators collected, kg	Waste batteries and accumulators Recycled, kg	Waste batteries and accumulators exported for treatment and recycling, kg
Portable	6073.4	2933	0
Automotive batteries	2599819.5	2494736.98	108684
Industrial	5052.5	6348.02	0
Total	2610945.4	2504018	108684

Pursuant to Article 35 of the Law on Management of Batteries and Accumulators and Waste Batteries set national targets for collection, including:

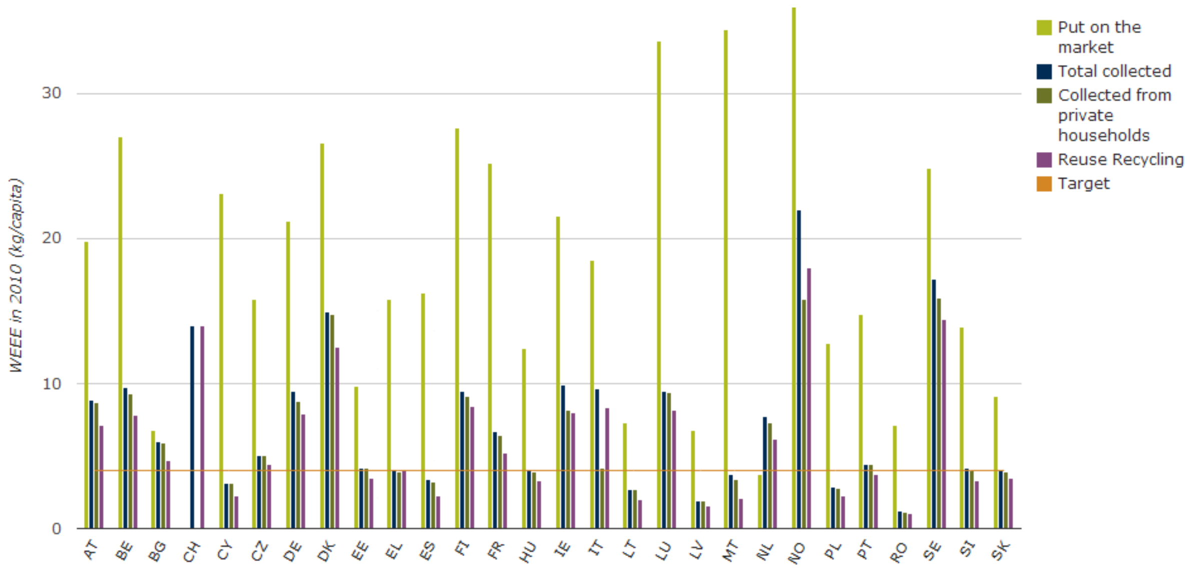
- by the end of 2016, you need to collect a minimum of 25% by weight of portable batteries and accumulators placed on the market in the territory of Republic of Macedonia
- by the end of 2020, we need to collect a minimum of 45% by weight of portable batteries and accumulators placed on the market in the territory of Republic of Macedonia.

3.1.7 Waste electrical and electronic equipment (WEEE)

Waste electrical and electronic equipment (WEEE) is currently considered to be one of the fastest-growing waste streams. WEEE contains a number of hazardous substances and at the same time valuable materials. There is also a time lag between the point at which a product is put on the market and when it is discarded. While there is a possible environmental advantage of using new products or their components in certain

EEE from an energy efficiency point of view, from a resource efficiency point of view it is often better to use products longer. Due to the life span of the majority of EEE products the comparison of the amount put on the market and the amount collected in the same year is just an indicative number. Ideally, a collection rate would have to be calculated as rate of the WEEE generated, but this data does not exist. Data indicates that while reuse and recycling of the collected waste electrical and electronic equipment (WEEE) seems to be on track in the majority of the EU and EFTA member countries, the collection of the WEEE has shown varying but generally improving results. It appears that the amounts of WEEE that are collected, are largely reused (either as a whole appliance or components) or recycled although there is still room for improvement in some countries. However, more attention should be given to the improvement of collection systems. The level of collection is still very low in many countries, especially when compared to the amount put on the market[6].

Figure 3-8: Electric and electronic equipment put on the market, WEEE collected and recycled/reused in 28 European countries (kg/capita/year), in 2010



The recast Directive (2012/19/EU), which entered into force on 13th of August 2012, introduces stepwise higher collection targets that will apply from 2016 and 2019[7]. The existing binding EU collection target is 4 kg of WEEE per capita, representing about 2 million tons per year, out of around 10 million tons of WEEE generated per year in the EU. By 2020, it is estimated that the volume of WEEE will increase to 12 million tons[8].

A European citizen has an average of 362 kg WEEE at his disposal. Subdivided into the specific fractions, the main portions contain "white goods (135 kg), cooling units (63 kg), TV/HiFi equipment (86 kg) and computers (37 kg)[9].

There are various methods to determine the generated WEEE quantities[10].

According to a household survey conducted within the 2-year project "Balkan E-Waste Management Advocacy Network (BEWMAN)", initiated by Metamorphosis Foundation (www.metamorphosis.org.mk)

---

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

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

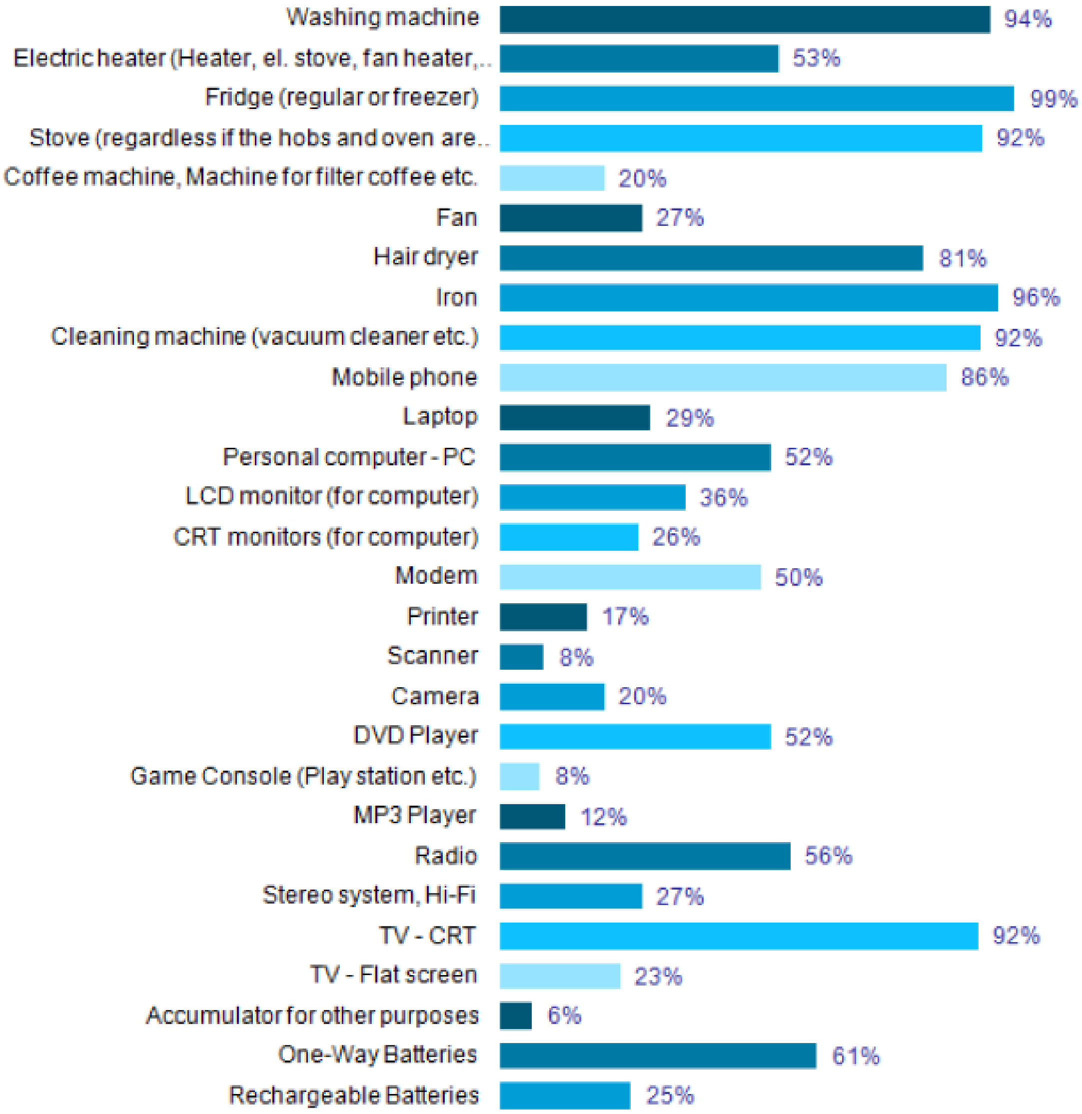
[8] http://ec.europa.eu/environment/waste/weee/index_en.htm

[9] http://ec.europa.eu/environment/waste/weee/pdf/final_rep_unu.pdf,http://www.wtert.eu/default.asp?Menue=1&ArtikelPPV=23470

[10] http://www.srcosmos.gr/srcosmos/showpub.aspx?aa=8522

and co-financed by the European Union's IPA 2008 Programme of the Civil Society Facility[11], the highest percentage, or 99% of the total population have refrigerator, 94% have washing machine, 92% have oven, 53% have some electric heating element, while only 20% have electric coffee machine.

Figure 3-9: Appliances that are in use in households, total



Source: E-Waste Assessment in Republic of Macedonia, 2011

[11] http://www.eco-innocentre.mk/en/sections/electronics/documents/e-wasteassess

Figure 3-10: Household products that are not in use, but still kept within the household

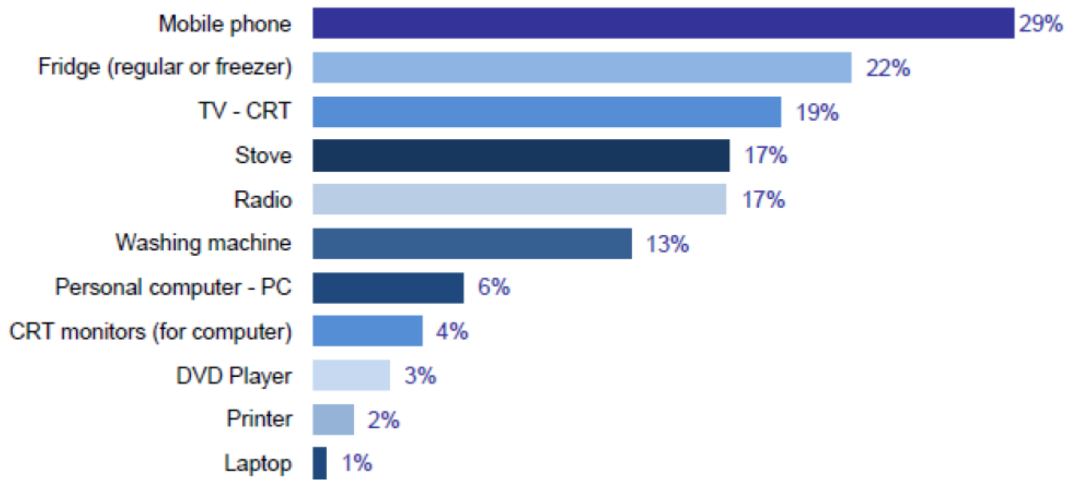
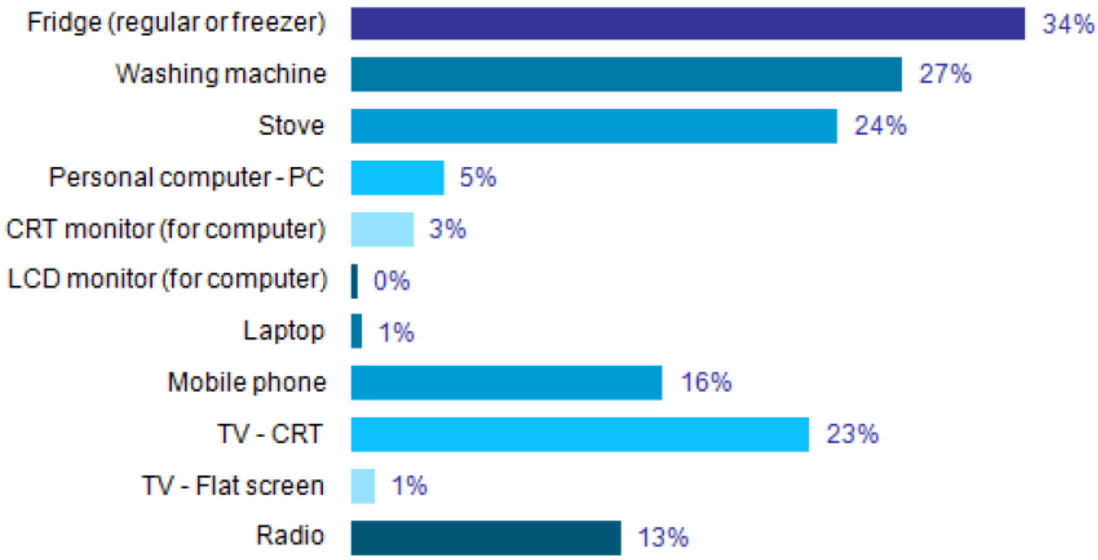


Figure 3-11: Household appliances that have been disposed from the household



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

The WEEE Law of Republic of Macedonia takes effect from 2014. The law enforces take-back obligations on EEE producers and requires them to pay a high environmental fee from 2015 if they fail to meet collection targets through individual or collective waste plans. In September 2013 the first application to act as a compliance organisation for WEEE, was submitted by Nula Otpad (Zero Waste). Nula Otpad was issued a license to manage waste batteries in October 2012[12].

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

3.1.8 Construction and demolition waste (C&D)

Construction and demolition (C&D) waste has been identified by the European Commission (EC) as a priority stream and in the Final report on C&D waste that was produced in 2011[13], provides precise orders of magnitude regarding the amounts that are generated in Europe. This study provides several recent sources with estimates of C&D waste arising in Europe.

Source	Total C&D waste arising (million tons)	C&D waste (t) per capita[14]
[WBCSD 2009] (2002 data)	510	1.1
[ETC/RWM 2009] (2004 data)	866	1.8
[EUROSTAT 2010] (2006 data)	970	2.0

Available estimates are therefore highly variable. These differences were analysed in the study in order to identify the sources of discrepancies and correct them so as to estimate the available quantities more accurately, which for some member states probably reflect a very incomplete reporting of C&D waste arising. The following ranges were extrapolated from the study's assumptions noting that the quality and reliability of the data currently available do not allow for a more precise range to be identified.

	Low estimate	High estimate
Generation of C&D waste per capita (t)	0.63	1.42
Generation of CD&E waste per capita (t)	2.74	5.9

Following the above conclusion of the EC Study, in the Southwest Region the following quantities were calculated:

	Low estimate	High estimate
Generation of C&D waste per capita (t)	138531	312245
Generation of CD&E waste per capita (t)	602501	1297357

(State Statistical Office's estimation on population for 2015 was used)

According to the National Waste Management Plan (2008-2014) of the Republic of Macedonia, there are no formal collection systems for construction and demolition waste so there are no recorded data on quantities. The estimated quantities of Construction and Demolition waste, including excavated soil from contaminated sites (identified as number 17 according to EWC) for the Republic of Macedonia according to the Plan are based on experience in other countries and a generation of approximately 230-250 kg/capita/year is assumed; which corresponds to average annual generation of C&D waste is estimated at ranging from 460000 t/yr to 500000 t/yr for the year 2005.

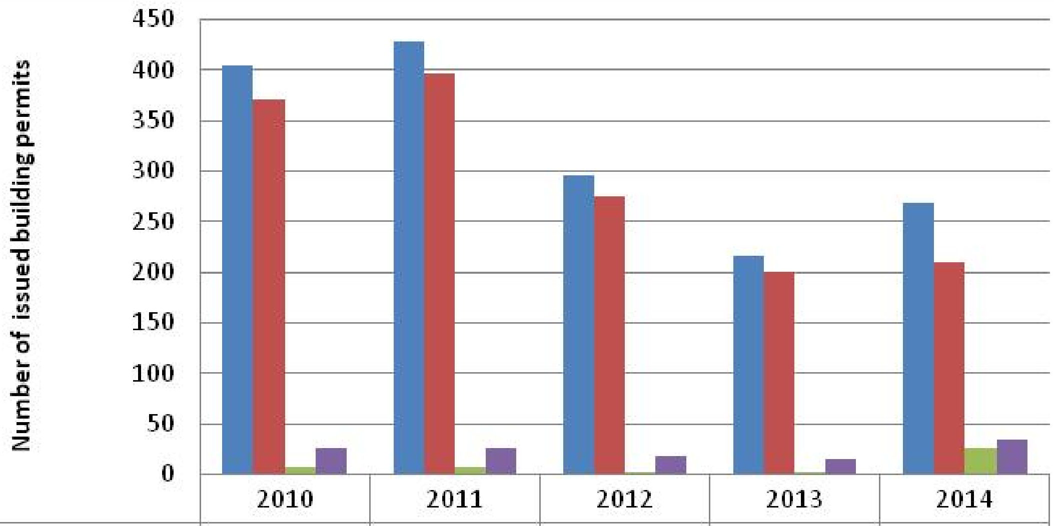
Following the NWMP's estimations, Southwest Regions annual generation of C&D (including excavated soil from contaminated sites) waste is estimated at ranging from 50575 t/y to 54973 t/y (State Statistical Office's estimation on population for 2015 was used).

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

[14] Population data from EUROSTAT (accessed April 2010) for the corresponding years

Furthermore, the annual generation of this C&D waste stream is highly dependent upon the construction activities in either the public or private sector. According to the State Statistical Office, data on issued building permits are used for monitoring the dynamics of the construction activities. For the Southwest Region the number of issued building permits indicates a rapid decrease in the construction sector since for the years 2012 and 2013 and an increase in 2014.

Figure 3-12: Number of issued building permits in Southwest Region (2010-2014)



	2010	2011	2012	2013	2014
Number of issued building permits, total	404	428	295	216	268
Of which, buildings	371	396	275	200	209
Of which, civil engineering	7	7	2	2	26
Of which, reconstruction	26	25	18	14	33

3.1.9 Agricultural waste

In the following table, the amounts of different types of generated wastes that are related to the agriculture (horticulture, aquaculture, forestry, hunting and fishing) are presented, using the six-digit code classification of the European Waste Catalogue (EWC) and Hazardous Waste List[15], published by the EPA. The data refer to the country level.

Table 3-19: Amounts of generated waste (tons), per EWC code, for the years 2008, 2010 and 2012

	Amount of generated waste (t)		
Agricultural waste	2008	2010	2012
020101 sludges from washing and cleaning	75.11	4.87	4.2
020102 animal-tissue waste	-	9.53	53.46
020103 plant-tissue waste	452.39	990.94	1451
020104 waste plastics (except packaging)	2.07	-	13.03
020106 animal faeces, urine and manure (including spoiled straw), effluent, collected separately and treated off-site	-	0.48	46.66
020110 waste metal	3	-	-

15 http://www.epa.ie/pubs/reports/waste/stats/EPA_waste_catalogue_hazard_list_2002.pdf

	Amount of generated waste (t)		
Agricultural waste	**2008**	**2010**	**2012**
020199 wastes not otherwise specified	6.67	-	0.5
020108 agrochemical waste containing dangerous substances	-	2.66	-
TOTAL	**539.2**	**1008.5**	**1568.9**

Source: State Statistical Office

Figure 3-13: Amounts of generated waste (t), per EWC code, for 2008

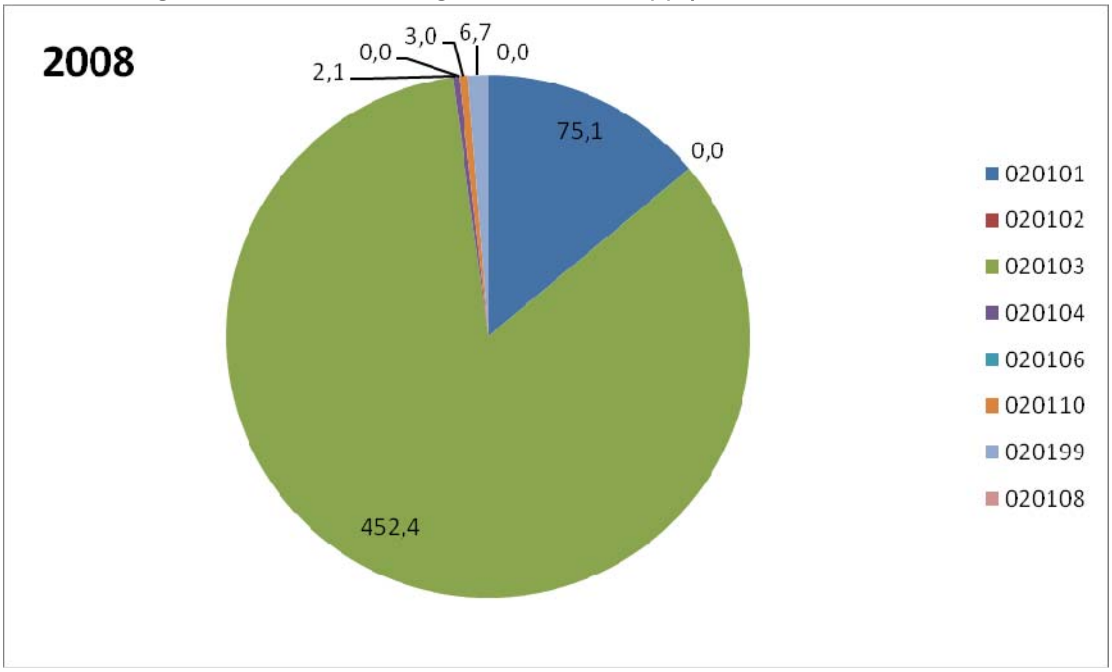


Figure 3-14: Amounts of generated waste (t), per EWC code, for 2010

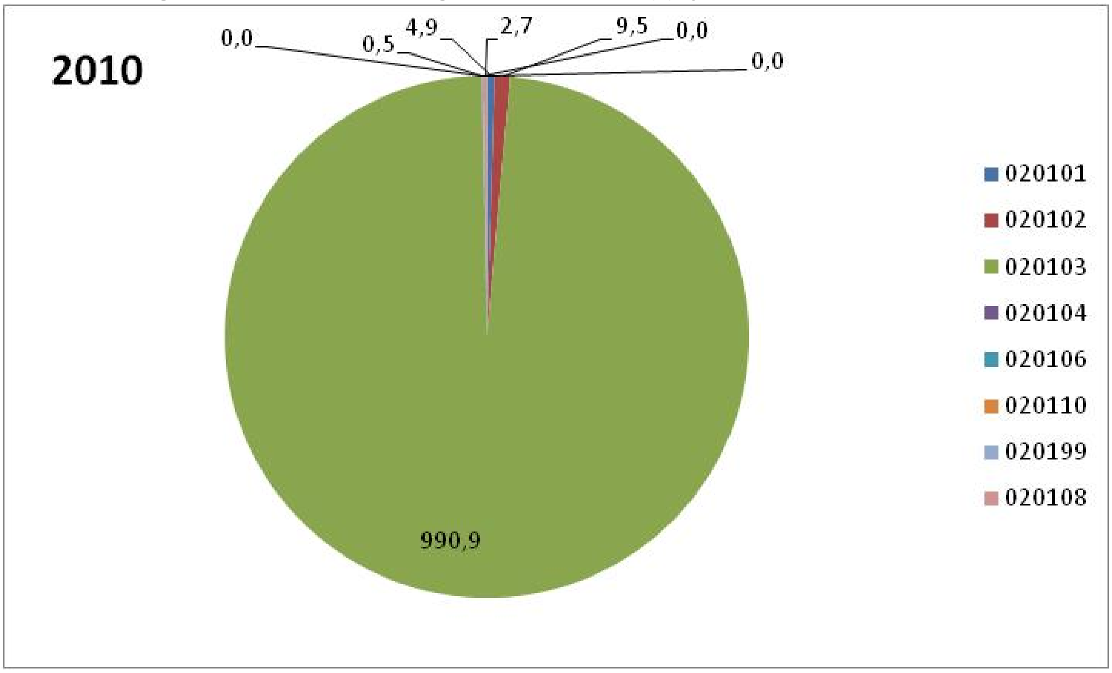
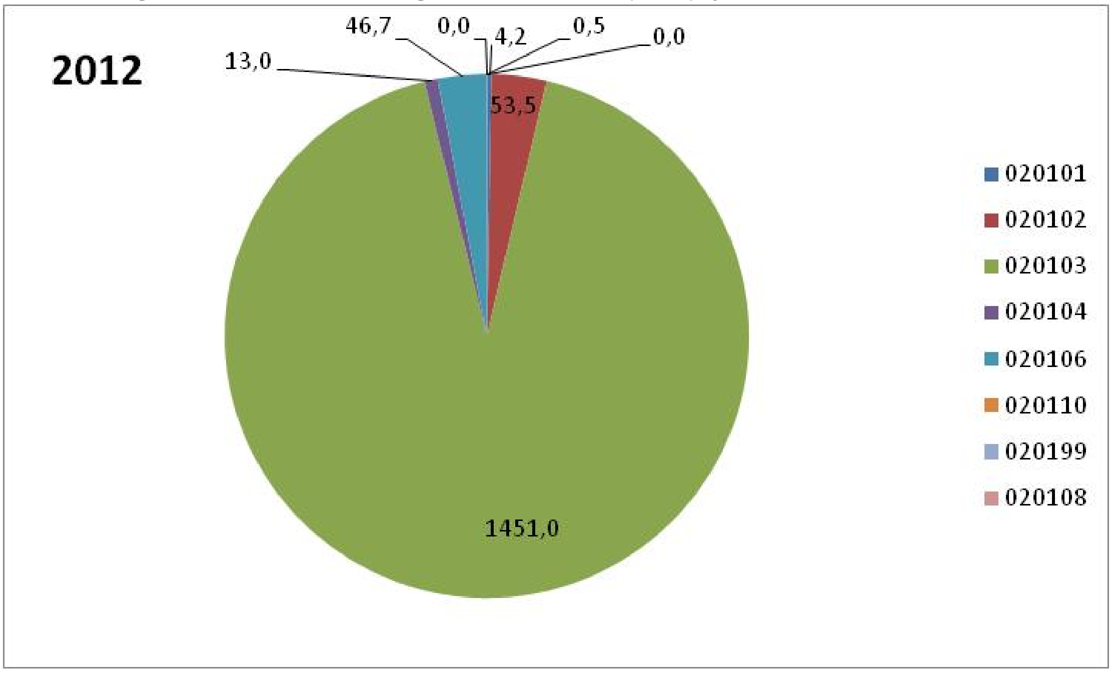


Figure 3-15: Amounts of generated waste (tons), per EWC code, for 2012



As can be seen from the table as well as the figures above, the total amount of generated agricultural waste within the beneficiary country in the year 2008 was 539,2 tons, and the respective amounts for 2010 and 2012 were 1008,5 tons and 1568,9 tons accordingly. The majority of generated waste is assigned to the 020103 code, which is plant-tissue waste. Waste category 020110 is almost absent (i.e. very low proportion, nearly 0 %) in all years' range. In more detail, most dominant fraction for the year 2008, was 'plant-tissue waste' (under the code 020103), with 452,4 tons, followed by the 'sludges from washing and cleaning' category (under the code 020101), with 75,1 tons. Similarly, dominant fraction for the year 2010, was 'plant-tissue waste' (under the code 020103), while all other waste categories were poorly represented (around 0,0% - 1,0% each). For the year 2012, the results are also similar, with dominant fraction the 'plant-tissue waste' (020103), and all other waste categories following with percentages ranging from 0,0% to 3,5%.

3.1.10 Industrial Waste

Southwest Region presents a considerable industrial activity which covers many different production sectors (Mining and Quarrying, Manufacturing and Electricity - Gas - steam and air conditioning supply).

According to the data provided by the State Statistical Agency for the Industrial sector (2014) and focusing on the non - hazardous industrial waste, in Southwest Region is produced 153539,2 tons of non hazardous industrial waste, almost the 8,5% of the overall country production. In more details the previous mentioned data are summarized in the following Table.

Table 3-20: Industrial Waste in Southwest Region (2014)

	Mining and quarrying waste (t)	Manufacturing waste (t)	Electricity, gas, steam and air conditioning supply waste (t)	Total industrial waste (t)
Southwest Region	5216.1	151621.2	233.9	157071.2

Table 3-21: Industrial Hazardous Waste in Southwest Region (2014)

	Mining and quarrying hazardous waste (t)	Manufacturing hazardous waste (t)	Electricity, gas, steam and air conditioning supply hazardous waste (t)	Total hazardous waste (t)
Southwest Region	94.6	3436.1	1.35	3532

Table 3-22: Industrial non-Hazardous Waste in Southwest Region (2014)

	Mining and quarrying non – hazardous waste (t)	Manufacturing non – hazardous waste (t)	Electricity, gas, steam and air conditioning supply non – hazardous waste (t)	Total non – hazardous waste (t)
Southwest Region	5121.5	148185.2	232.6	153539.2

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

The main centres of industrial activities and the legal entities in Southwest Region are presented in par. 2.14 of the Regional Waste Management Plan.

3.2 SOCIO - ECONOMIC DESCRIPTION OF THE REGION

3.2.1 Labor force and number of employees

A) Labor force in the country

The labor force comprises all employed and unemployed persons, thus the economically active population.

Working age population by economic activity in the Republic of Macedonia according to the available data from State Statistical Office of the last 5 years is presented in the table below:

Table 3-23: Working age population by economic activity for Republic of Macedonia

Economic activity	2011	2012	2013	2014	2015
Labour Force	940048	943055	956057	958998	954924
Employed	645085	650554	678838	690188	705991
Of which Unpaid family workers	61705	55336	60889	60747	56032
Employed (without Employed in agriculture)	524192	537931	551652	562750	579865
Active agricultural population	120893	112623	127186	127438	126126
Unemployed	294963	292502	277219	268809	248933
Inactive population	716166	726910	716403	714497	721735

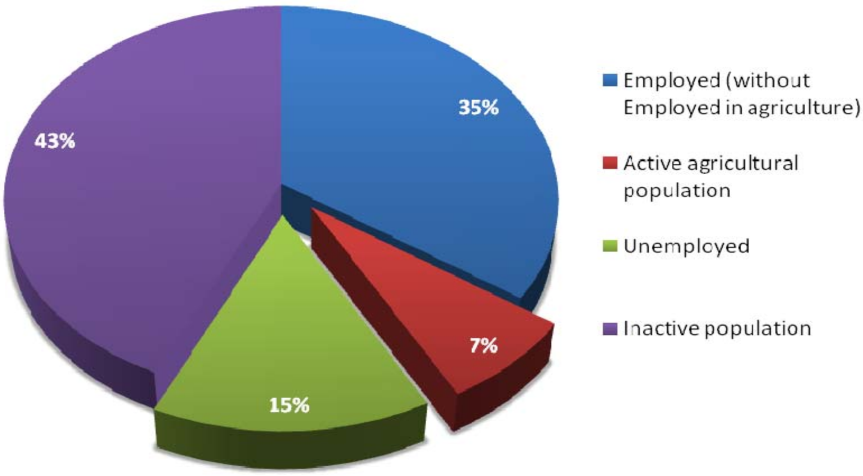
Source: State Statistical Office of the Republic of Macedonia, Labour Force Surveys, 2011-2015

Although the economically active population increases was increasing 0,8% on average annually until 2014, there has been a decrease of 0,42% for the year 2015. The highest increase is in active agricultural population was in 2013 were it was increased 13% comparing to the previous year. Unpaid family workers have also been increasing in the period, 2,3% on average.

Number of the inactive population has been inconsistent in the period, with a decrease from 0,27% to an increase to 1,5%.

The structure of the labour force in the Republic of Macedonia for the year 2015 is presented in the figure below:

Figure 3-16: Working age population by economic actvity in the Republic of Macedonia, 2015

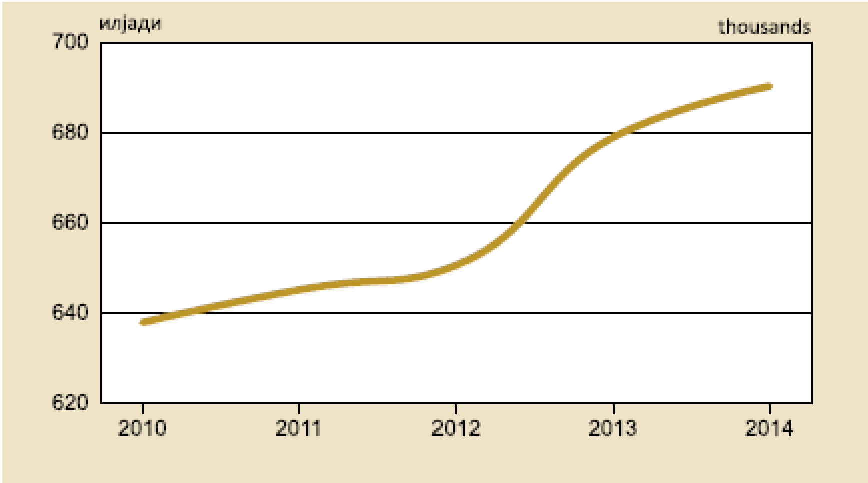


The largest share of the working age population in 2015 was the inactive population with a share of 43%, followed by the employed people with a share of 35%.

B) Number of employees in Republic of Macedonia

In the period from 2010 to 2015, the highest number of employed persons, 705991, was registered in 2014 and the lowest number, 637855, was registered in 2010.

Figure 3-17: Number of employees in the Republic of Macedonia in the previous years



Source Environmental statistics 2015 (data derived from State Statistical office of the Republic of Macedonia)

The number of employees in each sector of activity in Republic of Macedonia for the last four years is presented in the following table.

Table 3-24: Number of employees by sector of activity* in Republic of Macedonia

	2012	2013	2014	2015
Total	**650554**	**678838**	**690188**	**705991**
Agriculture, forestry and fishing	112623	127186	127438	126126
Mining and quarrying	5636	7085	7378	6681
Manufacturing	126892	131542	132937	137151
Electricity, gas, steam and air conditioning supply	10614	10602	9714	9558
Water supply, sewerage, waste management and remediation activities	10146	10076	11358	12062
Construction	41024	46955	48143	49866
Wholesale and retail trade, repair of motor vehicles and motorcycles	92822	91696	93265	97227
Transportation and storage	30411	37636	38789	35698
Accommodation and food service activities	23507	23986	24722	26944
Information and communication	11231	11039	13883	14525
Financial and insurance activities	9110	9274	8400	10148
Real estate activities	813	945	892	1265
Professional, scientific and technical activities	16486	13611	14305	12354
Administrative and support service activities	10408	11500	12804	11884
Public administration and defence, compulsory social security	43915	45066	48363	51743

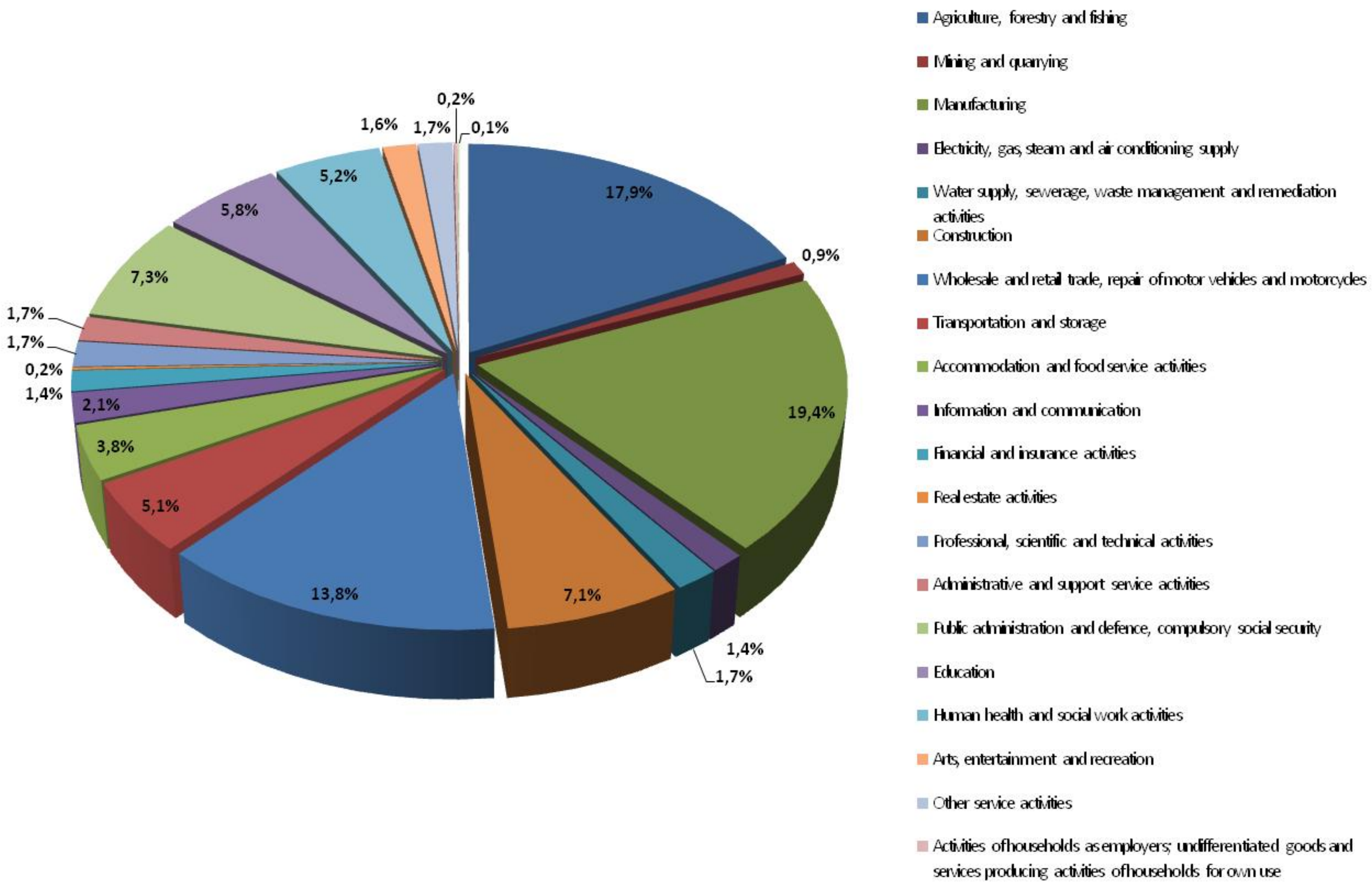
Education	42514	41467	40268	41167
Human health and social work activities	36091	37912	36807	36525
Arts, entertainment and recreation	10066	9579	9230	11421
Other service activities	13821	9979	10315	11703
Activities of households as employers; undifferentiated goods and services producing activities of households for own use	1344	1072	1025	1297
Activities of extraterritorial organisations and bodies	1080	632	-	646

Source Environmental statistics 2015 (data derived from State Statistical office of the Republic of Macedonia)
**For sectors of activity the National Classification of Activities according to the NACE Rev.2 is applied*

In the period from 2012 to 2015, the sectors Manufacturing (19%) and Agriculture, forestry and fishing (18%) had the highest share in the total employment, followed by Wholesale and Retail Trade Repair of Motor Vehicles and Motorcycles with share of 14% of the employees. Less were the employees in Activities of households as employers; undifferentiated goods and services producing activities of households for own use and Activities of extraterritorial organizations and bodies

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

Figure 3-18: Distribution of the number of employees by sectors in 2015



C) Average wage

Latest data from the State Statistical office of the Republic of Macedonia show that the average monthly net wage is 22356 MKD, for April of 2016. Regarding previous years, data indicate that net wage has been increasing.

Table 3-25: Average monthly net wage by year, Republic of Macedonia

	2010	2011	2012	2013	2014	2015
	M1 – M12					
Average monthly net wage, MKD	20554	20848	20903	21146	21394	21904
Monthly salary growth, y/y, %		1.4%	0.3%	1.2%	1.2%	2.4%

Source: MAKstat database, Republic of Macedonia

Average net wage per employee (MKD) by sectors for the period 2014-2014 in Republic of Macedonia is shown in the following tables.

Table 3-26: Average monthly net wage in 2015, by quarters, MKD Republic of Macedonia

	2015				2014			
	I	II	III	IV	I	II	III	IV
Total	**21443**	**21947**	**21923**	**22302**	**21091**	**21297**	**21282**	**21904**
Agriculture, forestry and fishing	14867	15814	16360	16213	15217	15571	16447	16095
Mining and quarrying	24908	25668	26250	26357	24840	22193	24681	25497
Manufacturing	16009	16462	16614	17283	15708	15990	16292	16713
Electricity, gas, steam and air conditioning supply	37139	36963	36706	36623	36286	36862	36822	3700
Water supply, sewerage, waste management and remediation activities	19095	19363	19572	19666	18793	18992	18986	19063
Construction	18312	19347	19579	19966	17776	18789	18838	18953
Wholesale and retail trade, repair of motor vehicles and motorcycles	19739	20349	19584	20424	19529	19693	19632	20316
Transportation and storage	21882	22217	22502	22570	22823	22976	22753	23143
Accommodation and food service activities	14948	14973	15407	15045	14721	14981	15144	15212
Information and communication	34211	34918	34841	36966	35072	34208	34164	35327
Financial and insurance activities	39087	39974	39235	40854	38024	38739	38597	39802
Real estate activities	24465	24779	24414	24505	25858	27900	25780	26394
Professional, scientific and technical activities	27412	29694	29635	29632	28545	29085	28918	30792
Administrative and support service activities	14878	15144	15397	15880	14486	14615	14424	14491
Public administration and defence, compulsory social security	25649	26146	25811	26155	25084	25288	25058	25874
Education	22117	22164	22164	22273	21305	21353	21226	22119
Human health and social work activities	24544	24831	24589	24383	23255	23670	23559	24457
Arts, entertainment and recreation	19238	20988	23085	21328	18046	18025	18206	18629
Other service activities	25119	25982	27443	25990	23265	23727	23926	24606

Labor force in Southwest region

The activity rate of the region comprises the share of the labour force in the working age population, thus all persons aged between 15 and 79 years old. Employment rate is the share of employed persons in the working age population. The Southwest region registers lower average employment rate than the national average.

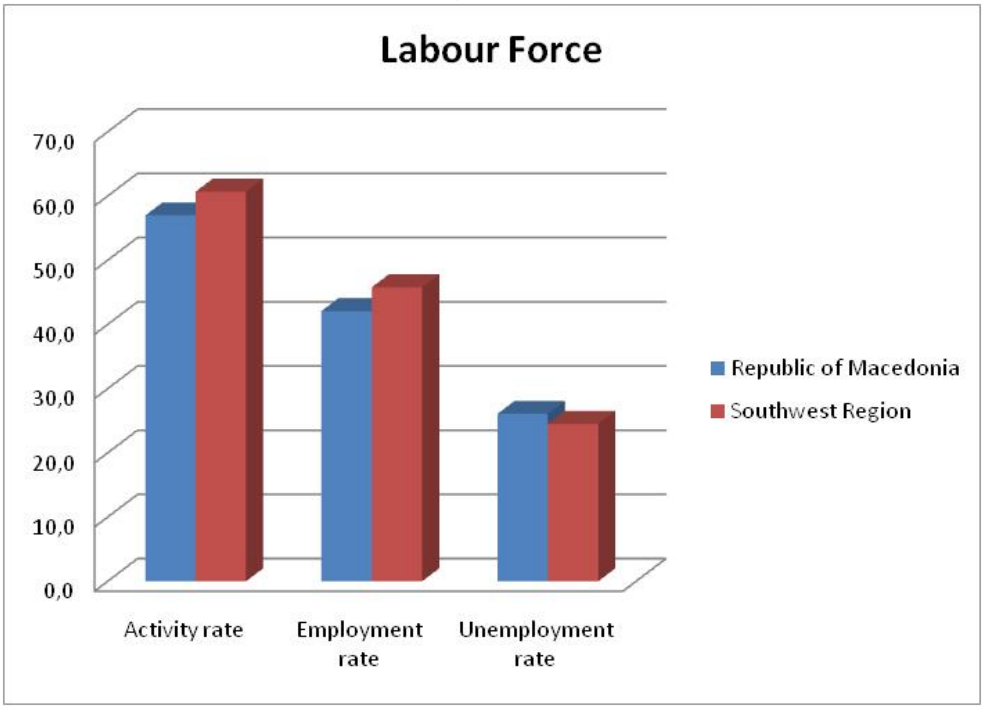
Data for population, working age population and labor force in Republic of Macedonia and Southwest region in 2015 are presented in the following table.

Table 3-27: Labour force in Republic of Macedonia and Southwest region in 2015

	measure	Republic of Macedonia	Southwest Region
Population	persons	2064032	220325
Working age population	persons	1676659	181293
Activity rate *	%	57.0	54.9
Employment rate*	%	42.1	36.2
Unemployment rate*	%	26.1	33.9
Labour Force	persons	955696	99530
Employed	persons	437608	61458

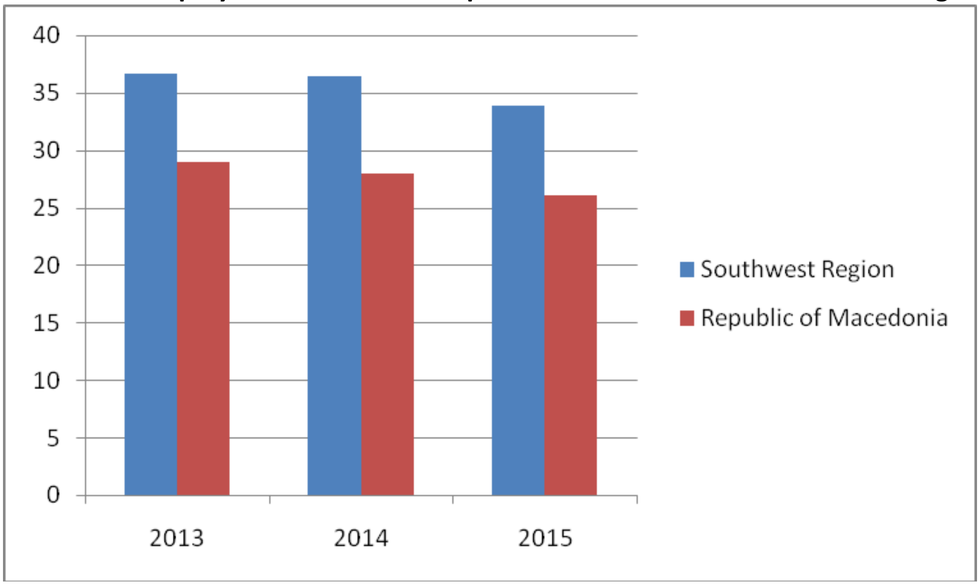
Source: State Statistical Office of the Republic of Macedonia, Regional Yearbook, 2016
* of the population aged 15 years and over.

Figure 3-19: Labour force in Southwest region compared to the Republic of Macedonia, %



As presented in the following chart, unemployment rate in the region has been decreasing for the years 2013 to 2015 but remains still above the national average.

Figure 3-20: Unemployment rate in the Republic of Macedonia and Southwest region, %



3.2.2 Gross Domestic Product

The following table presents the GDP per capita in denars for years 2010, 2011, 2012 and 2013 for Republic of Macedonia and for Southwest Region.

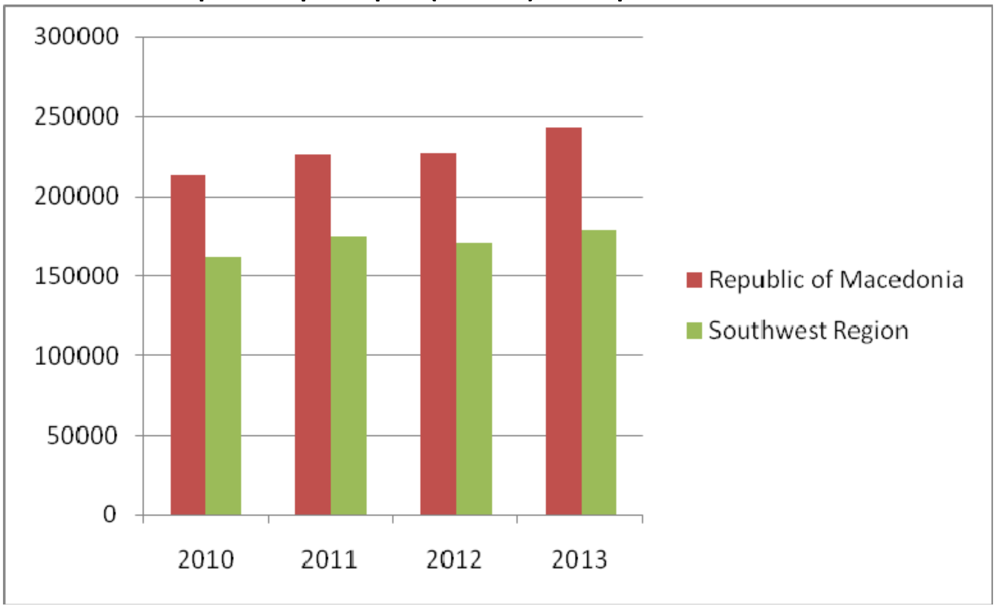
Table 3-28: Gross Domestic Product, per capita (MKD)

Year	Republic of Macedonia	Southwest Region	
2010	212795	161492	75.9%
2011	225493	174509	77.4%
2012	226440	170493	75.3%
2013	243161	178726	73.5%

Source: State statistical office, Regions of the Republic of Macedonia 2015 and 2016

According the data in the above table GPD per capita in Southwest Region for years 2010 - 2013 is lower than the average GDP per capita in the Republic of Macedonia.

Figure 3-21: Gross domestic produst per capita (in MKD) for Republic of Macedonia and Southwest region



The GDP in million denars for Republic of Macedonia and Southwest Region is presenting in the following table.

Table 3-29: Gross Domestic Product, in million denars

Year	Republic of Macedonia	Southwest Region	
2010	437296	35828	8.2%
2011	464187	38657	8.3%
2012	466703	37652	8.1%
2013	501891	39378	7.8%

Source: State statistical office of the Republic of Macedonia

Figure 3-22: Gross domestic product in million denars for republic of Macedonia and Southwest region

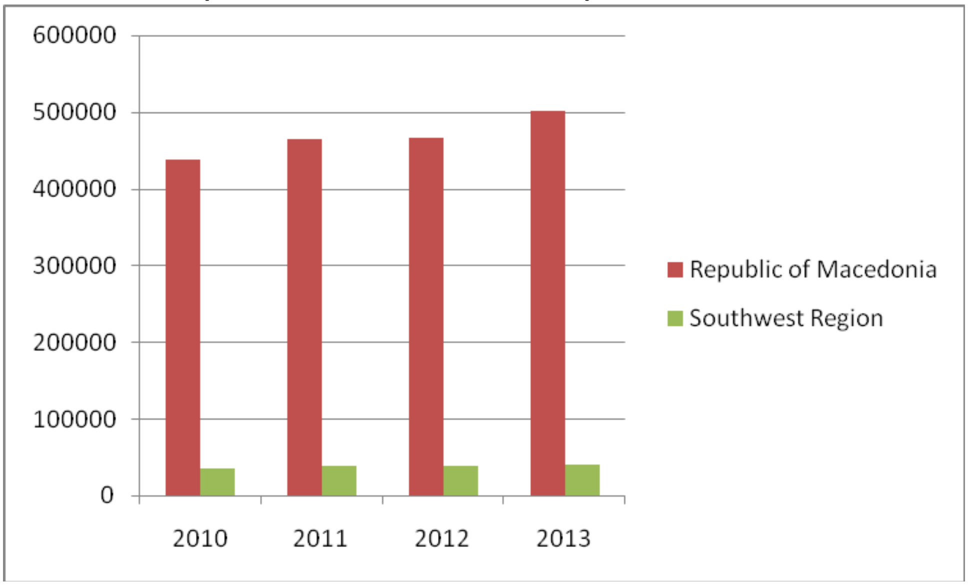


Table 3-30: Gross value added, by Sector of activity, by year, in million MKD, (% of total for the year)

	Republic of Macedonia			Southwest region		
	2011	**2012**	**2013**	**2011**	**2012**	**2013**
Gross value added	399376	403684	436706	33259	32568	34264
A Agriculture, forestry and fishing	43405	42493	50327	2505	1864	2241
B_E Mining, manufacturing, electricity, gas and water supply, sewerage , waste management, remediation activities	76013	71689	75397	6872	6163	5172
F Construction	24215	26695	35725	2310	2264	3076
G_I Wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and storage; accommodation and food service activities	79423	78150	92403	7178	7405	8681
J Information and communication	15942	16167	16177	240	116	89
K Financial and insurance activities	11327	13542	13863	521	677	692
L Real estate activities	56665	59862	60259	6764	7267	7355
M_N Professional, scientific and technical activities; administrative and support service activities	14371	14852	16058	874	652	605
O_Q Public administration and defense; compulsory social security; education; human health and social work activities	66496	69317	64277	5307	5458	5455
RSTU Arts, entertainment and recreation, repair of household good and other services	11518	10917	12221	689	702	897
Source: State Statistical Office Regional Yearbook 2016, ISSN 1857-6141						

3.2.3 Average income and available assets by decile group

Average net wage in Southwest region

Data provided by the State Statistical Office (Regions of the Republic of Macedonia, 2016) show that the index of the average monthly net wage paid per employee in 2015, compared to 2014, was 102,4. This increase is due primarily to the increase in the average monthly net wage paid per employee in the: Pelagonija Region (3,2%), East Region (3,1%) and Vardar Region (2,8%). The highest average monthly net wage paid per employee in 2015, compared to the overall average in the Republic of Macedonia, was observed in the Skopje Region (18,1%), while the lowest average monthly net wage paid per employee in 2014, compared to the overall average in the Republic of Macedonia, was recorded in the East Region (25,7%).

Table 3-31: Average net wage per employee, for the Republic of Macedonia and Southwest Region, MKD per year

	Republic of Macedonia			Southwest Region		
	2013	**2014**	**2015**	**2013**	**2014**	**2015**
Average net wage, paid in denars	21145	21394	21906	19329	19460	19670
A Agriculture, forestry and fishing	15639	15843	15821	17783	15595	15583
B Mining and quarrying	23293	24240	25761	16603	17386	18521
C Manufacturing	15747	16177	16594	14750	15140	15764
D Electricity, gas, steam and air conditioning supply	36362	36740	36856	35072	35395	33631
E Water supply; sewerage, waste management and remediation activities	18714	18959	19421	15633	15649	16084
F Construction	17302	18589	19306	15147	15800	17203
G Wholesale and retail trade; repair of motor vehicles and motorcycles	19263	19794	20024	13169	13318	14018
H Transportation and storage	22399	22923	22296	17998	18669	18418
I Accomodation and food service activities	15293	15015	15096	13430	13228	13706
J Information and communication	35214	34692	35241	18817	18535	20276
K Financial and insurance activities	37583	38791	39789	34701	35860	33802
L Real estate activities	25183	26489	24540	23774	24773	21193
M Professional, scientific and technical activities	27488	29332	29102	17477	19911	20322
N Administrative and support service activities	14002	14503	15330	13585	13166	14013
O Public administration and defence: compulsory social security	25054	25325	25942	22394	22536	22849
P Education	21235	21501	22180	20542	20849	21470
Q Human health and social work activities	23104	23736	24586	20923	21365	22004
R Arts, entertainment and recreation	17725	18230	21173	13914	14025	17231
S Other service activities	23573	23876	26129	18018	20913	23608

According to data from the State Statistical Office, the average household size for the Southwest region is 3,8 persons per household (Census 2002), higher than the country average 3,58 persons per household. The average household size varies from 2,8 in Debarca to 5 persons per household in Debar.

The annual publication "Household Consumption in the Republic of Macedonia" of the State Statistical Office provides data for the average household income and the ten decile groups of the Republic of Macedonia. According to the State Statistical Office, for the years 2014 and 2015 the average annual income per household in the Republic of Macedonia is 336,289 MKD and 360,198 MKD respectively. Data concerning the income in Southwest region are not provided from the State Statistical Office. In order to estimate the average annual income for years 2014 and 2015 in this region, the proportion of Southwest Region GDP in the Country's GDP was used.

Table 3-32: Total available assets on average, per household for 2014, MKD

		Decile groups by available assets						
	average	**first**	**third**	**fourth**	**fifth**	**sixth**	**eighth**	**tenth**
AVAILABLE ASSETS	336289	6 864	163881	210946	250712	303662	449582	853714
Monetary income	320318	63534	155338	195626	237658	288378	431615	817852
Income on the basis of regular work	205646	5307	54377	77902	148055	188140	330959	593119
Income on the basis of part-time work	11413	14293	15746	14718	14870	3319	16323	5647
Income on the basis of pension scheme	68308	25936	65011	73499	52516	72198	62144	105423
Other income on the basis of social insurance	5002	12151	1914	6828	1895	3442	4258	3550
Income from abroad	8 637	2 038	10 245	10 090	11 626	3 967	5 165	28 097
Net income from agriculture	16180	585	2997	4604	3250	1 473	8894	80113
Property renting and selling	883	342	-	313	1366	944	-	1538
Donations, gifts and similar contributions	560	1419	33	294	344	508	-	-
Loans (Borrowings)	290	11	299	9	-	-	-	-
Savings decrease	3398	1452	4715	7368	3737	4388	3871	365
Other incomes	3	100	-	-	-	-	-	-
Source: State Statistical Office								

Figure 3-23: Household income in Republic of Macedonia and Southwest region in 2014 by decile groups

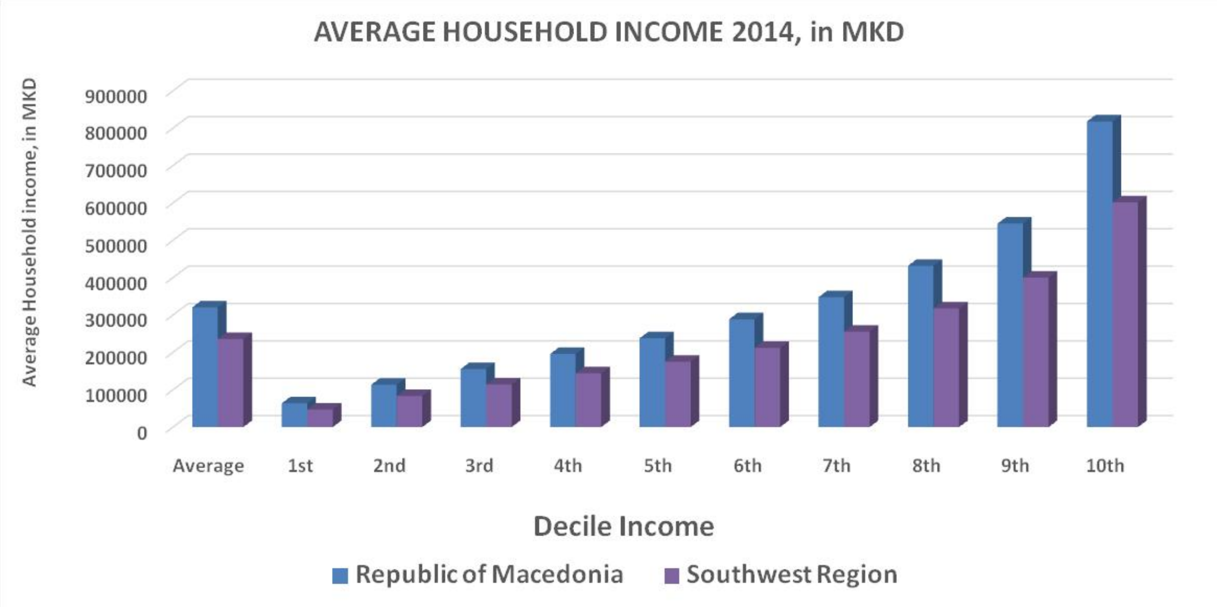
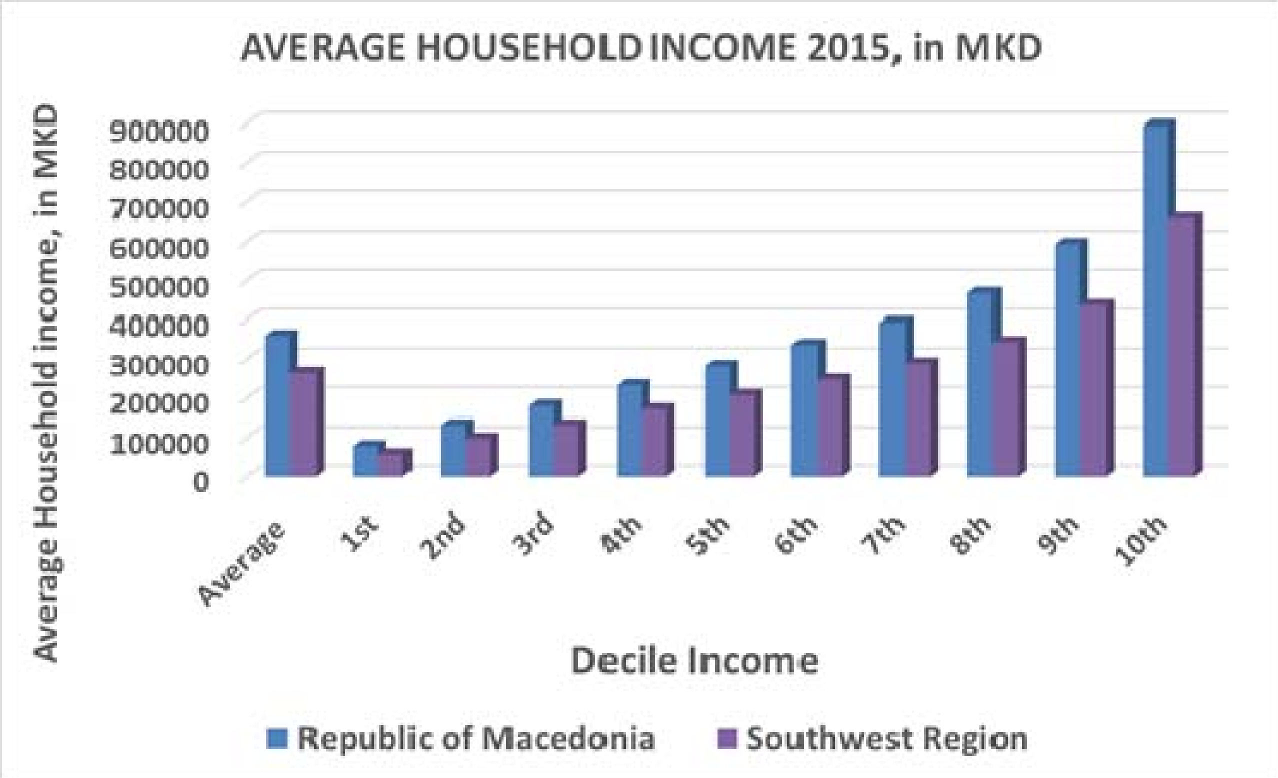


Table 3-33: Total available assets on average, per household for 2015, MKD

		Decile groups by available assets						
	average	first	third	fourth	fifth	sixth	eighth	tenth
AVAILABLE ASSETS	360,198	78,654	180,524	233,329	282,486	336,780	467,888	895,162
Monetary income	349,430	77,065	172,689	228,908	273,561	326,705	455,419	862,925
Income on the basis of regular work	225,129	11,606	57,195	120,692	167,038	210,664	317,511	650,728
Income on the basis of part-time work	10,762	7,357	21,318	14,956	15,052	7,212	11,900	10,990
Income on the basis of pension scheme	71,774	34,913	63,879	75,097	56,686	76,934	83,245	89,642
Other income on the basis of social insurance	6,413	11,379	7,041	4,145	4,774	5,009	5,580	6,749
Income from abroad	8,848	4,805	7,522	5,662	15,252	7,036	11,500	9,395
Net income from agriculture	16,648	344	5,357	2,481	5,676	8,932	15,356	80,495
Property renting and selling	1,947	-	506	1,323	29	566	3,573	7,772
Donations, gifts and similar contributions	1,687	2,455	3,778	411	2,323	2,904	1,291	596
Loans (Borrowings)	393	567	935	40	91	280	923	905
Savings decrease	5,769	3,638	5,158	4,100	6,271	7,169	4,540	5,652
Other incomes	60	-	-	-	370	-	-	-
Source: State Statistical Office								

Figure 3-24: Household income in Republic of Macedonia and Southwest region in 2015 by decile groups



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

3.3.1 Institutional Framework

The Competent Authority for preparing and adopting all legal instruments and to implement all waste related directives is the MoEPP as the national public administration responsible for environmental affairs. The competent authorities for carrying out inspection and other enforcement tasks are generally the State Inspection for Environment and the Local Inspection Authorised Inspectors (municipalities). The internal distribution of tasks and responsibilities does exist within the MoEPP and is based on the present structure of the MoEPP; the main role has the waste management is the establishment of the new waste management department with abroad scope of responsibilities and activities: planning, adopting and implementation of legislation, standards and rules on the management of various waste streams, monitoring, issuing permits for waste collectors, transporters, exporters and operators of waste management facilities as well as initiation and co-ordination of waste management projects. Preparation of the main primary and secondary legislation is carried out by the EU Department.

Tasks and responsibilities on the waste management field are in practice split among several institutions in the State. There are some missing activities like acquisition of reliable data on waste and on their generators, on characteristics/constituents of waste or missing registration on waste handlers/operators; such a situation renders any qualitative and quantitative overview on the real waste issue at source as being very difficult.

Regarding waste management issues, the Ministry of Economy (MoE), Ministry of Finance and MoEPP are responsible for common preparation of several regulations related to packaging and packaging waste and other end-of-life products. Inspection of the fulfilled requirements related to the products on the market is the obligation of the State Market Inspectorate (within MoE). The Ministry of Finance (MoF) plays an important role in decision making/taking and in implementation of available and effective financial/economic instruments and funds to encourage the development of waste management, in particular on approval of setting fees/charges/surcharges/earmarked taxes, management of earmarked funds, and on the cost recovery mechanisms for MSW investments and executed services. MoF is in charge of the allocation of annual budgets for all Ministries and local communities, and executes expenditure monitoring, provides co-financing for projects under international financial support (grants, loans, warranties, etc) and finally, it approves the appointment of new employees in the State institutions.

The Ministry of Health (MoH) and the MoEPP are obliged to prepare and to adopt regulations as well as to inspect the implementation of medical waste management. Collection, treatment and final disposal of animal by-products and survey on active substances for plant protection are the responsibility of the Ministry of Agriculture, Food and Water Environment (MoAFWE). The Ministry of Transport and Communication (MTC) is responsible for International regulations and required documentation for hauliers transporting dangerous or hazardous goods by road or by vehicles on ships (ADR licences).

As a consequence of the decentralization process in the country, a lot of responsibilities were delegated to the municipalities. The municipalities are responsible for many important activities: organising the collection, transportation and disposal of municipal wastes; supervising transportation and disposal of industrial non–hazardous waste, deciding on the location of waste management facilities, issuing local regulations on waste management, financing and supervising dump/landfill closures and termination of waste management facilities. It is confusing that municipalities grant construction permits even if it is for their own investments and they even grant environmental permits (IPPC B-permits). The establishment of non-hazardous and inert waste landfills is also the responsibility of the municipalities. However, still a great deal of effort will be required to establish local administrative and expert institutions as well as operative organisations on the inter-municipal level, which shall be established and adopted by all involved municipalities.

In order to achieve successful co-ordination in the development process of the contemporary waste management system, monitoring and enforcement of waste management in the country, all institutions should strengthen their capacities by additional re-organisation and financial resources, by additional employment and also by executing adequate training of staff at a national, regional and local level.

Operative stakeholders in the waste management process execute the collection, treatment and landfill operations for all kinds of waste, regardless of their hazardous properties: public enterprises, waste handlers, and informal collectors of usable waste fractions. Some enterprises are in possession of their assets and operate their own waste treatment facilities and landfills. However, in spite of the existing legal basis for gathering, recording and reporting on wastes that enter/leave the waste management process, environmental monitoring of waste management facilities is almost not carried out, a functioning data recording and reporting system is not fully operative yet.

Other institutional stakeholders in waste management processes and development are associations like the Association of Local self government units (ZELS), Chamber of Commerce, Association of Public communal enterprises, Association of Waste Handlers, NGO-s and scientific institutions of universities. Institutional stakeholders in waste management are particularly active in consultations regarding legislation, waste management functioning and financing, recognition and explanation of relationships between environmental parameters, development of environmental technologies and monitoring, and in the presentation of interests of different groups of society regarding waste management issues in the country.

State Environmental Inspectorate

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

As of January 2011, SEI consisted of the Director, who coordinates the activities of the Inspectorate, 13 State inspectors for the environment located in Skopje-5, Tetovo-3, Bitola-1, Gostivar-1, Strumica-1, Stip-1 and Veles-1. At the same time, as a transitional measure, five of these inspectors act as State nature protection inspectors (Skopje-3, Strumica-1 and Bitola-1). SEI is also composed of a Technical Secretary in Skopje and a younger collaborator for administrative issues in Gostivar. These staff members are mainly administrative and technical workers, and do not perform inspection duties.

In addition to the central office in Skopje, SEI has 10 branch offices. The procedures for inspection supervision by State environmental inspectors and State nature protection inspectors are defined by the Law on Environment and the Law on Nature Protection. At the same time, other laws determine the specific jurisdiction of inspection supervision in accordance with subject matter.

SEI no longer has the legal obligation to submit their annual inspection plans to MoEPP for approval, apparently leaving SEI to communicate to MoEPP based on goodwill. Additionally, cutting the responsibilities of the state environmental inspector in the process of issuing IPPC and waste management permits, as previewed in the current draft amendments to the Law on Environment, leads to even further reduced communication and coordination between these two institutions.

Regarding the local level, SEI communicates directly with the local authorized environmental inspectors regarding performed inspections and inspection plans. The Mayors of the LSGUs have the responsibility to send to SEI their annual inspection plans for approval. Communication between central and local level is currently not as effective as it needs to be.

In terms of coordination, SEI is the national authority for enforcement of environmental legislation and therefore has the responsibility for the supervision of local environmental inspection plans.

SEI must increase the level of communication and coordination with the Environmental Administration in MoEPP regarding inspection of different environmental issues (IPPC, waste, etc.).

Office for the Spatial Information System

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

This system basically features a few functions, such as:

- A mapping basis for daily evidence and management of data and information obtained from the environmental media databases, which are maintained and managed;
- A basis for the adoption of strategic decisions in the area of environmental protection and management;
- Media for presentation of data and information.

Environmental Administration

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

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

The Environmental Administration is an integral part of MoEPP. The Director is appointed by the Government. Although appointed by the Government, AE is under MoEPP administrative supervision. The Environmental Administration started with a staff of about 25-30 people and is growing both in terms of human capacity as number of units.

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

- Implementing environmental laws;
- Informing the public about environmental protection;
- Providing scientific support to the Government;
- Liaising with EEA when preparing the state of the environment reports or other environmental assessments[16].

At the moment, the above functions are performed by the Environmental Administration as a body within the MoEPP.

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

Merging EA, SEI and Department for Physical Planning and grouping the functions in a single entity could improve performance and efficiency while at the same time displaying the political commitment to implementation of environmental legislation in the country.

Centres for development of the planning regions (CDPR)

The Centres for development of the planning regions (CDPR) are 8 (eight) in Republic of Macedonia, formed in accordance with the law of Balanced Regional Development.
The policy of regional development is a system of objectives, instruments and measures aimed to reduce regional disparities and achieve balanced and sustainable regional development. This is accomplished through: increasing cooperation among planning regions by capacity building, optimizing and valorising natural wealth, human capital and economic characteristics of the different regions, conserving, developing and promoting the special identity of planning regions, revitalizing the villages, developing areas with the specific needs, supporting inter-municipal and cross-border cooperation of local self-government units to promote balanced regional development and increase the quality of life for the citizens in the region.
CDPRs perform the following tasks:

•Prepare the proposed program for development of the planning region
•Prepare the proposed action plan for implementation of the program for development of the planning region
•Prepare project proposal for development of the planning region and for the areas with special development needs
•Coordinate the activities related with implementation of the program for development of the planning region and realize the projects for development of the planning region
•Provide information to all stakeholders for the realization of program for development of the planning region and other issues related to regional development
•Provide professional and technical assistance to the local self government units for preparing development programs
•Provide professional services to the Associations for citizens and other stakeholders for preparating projects related to regional development
•Promote inter municipal cooperation in the frame of planning development
•Implement project for promoting development of the planning region, financed by EU funds and other international sources
•Promote developmental potentials of the planning region
•Provide professional, administrative and technical tasks for the needs of the Council for development of the planning region.

The Centres for development of the planning regions (CDPR) in the four project pilot regions are specific stakeholders, and although they are not directly involved in the waste management system, in the reality have a focal role for the project on the regional level, reflected also in their participation in the PSC. The RDC are active structures, with gained trust among the municipalities of the respective regions, as well as experience in coordinating municipalities for different activities on regional level. The CDPR were involved in the setting of the intermunicipal waste management boards/enterprises as well, being coordinators and providing an acting provisional manager for the regional waste management bodies established. In this position and situation they exercise high influence to all local stakeholders.
The CDPR are involved in the project from the beginning of its implementation and have demonstrated a very strong interest and support to the project activities. It is expected that this activeness and support will continue throughout the project implementation period and the CDPR will have a central role in coordinating the municipalities for different activities on regional level, support and strengthening of the intermunicipal waste management boards/enterprises. The interest of the CDPR may be defined to a great extent in terms of the Centres' institutional goals and drive towards accumulating experience, influence and trust.

3.3.2 Organisational Framework

Intermunicipal Waste Management Board

Management Boards have been recently established and is fully operational. The Intermunicipal Boards shall be seen as a complementary body to the Inter-municipal Waste Management Enterprise creating a clear distinction between planning/ contracting and operations, which will result in greater transparency and potentially higher cost efficiency.

Based on the assumption that the IWMB is and will be a planning and contracting unit and operation will be conducted on contract between the Boards and either the Intermunicipal Waste Management Enterprise, a private contractor or the municipality/ PUE, the functions of the IWMB can be defined as follows:

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

Figure 3-25: The Main Functions of the RWMB

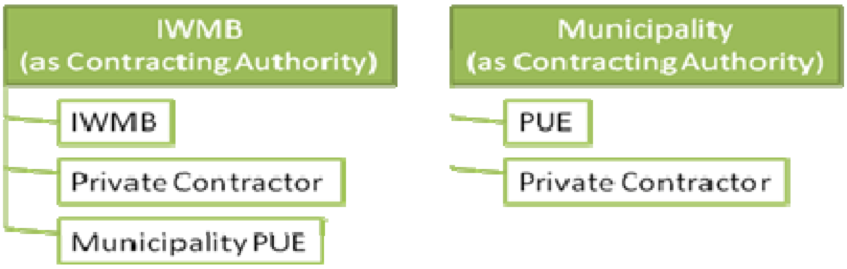
Public Communal Enterprises (PUEs)

The Municipalities hold the overall responsibility for waste management and the Public Utility Enterprises (PUE) are the main service provider of waste management services conducting the daily operation of waste collection services and landfill of waste. The Municipalities retain the responsibility for overall planning of waste management, tariff setting and the oversight of the PUEs.

There are four principal ways for the delivery of waste management services in the future as listed below and illustrated in *the* following figure:

- Through the IWMB with the RWMC as the service provider;
- Through the IWMB with the private sector as the service provider;
- Through the IWMB with a municipality or a local PUE as the service provider;
- Through the municipality with the local PUE or the private sector as the service provider.

Figure 3-26: The Principal Ways for Service Delivery under the Future Waste Management System



The IWMB must decide which services to be provided under the IWMB and how, and which services that will remain under municipal planning and implementation.

Currently, the municipalities hold the overall responsibility for waste management and the PUEs are the main service providers of waste management services conducting the daily operation of waste collection services and landfill of waste. The table below presents the PUEs per municipality.

Table 3-34: Public Utility Enterprises (PUEs) in Southwest Region

Municipality	Administrative structure of waste management			Administrative structure on disposal		Personnel for waste management service
	Name of administrative structure	Scope	% of population serviced	Landfill name	Company operator of the landfill	
Centar Zhupa	PUE Kale	Collection	45%			
Debar	PUE Standard	Collection, Transportation	80%	Town Landfill	PUE	34
Debarca	PUE Debrca	Collection, Transportation	80%		PU Komunalec Ohrid	17
Kichevo	PUE Komunalec Kichevo	Collection, Transportation	65%	Barbaras	PE Komunalec M. Brod	66
Makedonski Brod	PUE "Komunalna Higiena"	Collection, Transportation		Barbaras	PUE "Komunalna Higiena"	15
Ohrid	PE Ohridski Komunalec Ohrid	Collection, Transportation, partly Treatment	99%	Bukono	Nefi IK Dooel	162
Plasnica	PE Komunalec		40%			
Struga	PE "Komunalno"	Collection, Transportation	30%-100%		Tani Company	23
Vevchani	PUE Kale	Collection	100%			

In the municipality of Ohrid, PE "Ohridski Komunalec" has conducted a contract with PAKOMAK DOO – Skopje for use of the bins for packaging waste collection with (plastic, paper and glass) and with DOOEL Nutrivet for collection of baled waste paper and plastic. Additionally, the Contract with "Nutrivet" is semi-annual (renewable) and the income in 2015 from paper was 830046 MKD and from plastic- 88620 MKD.

There were no data provided from rest of the municipalities regarding other companies working in waste management.

3.3.3 Waste Tariffs

3.3.3.1 Legal Basis of the Waste Management System

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

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

According to Article 120 Sources of funding are as follows:

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

Article 121 defines the Fees for the services:

- The fee for collection and transportation of municipal waste shall be approved by the Council of the City of Skopje or Municipalities.
- The fees for collection and transport shall be determined on the basis of quantity and type of waste and expressed in the following units: MKD per square meter, MKD per cubic meter and MKD per kilogram.
- For legal and natural persons who create commercial waste, the price for collection and transportation of waste is determined by concluding special agreement a service provider based on quantity and type of waste expressed as a MKD per kilogram or MKD for cubic meter of waste.
- In setting the fee for the service, at the proposal of the Mayors of Municipalities, the Councils of the Municipalities shall determine incentive fees for households, legal entities and individuals on the basis of established systems for waste selection with aim to reduce the total amount of waste, intended for disposal of landfill.
- The fee of waste disposal shall be set in accordance to the amount of waste delivered for disposal expressed in MKD per ton of generated waste.
- When setting the fee for the services provided, care shall be taken to include the costs for the provided service.

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

Tariffs of waste disposal landfill are set as follows:

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

B. Methodology for calculation and formation of integrated waste management

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

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

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

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

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

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

The tariff is based on the following elements:

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

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

General costs for waste management:

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

Collection costs

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

Capital costs include the following costs:

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

- waste containers.

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

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

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

The individual and collective housing unit price for the service can be: MKD/m^2, MKD/m^3 and MKD/ kg.

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

- large legal entities (manufacturing facilities, shopping centers, factories, banks, hotels, insurance companies, warehouses and other legal entities) for which the unit cost of the service can be MKD/m2 and MKD/m3.
- Small legal entities (supermarkets, grocery, offices, restaurants, etc.), categorized based on the type and quantity of waste unit price for the service can be MKD/m2 and lump sum.
- Schools, kindergartens, health care facilities, retirement homes, religious buildings, etc., for which the unit price of the service can be MKD/m2 and MKD/m3.

Landfill costs

Cost of service is based on capital and operating costs of the service, in accordance with Articles 89 and 90 of the Law on Waste Management and the type of waste. Unit price for performing a service is MKD/tone. Costs for care after the landfill stops working can be recovered by adding a price of landfill entrance. Alternatively, the costs can be financed from the state budget and municipal budgets.

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

3.3.3.2 Current tariff system in Municipalities

The current system for waste management in the country is primarily focusing on waste collection and disposal. There are three categories of waste service users in the part of **households**:

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

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

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

Tariffs are presented separately for each household and business entity in accordance with existing services and the availability of facilities (source questionnaires).

Table 3-35: Tariffs in the Municipalities of Southwest region

Municipality	Existing tariff system for households	Existing tariff system for commercial and private entities
Centar Zhupa		
Debar		
Debarca	150MKD/household / month	
Kichevo	Depends on the property size	Depends on the property size, the activity and the location (rural , urban)
Makedonski Brod		Small stores up to 20 m^2 – Flat rate 457 MKD /year Yard – 2.31 MKD / m^2/year Roof area – 4.57 MKD/m^2/year
Ohrid	240 MKD/ household / month	196 MKD/m^2 /year (for commercial activity with usable area of less than or equal to 100 m^2) 132 MKD/m^2/year (commercial activity usable area larger than 100 m^2 less than 500 m^2) 38 MKD/m^2 /year (usable area larger than 500 m^2) 73 MKD/m^2/year (non-profit activity), 65 MKD/m^2 /year (half price-big hotels winter 6 months for half price)
Plasnica	1800 MKD/ household / year.	A flat rate for commercial facilities costs 4800 MKD / year
Struga	-	-
Vevchani	150 MKD / household / month	Waste collection fee for commercial and private facilities is prepared on a monthly basis of a flat rate/250 MKD for stores, restaurants

The tariffs for individuals vary from 150 MKD/month per household or 1800MKD/year per household to 240 MKD/month per household or 2880MKD/year.
The tariffs of legal entities are differing between municipalities and they are calculated by taking into account the size of property. Unusually high are tariffs in Ohrid and these vary between 38 MKD/m^2 /year to 196 MKD/m^2 /year.

3.3.3.3 Cost of waste management system

Costs of waste management system are divided into:

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

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

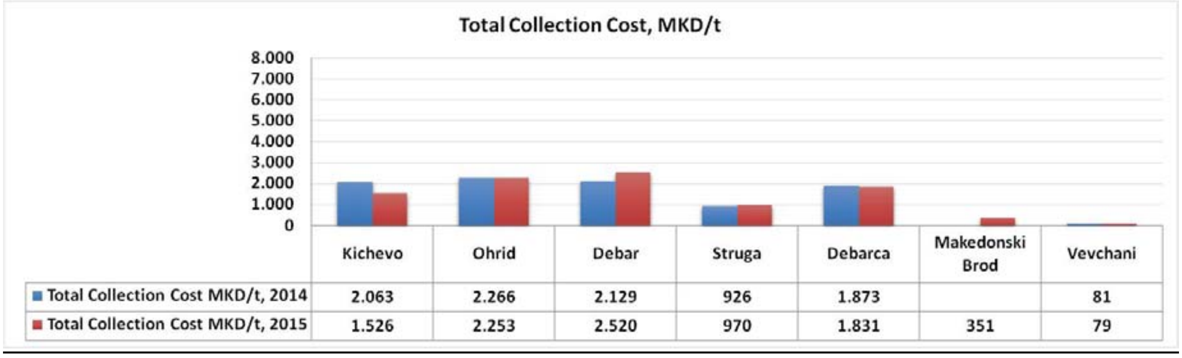
Collection operational costs and unit waste collection cost per t collected residual waste are presented in the following table:

Table 3-36: Collection costs (MKD) and collection cost per t collected waste (MKD/t)

Municipality	Collection cost, MKD		Collection cost per t collected waste (MKD/t)	
	2014	2015	2014	2015
Kichevo	18,972,869	14,033,730	2,063	1,526
Ohrid	45,426,766	45,171,109	2,266	2,253
Debar	12,269,956	14,521,440	2,129	2,520
Struga	8,159,147	8,548,212	926	970
Debarca	804,000	786,000	1,873	1,831
Makedonski Brod		415,738		351
Plasnica				
Centar Zhupa				
Vevchani	1,143,466	1,112,417	81	79

The following diagram presents the collection costs, summarizing the aforementioned data.

Figure 3-27: Collection cost per t collected waste (MKD/t) in Southwest Region



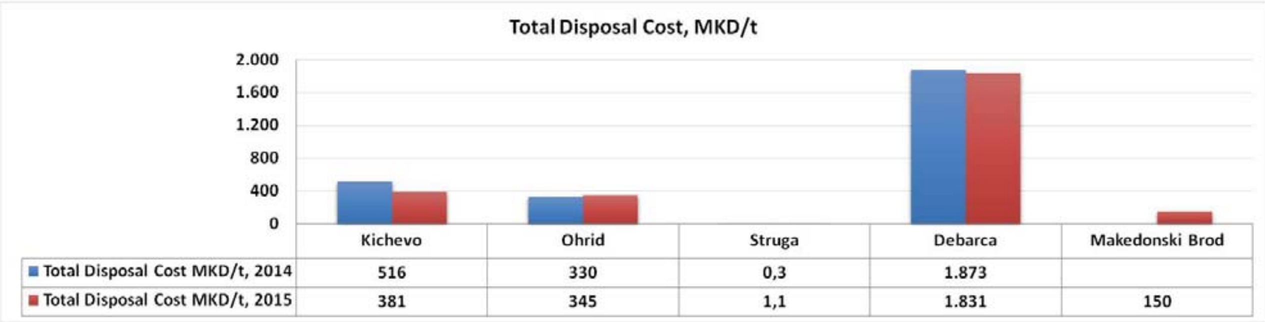
Disposal operational costs and unit waste disposal cost per t collected residual waste are presented in the table below:

Table 3-37: Disposal costs (MKD) and disposal cost per t collected waste (MKD/t)

Municipality	Disposal cost, MKD		Disposal cost per ton collected waste (MKD/t)	
	2014	2015	2014	2015
Kichevo	4,743,217	3,508,433	516	381
Ohrid	6,526,445	6,829,818	326	341
Debar				
Struga	2,998	10,013	0.3	1.1
Debarca	804,000	786,000	1,873	1,831
Makedonski Brod		178,174		150
Plasnica				
Centar Zhupa				
Vevchani				

The following diagram presents the disposal costs, summarizing the aforementioned data.

Figure 3-28: Disposal costs per t collected waste (MKD/t) in Southwest Region



3.3.3.4 Revenues from waste service users

The operating revenues are composed of:

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

Table 3-38: Revenues (MKD)

Municipality	Total waste revenue, (MKD)		Household users , (MKD)		Commercial users , (MKD)	
	2014	2015	2014	2015	2014	2015
Kichevo	46,859,770	44,518,032	26,779,362	25,829,480	20,080,408	18,688,552
Ohrid	98,578,000	99,871,000	66,524,000	67,249,000	32,054,000	32,622,000
Debar	6,716,216	6,237,595	4,307,421	3,703,243	2,408,795	2,534,352
Struga	19,109,168	22,778,578	19,109,168	22,778,578	0	0
Debarca	2,240,000	2,404,000	1,860,000	2,000,000	380,000	404,000
Makedonski Brod	0	233,851	0	74,088	0	159,763
Plasnica	671,900	1,145,147	623,900	1,085,147	48,000	60,000
Centar Zhupa	0	0	0	0	0	0
Vevchani	1,464,410	1,342,198	1,261,260	1,127,850	203,150	214,348
Total	**175,639,464**	**178,530,401**	**120,465,111**	**123,847,386**	**55,174,353**	**54,683,015**

Table 3-39: Revenues (MKD/t)

Municipality	Total waste revenue, (MKD/t)		Household users , (MKD/t)		Commercial users , (MKD/t)	
	2014	2015	2014	2015	2014	2015
Kichevo	5,094	4,840	3,934	3,794	8,396	7,814
Ohrid	4,917	4,982	3,493	3,531	31,979	32,545
Debar	1,165	1,082	1,150	989	1,194	1,256
Struga	2,168	2,584	2,409	2,871		
Debarca	5,218	5,600	6,189	6,655	2,950	3,137
Makedonski Brod		197		69		1,348
Plasnica	1,052	1,794	1,086	1,889	752	940
Centar Zhupa						
Vevchani	104	96	100	89	145	153

Figure 3-29: Revenues per t collected waste in 2014, for Southwest Region

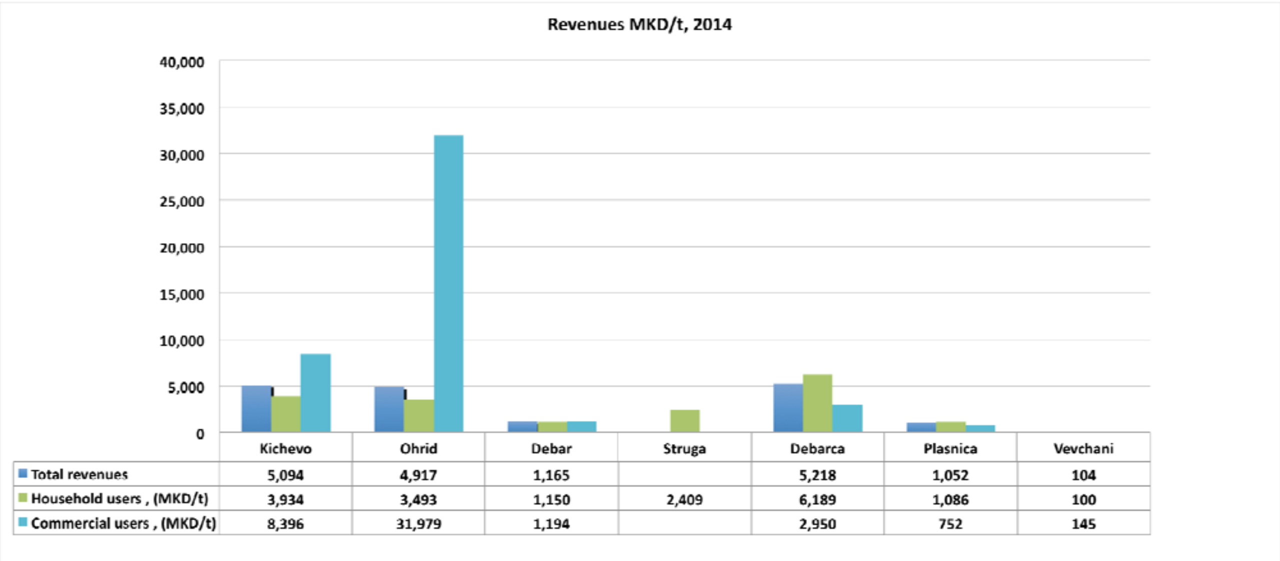
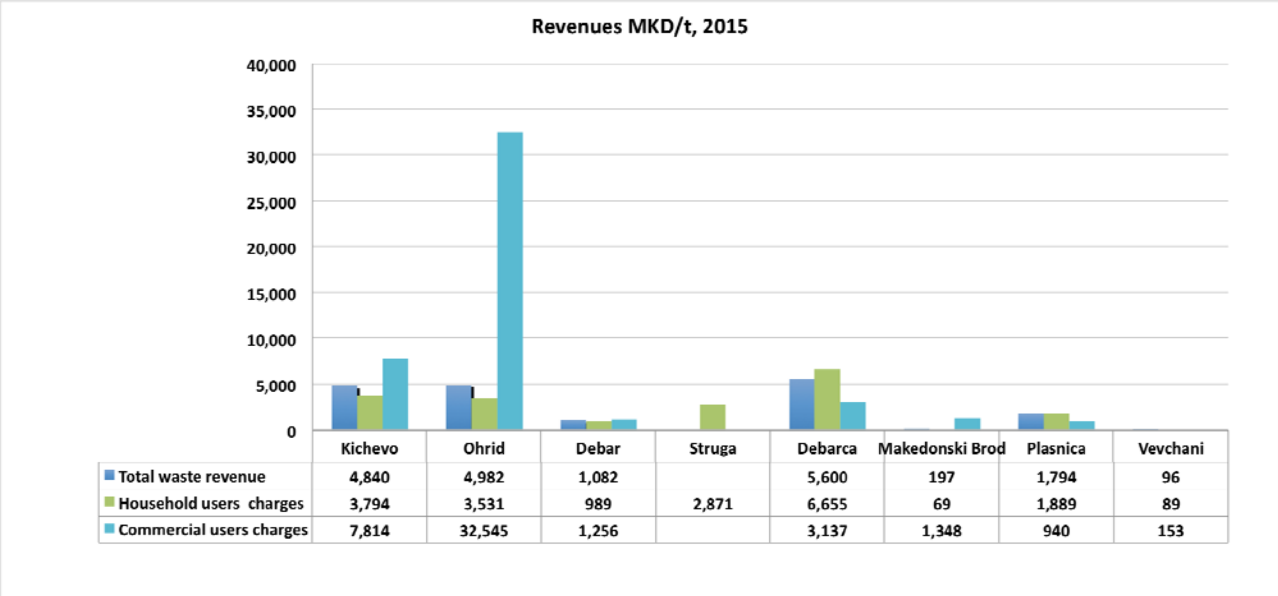


Figure 3-30: Revenues per t collected waste in 2015, for Southwest Region



	Kichevo	Ohrid	Debar	Struga	Debarca	Makedonski Brod	Plasnica	Vevchani
Total waste revenue	4,840	4,982	1,082		5,600	197	1,794	96
Household users charges	3,794	3,531	989	2,871	6,655	69	1,889	89
Commercial users charges	7,814	32,545	1,256		3,137	1,348	940	153

According to the above-presented calculations, in 2014 the total revenues per t of collected waste in the Southwest region vary from 104 MKD/t (Vevchani) to 5,218 MKD/t (Debarca). In 2015 the total revenues per t collected waste vary from 96 MKD/t (Vevchani) to 5,600 MKD/t (Debarca).

3.3.3.5 Affordability

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

According to the State Statistical Office, for the years 2014 and 2015 the average annual income per household in the Republic of Macedonia is 336,289 MKD and 360,198 MKD respectively and the lowest income is 65,864 MKD and 78,634 MKD for the years 2014 and 2015 respectively. Data concerning the income in Southwest region are not provided from the State Statistical Office. In order to estimate the average annual income and the lowest annual income for years 2014 and 2015 in this region, the proportion of Southwest region GDP in the Country's GDP was used. The following table provides the average and lowest estimated annual income for Southwest Region for 2014 and 2015.

Table 3-40: Average and lowest estimated annual income for Southwest Region for 2014 and 2015

Southwest region		
	Average income	Lowest income
2014	247,176	48,411
2015	264,749	57,811

In order to calculate the affordability level, the annual average income for the region, extracted from the State Statistical Office, was taken into consideration. The affordability level in Southwest region for the years 2014 and 2015 is 3,708 MKD and 3,971 MKD, respectively. The following table presents the affordability level, based on the average and the lowest annual income for Southwest region for years 2014 and 2015.

Table 3-41: Affordability level in Southwest region for the years 2014 and 2015

Municipality	% of affordability level based on the average income		% of affordability level based on the lowest income	
	2014	2015	2014	2015
Kichevo	60%	54%	309%	249%
Ohrid	120%	113%	614%	519%
Debar	33%	27%	169%	122%
Struga	47%	53%	242%	241%
Debarca	65%	65%	331%	298%
Makedonski Brod	-	1%	-	6%
Plasnica	33%	53%	167%	243%
Centar Zhupa	-	-	-	-
Vevchani	57%	48%	291%	218%

According to the above calculations concerning the average annual income per household, for all municipalities that provided relevant data, the waste fees per household were not affordable only for the municipality of Ohrid for both years 2014 and 2015. Regarding the lowest annual income per household, the waste fees per household were not affordable for all municipalities for both years 2014 and 2015.

3.3.4 Waste generation and composition

3.3.4.1 Waste generation index

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

Data were collected and recorded per dwelling zone – sector where the waste whose mass was weighed was collected. The obtained waste weightings and results for each municipality are presented analytically in the Assessment Report.

According to the data of waste production in the Region with the contribution of waste from seasonal population, Ohrid Municipality which has the largest equivalent seasonal population, has the largest share (36%) in the regional waste generation while Vevchani Municipality, covers the 0,74% of the overall waste generation in Southwest Region. The weighted average waste production per capita per year of the Southwest Region is 251 kg/capita/yr.

The following table presents an overview of main calculations for annual produced quantities of municipal waste in Southwest Region with the contribution of municipal waste derived from seasonal population.

Table 3-42: Waste generation index per municipality

Municipalities (Southwest Region)	Permanent Population Estimation 2016 (Project team)	Number of tourists nights	Equivalent Seasonal population 2016	Waste Generation for tourists (kg/night)	Waste generation for permanent population (kg/ca/yr)	Generated waste from permanent population, 2016 (t)	Generated waste from tourists, 2016, (t)	Weighted Waste generation (kg/ca/y)
Kichevo	**57,088**	9,543	26	1.2	**214**	**12,197**	11	214
Kichevo urban	*32,065*				*233*	*7,479*		
Kichevo rural	*25,024*				*189*	*4,718*		
Ohrid	**52,257**	967,170	2,650	1.2	**361**	**18,886**	1,161	365
Ohrid urban	*40,648*				*377*	*15,344*		
Ohrid rural	*11,609*				*305*	*3,542*		
Debar	**20,630**	205,272	562	1.2	**315**	**6,503**	246	318
Debar urban	*15,396*				*331*	*5,101*		
Debar rural	*5,234*				*268*	*1,402*		
Struga	**65,202**	400,857	1,098	1.2	**174**	**11,352**	481	178
Struga urban	*39,065*				*189*	*7,368*		
Struga rural	*26,137*				*152*	*3,985*		
Vevchani	**2,449**	-	-	1.2	**170**	**417**	-	170
Vevchani urban	*0*				*0*	*0*		
Vevchani rural	*2,449*				*170*	*417*		
Centar Zhupa	**6,995**	62,641	172	1.2	**125**	**872**	75	125
Centar Zhupa urban	*0*				*0*	0		
Centar Zhupa rural	*6,995*				*125*	872		
Debarca	**4,066**	-	-	1.2	**198**	**805**	-	198
Debarca urban	*0*				*0*	*0*		

Debarca rural	*4,066*				*198*	*805*		
Makedonski Brod	**6,328**	-	-	1.2	**271**	**1,717**	-	271
Makedonski Brod urban	*3,324*				*298*	*992*		
Makedonksi Brod rural	*3,004*				*241*	*725*		
Plasnica	**4,848**	-	-	1.2	**309**	**1,500**	-	309
Plasnica urban	*0*				*0*	*0*		
Plasnica rural	*4,848*				*309*	*1,500*		
TOTAL	**219,863**	**1,645,483**	**4,508**		**247**	**54,250**	**1,975**	**251**

Municipalities (Southwest Region)	Population (Permanent and Seasonal)	Total Collected waste, 2016 (t)	Total Generated waste, 2016 (t)	Collection coverage %
Kichevo	57,114	9,199	12,208	75%
Ohrid	54,907	20,047	20,047	100%
Debar	21,192	5,763	6,749	85%
Struga	66,300	8,815	11,833	74%
Vevchani	2,449	417	417	100%
Centar Zhupa	7,167	332	948	35%
Debarca	4,066	429	805	53%
Makedonski Brod	6,328	1,186	1,717	69%
Plasnica	4,848	638	1,500	43%
TOTAL	**224,371**	**46,826**	**56,224**	**83%**

3.3.4.2 Waste composition

Methodology

There is a great diversity of methodologies which are used to determine the composition of waste. Each has advantages and disadvantages and challenge is to choose the model that is most applicable for the given conditions. The methodology used in this project stemmed from the observation and analysis of different methodologies from EU countries.

For purpose of sampling and analysis of morphological composition of waste on the municipality level, it is necessary to bring waste samples of approximately 300 kg in weight to the site for analysis. Local representatives in cooperation with technical supervisors determined that samples will be taken from two types of urban zone (individual and collective housing) as well as rural part of the regions:

- urban zone I –collective housing and commercial areas (settlements with blocks of residential buildings);
- urban zone II – individual houses (settlements with houses that own yard /garden, situated in the urban zone), and
- rural zones – within the municipalities (settlements with houses that own yard / garden, situated in a rural zone of the municipality)

The obtained results for each municipality are presented in Annex II.

Overall Data of Waste Composition at Regional Level

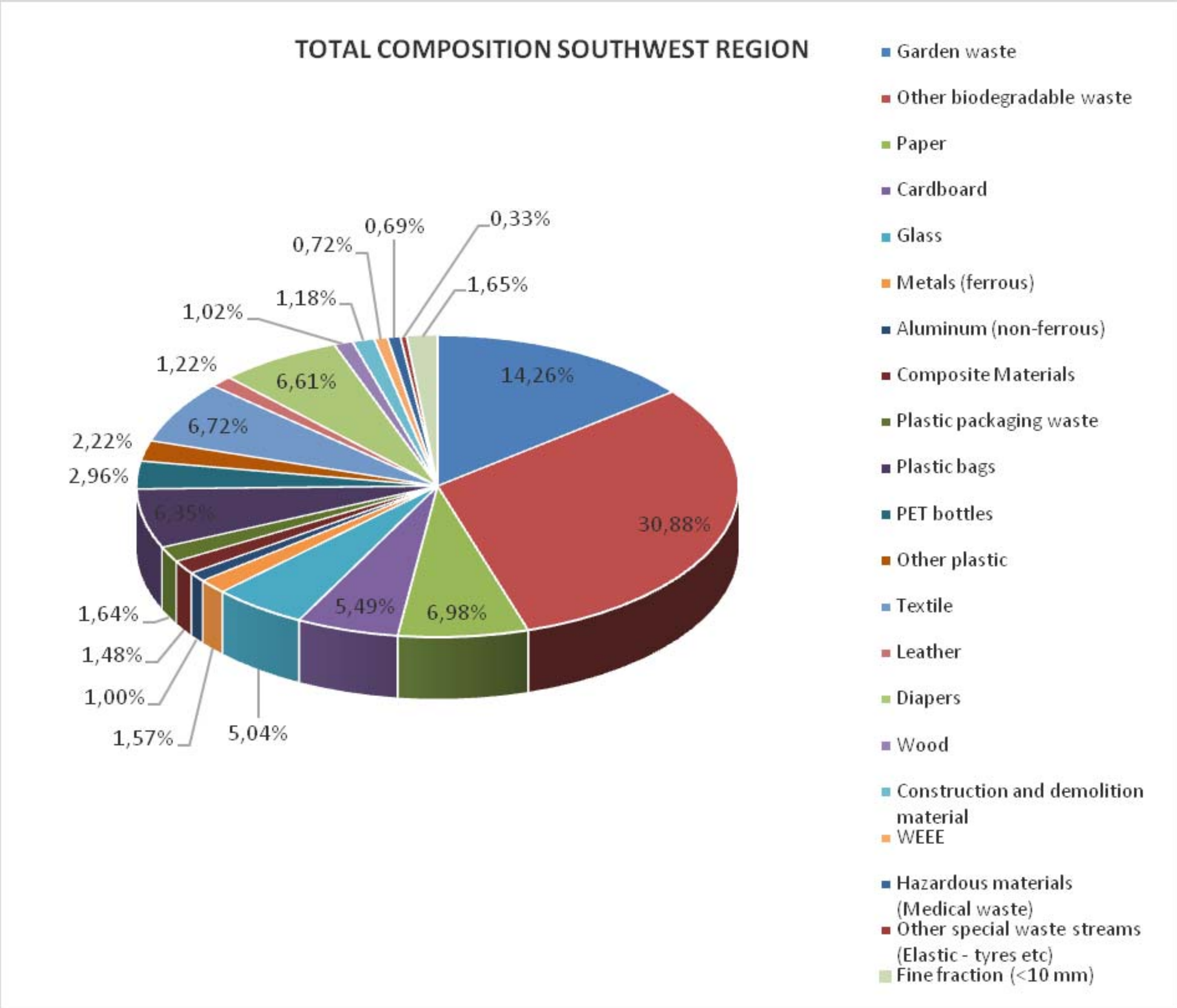
The average waste composition in the region has been calculated, and presented in the following table. Analytical calculations are shown in Annex II.

Table 3-43: Weighted average morphological waste composition for Southwest region

Waste category	Average Mass share
Garden Waste	14.26%
Other Biodegradable waste	30.88%
Paper	6.98%
Cardboard	5.49%
Glass	5.04%
Ferrous metal packaging and other	1.57%
Aluminum (non-ferrous) metal packaging and other	1.00%
Composite Materials	1.48%
Other Plastic packaging waste	1.64%
Plastic bags	6.35%
PET Bottles	2.96%
Other plastic/Hard plastic	2.22%
Textile	6.72%
Leather	1.22%
Diapers	6.61%
Wood	1.02%
Construction and demolition material	1.18%
WEEE	0.72%
Medical Waste	0.69%

Waste category	Average Mass share
Other special waste streams (Elastic-tires, etc)	0.33%
Fine elements <10mm	1.65%
TOTAL	100.00%

Figure 3-31: Weighted average waste composition for Southwest region



3.3.5 Waste Disposal

As approved by the TOR in total 9 municipalities are included in Southwest Region. In 7 of them (Debar, Kichevo, Makedonski Brod, Ohrid, Plasnitsa, Struga and Centar Zhupa) manage at least one MSWS landfill, and after screening and data collection process, following conclusion could be drafted:

- All of the municipalities have operational waste collection and handling systems, but none of them have system for separate waste collection and as mixed as is waste is disposed. Only Veles operates separate demolition and construction waste landfill.
- Waste composition is closely related to settlements type (urban or rural) and population size, and although mixed MSW is dominant, biodegradable waste, construction and demolition and in some cases hazardous industrial and medical waste are disposed.

- Some of the landfills are located on the river terraces and others on relatively step slopes with seasonal surface water flows and large drainage areas, so migration of contaminants with leachate form the landfills to surface or ground waters is very likely.
- Capping is performed only on 3 landfills (Kichevo, Struga and Centar Zhupa) and in other cases translocation of contaminants with wind or water erosion is evident. Light fractions of waste are dispersed by wind to significant distances from the landfills polluting large surrounding areas.
- None of the existing landfills has drainage collection systems for leachate or drainage waters.

3.3.5.1 Non-compliant municipal landfill sites (active and closed)

According to the field investigation conducted, there are 8 municipal landfill sites, especially in urban areas. The following table presents the municipal landfill sites and their main characteristics (area, etc.).

Table 3-44: Non-compliant municipal landfill sites (active and closed)

ID No	Municipality	City/Village	Coordinates	
			X	Y
RALL 001	Makedonski Brod	Makedonski Brod	41°30'31.30"	21°16' 34.9"
RALL 002	Plasnica	Plasnica	41°27'44.9"	21°04'52.4"
RALL 003	Kichevo	Kichevo	41°34'22.7"	20°59'38.5"
RALL 004	Ohrid	Ohrid	41°10'21.50"	20°57'28.4"
RALL 005	Ohrid	Ohrid	41°08'20.8"	20°46'15.7"
RALL 006	Struga	Struga	41°11'25.1"	20°40'06.3"
RALL 007	Debar	Debar	41°32'22.43"	20°30'58.52"
RALL 008	Centar Zupa	Pareshi	41°29'51.10"	20°32'52.94"
RALLC001	Struga	Struga	41°10'34.5"	20°39'40.6"
RALLC002	Struga	Kjafasan	41°06'19.7"	20°36'57.5"

3.3.5.2 Dumpsites

In addition in all of the municipalities (excluding Vevchani), small landfills or so called "dumpsites" without any engineering or other control measures for environmental protection are identified. The dumpsites are usually created in areas where no organized waste collection services are available or unknown perpetrators trying to avoid disposal costs. Although small in size (area and volume) due to different types of wastes sometimes including biological waste, chemicals or even industrial wastes (sludge's) they can pose great risks to surrounding environment.
According to the field investigation conducted, there are 87 uncontrolled dumpsites, especially in rural areas. The following table presents the main characteristics of the uncontrolled dumpsites (area, etc.).

Table 3-45: Dumpsites

ID No	Municipality	City/Village	Coordinates	
			X	Y
RAIL 001	M. Brod	M. Brod	41°30'48.4"	21°13' 45.4"
RAIL 002	M. Brod	Trebino	41°31'25.1"	21°12'43.2"
RAIL 003	M. Brod	Trebino	41°31'40.5"	21°13' 03.3"
RAIL 004	M. Brod	Suvodol	41°31'09.1"	21°14' 18.4"
RAIL 005	Plasnica	Plasnica	41°28'22.8"	21°07' 17.1"
RAIL 006	Plasnica	Plasnica	41°28'07.1"	21°07' 03.9"
RAIL 007	Plasnica	Plasnica	41°28'19.3"	21°05' 57.9"

ID No	Municipality	City/Village	Coordinates	
			X	Y
RAIL 008	Plasnica	Plasnica	41°28'28.9"	21°04' 57.2"
RAIL 009	Ohrid	Kosel	41°10'31.6"	20°50'16.6"
RAIL 010	Ohrid	Kosel	41°10'28.8"	20°51'35.3"
RAIL 011	Ohrid	Ohrid	41°07'29"	20°46'33.3"
RAIL 012	Ohrid	Ohrid	41°07'23.1"	20°46'28.2"
RAIL 013	Ohrid	Ohrid	41°09'11.6"	20°45'11.14"
RAIL 014	Ohrid	Ohrid	41°07'59.9"	20°45'55.5"
RAIL 015	Ohrid	Ohrid	41°07'47.161"	20°46'07.064"
RAIL 016	Ohrid	Ohrid	41°07'27.9"	20°46'49.3"
RAIL 017	Ohrid	Ohrid	41°06'36.4"	20°49'07"
RAIL 018	Debarca	Botun	41°16'13.6"	20°46'45.7"
RAIL 019	Debarca	-	41°16'37.5"	20°46'56.9"
RAIL 020	Debarca	Belchishta	41°18'32.3"	20°50'05.9"
RAIL 021	Debarca	Leshani	41°16'36.96"	20°52'40.6"
RAIL 022	Debarca	Mesheishta	41°14'27.4"	20°45'50.8"
RAIL 023	Debarca	Volino	41°12'57.1"	20°44'48.7"
RAIL 024	Debarca	Trebenishta	41°12'29.1"	20°45'58.6"
RAIL 025	Debarca	Orovnik	41°10'11.5"	20°44'55"
RAIL 026	Struga	Struga	40°10'04.86"	20°43'32.7"
RAIL 027	Struga	Struga	40°10'25.34"	20°42'32.1"
RAIL 028	Struga	Struga	40°10'37.44"	20°41'18.5"
RAIL 029	Struga	Struga	40°10'19.039"	20°39'51.5"
RAIL 030	Struga	Kalishta	40°09'47.1"	20°39'02.8"
RAIL 031	Struga	Kalishta	40°09'30"	20°39'01.5"
RAIL 032	Struga	Kalishta	40°09'21.4"	20°39'01.3"
RAIL 033	Struga	Struga	40°08'31.5"	20°39'01.5"
RAIL 034	Struga	Struga	41°10'32.5"	20°38'40.3"
RAIL 035	Struga	Struga	41°10'51.5"	20°39'56"
RAIL 036	Kichevo	Kichevo	41°29'41.23"	20°57'45.88"
RAIL 037	Kichevo	Kichevo	41°29'50.13"	20°57'44.30"
RAIL 038	Kichevo	Kichevo	41°30'29.33"	20°57'50.82"
RAIL 039	Kichevo	Kichevo	41°30'14.45"	20°56'39.79"
RAIL 040	Kichevo	Kichevo	41°30'32.56"	20°56'49.66"
RAIL 041	Kichevo	Kichevo	41°31'06.42" 41°30'58.53" 41°30'52.95" 41°30'49.48" 41°30'40.49"	20°57'03.06" 20°57'01.04" 20°56'59.30" 20°56'58.56" 20°56'56.47"
RAIL 042	Kichevo	Kichevo	41°31'15.50"	20°56'54.56"
RAIL 043	Kichevo	Kichevo	41°31'07.17" 41°31'03.87"	20°57'17.11" 20°57'24.04"
RAIL 044	Kichevo	Kichevo	41°30'50.11"	20°58'01.77"
RAIL 045	Kichevo	s.Crvica	41°33'04.37"	20°59'41.62"
RAIL 046	Kichevo	Oslomej	41°33'42.02"	20°59'27.16"
RAIL 047	Kichevo	Oslomej	41°33'48.99"	20°59'22.31"
RAIL 048	Kichevo	Oslomej	41°34'27.17"	20°59'54.07"

ID No	Municipality	City/Village	Coordinates	
			X	Y
			do 41°34'23.58"	do 20°59'34.90"
RAIL 049	Kichevo	Oslomej	41°34'10.26"	20°59'19.18"
RAIL 050	Kichevo	Drugovo	41°29'44.79"	20°56'40.65"
RAIL 051	Kichevo	Drugovo	41°29'30.45"	20°56'22.34"
RAIL 052	Kichevo	Drugovo	41°28'46.62"	20°55'06.65"
RAIL 053	Debar	Debar	41°31'06.71"	20°31'10.87"
RAIL 054	Debar	Konjari	41°31'24.47"	20°30'11.88"
RAIL 055	Debar	Konjari	41°31'25.70"	20°30'22.40"
RAIL 056	Debar	Kosovrasti	41°32'04.61"	20°34'48.32"
RAIL 057	Debar	Kosovrasti	41°32'21.03"	20°35'00.30"
RAIL058	Debar	Mogorche	41°32'22.19"	20°37'12.79"
RAIL059	Debar	Debar	41°30'52.87"	20°32'01.16"
RAIL060	Debar	Debar	41°30'36.58"	20°31'11.92"
RAIL061	Debar	Dzepchishte	41°26'16.04"	20°32'26.58"
RAIL062	Debar	Otishani	41°27'07.07"	20°31'12.86"
RAIL063	Centar Zupa	Gorenci	41°30'30.35"	20°33'29.81"
RAIL064	Centar Zupa	Gorenci	41°29'52.94"	20°33'11.83"
RAIL065	Centar Zupa	Broshtica	41°29'28.75"	20°35'07.17"
RAIL066	Centar Zupa	Broshtica	41°29'37.90"	20°36'56.99"
RAIL067	Centar Zupa	Broshtica	41°29'42.71"	20°34'45.01"
RAIL068	Centar Zupa	Balanci	41°28'59.27"	20°32'47.43"
RAIL069	Centar Zupa	Golem Papradnik	41°28'48.47"	20°32'48.07"
RAIL070	Centar Zupa	Golem Papradnik	41°28'28.96"	20°32'38.97"
RAIL071	Centar Zupa	Mal Papradnik	41°28'00.97"	20°32'38.45"
RAIL072	Centar Zupa	Zitineni	41°28'11.03"	20°33'46.38"
RAIL073	Centar Zupa	Zitineni	41°28'06.72"	20°34'13.78"
RAIL074	Centar Zupa	Bajramovci	41°28'47.88"	20°34'21.06"
RAIL075	Centar Zupa	Breshtanik	41°27'21.79"	20°35'09.68"
RAIL076	Centar Zupa	Breshtanik	41°27'20.08"	20°35'12.98"
RAIL077	Centar Zupa	Pralenik	41°27'37.83"	20°32'58.12"
RAIL078	Centar Zupa	Kodzadzik	41°26'29.42"	20°35'45.19"
RAIL079	Centar Zupa	Kodzadzik	41°26'25.32"	20°36'23.41"
RAIL080	Centar Zupa	Novak	41°26'17.99"	20°36'44.13"
RAIL081	Centar Zupa	Novak	41°26'12.23"	20°36'50.93"
RAIL082	Centar Zupa	Novak	41°26'22.15"	20°36'53.57"
RAIL083	Centar Zupa	Novak	41°26'04.56"	20°37'01.42"
RAIL084	Centar Zupa	Elevci	41°25'19.01"	20°37'4.98"
RAIL085	Centar Zupa	Dolgash	41°25'25.46"	20°35'19.34"

3.4 ANALYSIS OF THE WEAKNESSES OF THE EXISTING WASTE MANAGEMENT SYSTEM

3.4.1 Legal and Regulatory Framework

3.4.1.1 Brief overview

In strategic terms, EU waste policy, according to the Roadmap to a resource efficient Europe, aims to ensure that by 2020 waste is managed as a resource; waste generated per capita is in decline; re-use and recycling of waste are economically attractive options for public and private actors; more materials are recycled according to high quality standards; energy recovery is limited to non-recyclable materials; landfilling is virtually eliminated; and illegal shipments are eradicated. The revised Waste Framework Directive introduced a five-step waste hierarchy where prevention is the best option, followed by re-use, recycling and other forms of recovery, with disposal such as landfill as the last resort. EU waste legislation aims to move waste management up the waste hierarchy[17].

On a national level, the general waste management policy was established in the Law on Environment ("Official Gazette" No.53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/2013, 44/2015), in the National Environmental Programmes (NEAP 1996/2007) and particularly in the Law on Waste Management ("Official Gazette" No.68/04, 71/04, 107/07, 102/08, 134/08, 124/10, 08/11, 51/11, 123/12, 147/13 and 163/13). The Law on Waste Management has important links to other Laws related to tasks and responsibilities regarding administrative, organizational and operational issues in waste management, in particular to the Law on the Environment, which includes basic provisions on environmental permitting, EIA procedure and greenhouse gas emissions. The national LoE is the framework legal act setting out the main requirements for environmental protection in the country and regulates the SEA, EIA and Integrated permits being horizontal issues for all sectors. It contains the fundamental environmental protection principles, which provide a basis for determining procedures for management of the environment and which are common to all laws regulating specific environmental media. It also defines the roles and responsibilities of the state administrative bodies, municipal authorities and legal and physical persons in the implementation of the legal provisions.

The issue related to the management of sludge from urban wastewater treatment is regulated in the Law on Water. Moreover, separate laws have been adopted for packaging and packaging waste, WEEE and batteries and accumulators, namely:

- The Law on Packaging and Packaging Waste (2009) (LoPPW) ("Official Gazette" No. 161/09, 17/11, 47/11, 136/11, 6/12 and 163/13),
- the Law on Batteries and Accumulators and Waste Batteries and Accumulators (2010) (LoBAWBA) ("Official Gazette" No. 140/10, 47/11, 148/11, 39/12 and 163/13),
- the Law on Electric and Electronic Equipment and Waste Electric and Electronic Equipment (2012) (LoEEEWEEE) ("Official Gazette" No. 6/12 and 163/13)

Secondary legislation based on these laws has been adopted as well

The National Waste Management Strategy of the Republic of Macedonia 2008 – 2020 ("Official Gazette" No.39/08, 24.03.2008) defined the directions and principles of waste management in the country, whereas the National Waste Management Plan 2009-2015 ("Official Gazette" No.77/09, 19.06.2009), based on the NWMS, laid out the technical work and timeline needed to harmonize with the standards of the European

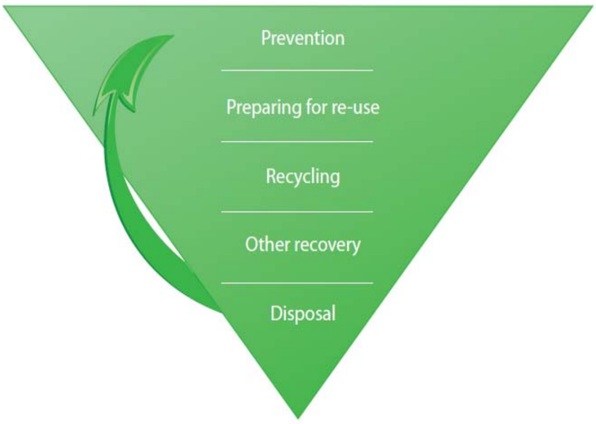
[17] European Environment Agency (EEA) (2013). *EEA Report, N.8/2013 - Towards a green economy in Europe - EU environmental policy targets and objectives* [pdf]. Retrieved from http://www.eea.europa.eu/publications/towards-a-green-economy-in-europe

Union. The NWMS introduced the concept of waste management on a regional level. The establishment of regional waste management regions to coordinate waste management activities and operations on behalf of the member municipalities is a key recommendation of the National Waste Management Plan 2009-2015 (NWMP). Furthermore, the municipalities are obliged to elaborate and implement Municipal Waste Management Plans in order to implement the National Waste Management Plan (NWMP) and the future Regional Waste Management Plan (RWMP). The MWMP has to be adopted by the municipal council of the municipality involved and approved by MoEPP. For implementing the Municipal plan there shall be an annual municipal programme.

3.4.1.2 EU Policy and legislation

The EU's Sixth Environment Action Programme (2002-2012) identified waste prevention and management as one of its top priorities. Its primary objective was to ensure that economic growth does not lead to more and more waste. This led to the development of a long-term strategy on waste. The 2005 Thematic Strategy on Waste Prevention and Recycling resulted in the revision of the Waste Framework Directive, the cornerstone of EU waste policy. The revision brought a modernised approach to waste management, marking a shift away from thinking about waste as an unwanted burden to seeing it as a valued resource. The Directive focused on waste prevention and puts in place new targets which will help the EU move towards its goal of becoming a recycling society. The Directive introduced a five-step waste hierarchy where prevention is the best option, followed by re-use, recycling and other forms of recovery, with disposal such as landfill as the last resort. EU waste legislation aims to move waste management up the waste hierarchy, as presented in the following figure[18].

Figure 3-32: Moving up the waste hierarchy



The revised Waste Framework Directive gives greater emphasis than has been present hitherto to the priority position accorded to waste prevention. Also, the revised Directive suggests that policy would do well to take heed of the requirement to:

- Develop waste management policy and law in such a way as to enshrine the hierarchy outlined in Article 4 of the WFD, though with departures from this ranking made clear where the case, based on life-cycle thinking, justifies this;
- Include a specific programme for waste prevention. A forward looking strategy would pre-empt the decoupling objective foreseen by the WFD;

[18] EU (2010) Being wise with waste: the EU's approach to waste management (http://ec.europa.eu/environment/waste/pdf/WASTE%20BROCHURE.pdf).

- Put in place means to ensure that targets for recycling of at least 50% from household waste and 70% from construction and demolition waste are met in the spirit of pre-empting the WFD objectives;[19]
- Ensure that mechanisms are in place which lead to the separate collection of glass, metals, paper and plastic (where appropriate), again pre-empting the WFD requirements;
- Implement measures designed to lead to separate collection of bio-waste;
- Implement policies or mechanisms that encourage the use of products of bio-waste management;
- Ensure that where incineration or co-incineration are employed, permits should not be issued unless the recovery of energy takes place *'with a high level of energy efficiency';*
- Apply the polluter pays principle;
- Apply the proximity and self-sufficiency principle
- Give substance to the concept of resource efficiency.

In strategic terms, EU waste policy, according to the Roadmap to a resource efficient Europe, aims to ensure that by 2020 waste is managed as a resource; waste generated per capita is in decline; re-use and recycling of waste are economically attractive options for public and private actors; more materials are recycled according to high quality standards; energy recovery is limited to non-recyclable materials; landfilling is virtually eliminated; and illegal shipments are eradicated.

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

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

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

Table 3-46: EU legislation for waste sector

Sub-sectors and objectives	Sources	Deadline for implementation
Recycling targets for batteries (by average weight): -65 % of lead acid batteries and accumulators, -75 % of nickel cadmium batteries and accumulators -50 % of other batteries and accumulators	Directive 2006/66/EC	⇨2010
Collection target for batteries: 45 %	Directive 2006/66/EC	⇨ 2016
Targets for end-of-life vehicles (by average weight per vehicle per year): reuse and recovery: 95 % - reuse and recycling: 85 %	Directive 2000/53/EC	⇨ 2015
WEEE, with reference to Annex I categories*: cat. 1 or 10: 85 % recovery and 80 % preparation for reuse and recycling cat. 3 or 4: 80 % recovery and 70 % preparation for reuse and recycling cat. 2, 5, 6, 7, 8 or 9: 75 % recovery and 55 %	Directive 2012/19/EU	⇨ 2015-2018

[19] European Commission (2011) Commission Decision establishing rules and calculation methods for verifying compliance with the targets set in Article 11 (2) of Directive 2008/98/EC of the European Parliament and of the Council, July 2011.

Sub-sectors and objectives	Sources	Deadline for implementation
preparation for reuse and recycling Gas discharge lamps: 80 % recycling		
WEEE, with reference to Annex IIII categories*: cat. 1 or 4: 85 % recovery and 80 % preparation for reuse and recycling cat. 2: 80 % recovery and 70 % preparation for reuse and recycling cat. 5 or 6: 75 % recovery and 55 % preparation for reuse and recycling cat. 3: 80 % recycling	Directive 2012/19/EU	➪From2018
Collection target for WEEE: 45 % of the average weight of EEE placed on the market in the three preceding years in the Member State concerned	Directive 2012/19/EU	➪ From 2016
Collection target for WEEE: - 65 % of the average weight of EEE placed on the market in the Member State in the three preceding years or - 85 % of WEEE generated in the Member State.	Directive 2012/19/EU	➪From 2019
Preparation for reuse, recycling and any other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste, excluding naturally occurring material (cat. 17 05 04), shall be increased to a minimum of 70 % by weight	Directive 2008/98/EC	➪ 2020
Preparation for reuse and recycling of 50 % by weight of materials such as at least paper, plastic, glass and metal from households and possibly from other origins as far as their waste streams are similar to waste from households	Directive 2008/98/EC	➪ 2020
Disposal of biodegradable municipal waste: reduction to 35 % of total 1995 biodegradable municipal waste	Directive 1999/31/EC	➪ 2016

* Large household appliances, 2 Small household appliances, 3 IT and telecommunications equipment, 4 Consumer equipment and PV panels, 5 Lighting equipment, 6 Electrical and Electronic tools (with the exception of large scale stationary industrial tools, 7 Toys, leisure and sports equipment, 8 Medical devices (with the exception of all implanted and infected products), 9 Monitoring and control instruments, 10 Automatic dispenses

3.4.1.3 National Waste Management Legislation

Law on Environment ("Official Gazette" No.53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/2013, 44/2015) (LoE)

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

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

Including several aspects of environmental protection in a single Law is definitely a valid approach, as it helps ensure coherence within the system and facilitate access to legislation for citizen who do not have to read several documents but can find most of the information in one. The Law is complemented by and further specified in several thematic rulebooks and by-laws relating to the different topics covered[20].

According to the LoE:

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

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

Regarding waste management the activities requiring A-IEP are:

- Installations for the disposal, recovery and/or co-incineration of hazardous waste with a capacity exceeding 10 tons per day
- Installations for the incineration of communal waste with a capacity exceeding 3 tons per hour
- Installations for disposal of non-hazardous waste a capacity exceeding 50 tons per day
- Landfills receiving more than 10 tons per day or with a total capacity exceeding 25000 tons, excluding landfills of inert waste
- Installations for incineration of animal carcases
- Installations for managing mining waste

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

Strategic Environmental Assessments (SEAs)

The implementation of the Strategic Environmental Assessment (SEA) procedure for strategies plans and programmes (hereinafter: planning documents) is regulated in Chapter X of the Law on Environment as amended and relevant bylaws based on the Law[21].

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

The Law emphasizes that the details for SEAs have to be developed in secondary legislation. In 2007, the Government adopted the list of criteria for determining whether a given planning document is likely to have a significant impact on the environment. Also in 2007, two subsidiary acts were adopted for determining the procedure for performing SEAs. The Government determined the planning documentation, which is subject to SEA, via the Decree on the strategies, plans and programmes, and their amendments for which the SEA

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

[21] www.sea-info.mk

procedure must be carried out. Changes in the secondary legislations were made at the beginning of 2011. The general obligation for the performance of SEAs is the responsibility of MoEPP (Sector for Sustainable Development and Investments), and all other State administrative bodies and LSGU entities are obliged to perform the SEA procedure if they are competent for the adoption of some of the plans stipulated in the above-mentioned Decree.

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

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

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

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

Environmental Impact Assessments (EIAs)

The legal framework for EIA is well along. The Law on Environment gives detailed instructions for the steps and conditions involved in carrying out the procedure, including notification, screening, scoping, content of the study for EIA, and requirements for the expert preparing and assessing the quality of the documentation. The public's access to EIA documents and information is described in a different article, and covers all steps as well as the public hearing. The procedure is finalized with the issuing of a decision on whether to grant or reject the application for the project implementation. The legal effect of the decision is also determined by the Law. Practice shows that implementation is consistent with all these legal requirements.

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

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

The legal framework for waste management has been established by the 2004 Law on Waste Management. Relevant EU directives have been transposed in the Law on Waste Management (LpWM), also taking into consideration the local conditions. The Law regulates issues concerning the framework Policy on Waste; on Hazardous Waste; on Landfills; Waste Oils; PCB/ PCT; on Incineration of Non-hazardous Waste; on Incineration of Hazardous Waste; on Hazardous Substances Containing Batteries and Accumulators; on Packaging and Packaging of Waste; on End-of life Vehicles; and on Waste from the Titanium Dioxide

Industry. The Law on Waste Management also provides grounds for the adoption of several secondary legislation acts. The LoWM defines in details the responsibilities with regards to waste management planning, waste management activities, permitting and licensing system, rules for specific waste streams, monitoring, data collection and reporting, and financing

The EU recognises seven over-arching principles for waste management, which should be considered in the waste management plan[22]:

- **Waste Management Hierarchy**. Waste management strategies must aim primarily to prevent the generation of waste and to reduce its harmfulness. Where this is not possible, waste materials should be reused, recycled or recovered, or used as a source of energy. As a final resort, waste should be disposed of safely (e.g. by incineration or in landfill sites);
- **Self-Sufficiency** at Community and, if possible, at Member State level. Member States need to establish, in co-operation with other Member States an integrated and adequate network of waste disposal facilities;
- **Best Available Technique Not Entailing Excessive Cost (BATNEEC)**. Emissions from installations to the environment should be reduced as much as possible and in the most economically efficient way;
- **Proximity**. Wastes should be disposed of as close to the source as possible;
- **Precautionary Principle**. The lack of full scientific certainty should not be used as an excuse for failing to act. Where there is a credible risk to the environment or human health of acting or not acting with regard to waste, a cost-effective response to the risk identified should be pursued;
- **Producer Responsibility**. Economic operators, and particularly manufacturers of products, have to be involved in the objective to close the life cycle of substances, components and products from their production throughout their useful life until they become a waste;
- **Polluter pays**. Those responsible for generating or for the generation of waste, and consequent adverse effects on the environment, should be required to pay the costs of avoiding or alleviating those adverse consequences. A clear example can be seen in the EU Directive 99/31/EC on landfill of waste, Article 10.

Most of the above principles are incorporated in the Country's Law on Waste Management, for example Article 7 on priorities in waste management, Article 9 on the precautionary principle, Article 10 on the proximity principle and Article 12 on the polluter-pays. Therefore, the Law incorporates the basic principles of waste management. Waste management, as a public service, is based on the principle of service universality (non-discrimination, sustainability, quality and efficiency, transparency, affordable price and full coverage of the territory).

The Country's Law on Waste Management includes the following provisions concerning preparation of waste management strategies and plans under Section II:

Article 15, Planning in waste management

The responsible authorities of the Republic of Macedonia, the Municipalities and the City of Skopje, as well as legal and physical persons dealing with waste management shall adopt and implement strategic, planning and programme documents regarding the waste management in order to:

- protect the environment and human life and health;
- achieve the objectives and guidelines laid down in the National Environmental Action Plan;
- implement the general principles and guidelines regarding the waste management;
- establish an integrated national network of installations and plants for waste processing and disposal;
- fulfil the obligations with regard to the waste management undertaken by the Republic of Macedonia on an international level;

[22] Regional Environmental Center, Umweltbundesamt GmbH(2008) Handbook on Implementation of EU Environmental Legislation. (http://ec.europa.eu/environment/enlarg/handbook/handbook.pdf).

Within the procedure for adoption of strategies, plans and programmes provided for in the LoWM, strategic environmental assessment shall be undertaken in accordance with the Law on Environment.

Article 16, Strategy on Waste Management

The Government of the Republic of Macedonia shall, upon a proposal of the body of the public administration responsible for the affairs of the environment, adopt a Strategy on Waste Management.

The Strategy on Waste Management shall determine:

- basic guidelines for management of all types of waste;
- improvement of the general situation in the area of waste management;
- the necessary legal measures for implementation of the Waste Management Plan;
- the long-term needs of the Republic of Macedonia in the area of waste management;
- strategic approach to the development of the public awareness and education in relation to the waste management;
- other issues of importance for the development of the waste management.

The Strategy shall be valid for a period of twelve years.

Article 17, Waste Management Plan of the Republic of Macedonia

For the purpose of the implementation of the Strategy on Waste Management, the body of the public administration responsible for the affairs of the environment shall adopt a Waste Management Plan of the Republic of Macedonia.

The Plan shall be adopted for a period of ten years, and shall include in particular:

- description and assessment of the existing status of waste management;
- predictions of future trends in the waste management;
- guidelines and objectives related to waste management including the schedule of realisation thereof;
- implementation of measures, activities and manner of accomplishing the objectives of handling specific types of waste, schedule and scope of their realisation;
- incentives for implementation of the activities for avoidance and reduction of waste generation, as well as for re-use, recycling or use of the waste as a source of energy;
- manners of disposal of the waste that cannot be avoided and processed;
- specification of the type and quantity of waste according to which the obligation for the legal and physical persons for preparation of waste management programs is assigned;
- application of the monitoring system during waste management;
- concrete measures and activities for reducing the biodegradable components in the waste intended for disposal and the time schedule and extent for the implementation thereof,
- assessment of the needs of the Republic of Macedonia for construction of facilities and installations for waste processing and disposal, including the measures and deadlines of realisation;
- locations and installations for waste disposal;
- data on the integrated national network for waste disposal and installations for waste processing;
- technical and other conditions to be fulfilled when dealing with waste management;
- measures for remediation of illegal landfills and polluted areas;
- activities undertaken by the local self-government units concerning the waste management;
- educational and public awareness raising measures concerning the waste management;
- identification of waste management regions
- estimation of the costs for the waste processing and disposal operations; and
- financial instruments for the implementation of the Waste Management Plan.

Article 18, Waste Management Plans of the Municipalities and the City of Skopje OK according to the latest amendment, October 2012

For the purpose of the implementation of the Waste Management Plan of the Republic of Macedonia, the Councils of the Municipalities and of the City of Skopje shall adopt a Waste Management Plan for the respective Municipality, i.e. the City of Skopje, upon a proposal of the Mayor of the Municipality and the City of Skopje. The Plan shall be issued for a period of no less than three and no more than six years.

Article 18-a, Regional Plans

For the purpose of regional waste management, the Councils of the municipalities, the Council of the City of Skopje upon a proposal of the Inter-municipal Waste Management Boards adopt Regional Waste Management Plans, for the regions determined by the Waste Management Plan of the Republic of Macedonia. The Regional Waste Management Plans shall regulate and harmonise joint waste management objectives at regional level, according to the National Waste Management Strategy and the National Waste Management Plan. Regional Waste Management Plans are adopted for a period of 10 years. The Inter-municipal Waste Management Board may propose amendments to the regional plan every two years. The regional plan to be adopted by municipal councils or the City of Skopje Council shall be submitted for approval to the state government responsible for the environment. The Minister managing the body of the state administration responsible for the environment shall prescribe the content of regional plans.

Article 19, Waste Management Programmes

The implementation of the Waste Management Plan of the Republic of Macedonia shall be carried out through one-year programs on waste management, adopted by:

- The body of the public administration responsible for the affairs of the environment;
- The Councils of the Municipalities and of the City of Skopje, upon a proposal of the Mayors of the Municipalities and of the City of Skopje;
- The legal and physical persons dealing with waste management, determined in accordance with this Law and other regulations.

The Programmes shall be in accordance with the Waste Management Plan of the Republic of Macedonia and with the waste management plans of the Municipalities and of the City of Skopje. The Programmes shall specify the sources of funding of measures and activities, as well as the instruments for the waste management programmes implementation.

Responsibilities for enforcement of waste management legislation

Legal framework

Here are outlined the relevant provisions with regards to enforcement of waste management legislation which are found in the general administrative legislation, horizontal environmental legislation, specific waste management legislation as well as in other legal acts regulating specific issues.

Law on the Inspection Supervision 2010 (LoIS)

This law is a general administrative law setting out the general requirements for organising the inspection authorities in the country, their interrelation and cooperation as well as the main requirements for employment of the inspectors and their right and obligations as well as the types of inspections to be carried out. The law also provides for joint inspections of several inspectorates. The establishment of Inspection Council as a supervisory body is also regulated. The law shall be enacted as of 1st April 2011. Therefore the provisions of this law would be applicable for the activities of the inspection authorities mentioned hereinafter.

Law on Environment ("Official Gazette" No.53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/2013, 44/2015) (LoE)

The national LoE is a framework legal act setting out the main requirements for environmental protection in the country and regulates the SEA, EIA and Integrated permits being horizontal issues for all sectors. The supervision for the compliance with the legal requirements therein is assigned to the Inspectors of

Environment from the State Environmental Inspectorate (SEI) and the Authorised Inspectors of Environment employed by the municipalities.

Law on Waste Management ("Official Gazette" No.68/04, 71/04, 107/07, 102/08, 134/08, 124/10, 08/11, 51/11, 123/12, 147/13 and 163/13)

Chapter XII of LoWM lays down the legal requirements referring to supervision and competent authorities. The competences are mainly divided between the State Environmental Inspectorate and its Inspectors of Environment and the municipalities, which appoint Authorised Inspectors of Environment. Further some competences are granted to the State Sanitary and Health Inspectorate and the State Market Inspectorate. The law explicitly lists the rights and obligations of the supervising authorities.

Chapter XIII sets out the sanction and the procedure for their imposing in case of violating the waste management law.

Law on Packaging and Packaging Waste ("Official Gazette" No. 161/09, 17/11, 47/11, 136/11, 6/12 and 163/13)

Chapter V of the law describes the responsible authorities and their rights and obligations while the next Chapter VI sets out the sanctions for violation of the legal rules. The supervision for compliance with the legal requirements is again divided between the State Environmental Inspectorate, the municipalities and the State Market Inspectorate. In addition the Communal inspectors at the municipalities are also granted with the right to enforce this law.

Law on Batteries and Accumulators and Waste Batteries and Accumulators ("Official Gazette" No. 140/10, 47/11, 148/11, 39/12 and 163/13)

Chapter VI of the law describes the responsible authorities and their rights and obligations and Chapter VII sets out the sanctions for violation of the legal rules. As in the Law on packaging and Packaging waste the supervision for compliance with the legal requirements is divided between the State Environmental Inspectorate, the municipalities and the State Market Inspectorate. In addition the Revenue Authorities are responsible for collection of the fees.

Law on Electric and Electronic Equipment and Waste Electric and Electronic Equipment ("Official Gazette" No. 6/12 and 163/13) (LoEEEWEEE)

Chapter V of the law describes in details the responsible authorities and their rights and obligations and Chapter VI sets out the sanctions for violation of the legal rules. The supervision for compliance with the legal requirements is divided between the State Environmental Inspectorate, the municipalities and the State Market Inspectorate. In addition the Revenue Authorities are responsible for collection of the fees due.

Law on Communal Activities (1997, as amended)

The supervision for ensuring compliance with the requirement of this law is assigned to the State Communal Inspectorate at the Ministry of Transport and Communications and the municipal communal inspectors. In case the municipality has not appointed a communal inspector, the State communal inspectorate may carry out the inspection control for the account of the municipality.

Law on the public cleanliness (2008, as amended)

With regards to waste management the provisions of the Law on the public cleanliness refer to collection of communal waste and setting bans for illegal dumping and other waste treatment operations such as firing (incineration), burial and destruction of waste. The control is assigned to the State Communal Inspectorate at the Ministry of Transport and Communications and the municipal communal inspectors. The municipalities may employ communal wardens to supervise for violations of the legal provisions.

Law on Market Inspection (2007)

This law regulates the establishment of the State Market Inspectorate at the Ministry of Economy and the scope of its competence and activities. Its competences are related to labelling and marking of the products placed on the market and controlling of the deposit systems for specific waste streams.

Law on the Sanitary and Health Inspection (2006, as amended)

This law regulated the establishment of the State Sanitary and Health Inspectorate as a constituent body at the Ministry of Health and the scope of its competence and activities in relation to medical waste.

The table below summarises the responsibilities of the designated authorities at central level.

Table 3-47: The responsibilities of the designated authorities at central level

Authority	Scope of work/responsibility
Ministry of Environment and Physical Planning – State Environment Inspectorate	• EIA – Checking for compliance with all the requirements set for EIA procedures – preparation and submission of studies or elaborates for approval by the competent authorities including contents of the study and further checks for compliance with the EIA decision in the implementation phase; • Integrated permits - Control for obtaining A/B integrated permits and inspection and control for compliance with the permit conditions including the waste management requirements; Control of the monitoring systems and equipment of the operators and checks for compliance with the permit conditions and the requirements for submission of monitoring data; • WM programmes – checking compliance with the requirements to elaborate and submit WM programmes of legal entities and reports on their implementation to the MoEPP; • Waste streams - inspection and control on compliance with the requirements for management of different waste streams, including labelling and marking, recording and reporting; • Waste permits – control for obtaining the necessary permit or license for carrying out waste operations or trading, including import and export and for compliance with the conditions of the permit or license; • Waste manager - inspection and control for employment of a duly qualified Waste Manager, where required; • Landfills – inspection and control on disposal of waste at landfills, including acceptance of waste, monitoring and reporting and implementation of after closure measures; • Incineration - inspection and control on whether the disposal of the waste by way of co-incineration or incineration is performed in compliance with the legal requirements for permitting, acceptance of waste, monitoring, etc. • Reporting - inspection and control on whether all waste management records in all facilities are kept in accordance with the legal requirements and the reports are duly submitted to the responsible authority.
Ministry of Health – State Sanitary and Health Inspectorate	• Inspection and control of medical waste management only transport and storage, not of disposal)
Ministry of Economy - State Market Inspectorate	• Inspection and control for labelling and marking of the products and packaging placed on the market in accordance with the legal requirements; • Inspection and control on trading with non-hazardous waste; • Inspection and control for deposit payments in case of return systems for products and packaging, provision of data to users for returning the products for re-use and recycling and placing of vessels for collection of specific waste; • Control for availability of statements of accordance with the environmental requirements of the products placed on the market.

In accordance with the LoE and the LoWM the municipalities shall employ Authorized Inspectors for Environment while in accordance with the LoCA there shall be communal inspectors (and/or wardens). The table below describes the distribution of the responsibilities of inspection authorities at Local level:

Table 3-48: The responsibilities of the inspection authorities at local level

Authority	Scope of work/responsibility
Authorized Inspectors for Environment	• EIA –Checking for compliance with all the requirements set for EIA procedures – preparation and submission of elaborates for approval by the competent authorities including contents of the study and further checks for compliance with the EIA decision in the implementation phase; • Integrated permits - Control for obtaining ‘B’ integrated permits and inspection and control for compliance with the permit conditions including the waste management requirements; Control of the monitoring systems and the equipment of the operators and checking for compliance with the permit conditions and the requirements for submission of monitoring data; • Inspection and control for obtaining of adjustment permits for installations subject to ‘B’ integrated permit and implementation of the adjustment plan; • WM programmes – supervision on compliance with the requirements to elaborate and submit WM programmes and reports on their implementation to the municipality; • Inspect and control the installations with ‘B’ integrated environmental permit, including their monitoring; • Supervision for uncontrolled disposal of waste; • Non-hazardous waste – checking the waste management activities of the permit holders, including industrial non-hazardous waste from installations having ‘B’ integrated environmental permit, including record keeping and reporting; • Assessing the impact of waste on private properties; • Control for contracting the collection of commercial waste to permit holders; • Inspection and control on the disposal of municipal waste at the places and bins designated for collection and selection of waste; • Inspection and control of the placing of waste collection bins by service providers; • Inspection and control of the service providers at least once a year to check whether they meet the obligations set out in the permit for collection and transportation of municipal waste; • Inspection and control of whether inert waste is handled in accordance with the legal requirements. • Inspection and control on the activities of the public enterprises including those performing collection, transportation and treatment of municipal waste

3.4.1.4 National Waste Management Strategy (2008-2020)

The National Waste Management Strategy of the Republic of Macedonia (2008 - 2020)[23] defined the directions and principles of waste management in the country, whereas the National Waste Management Plan 2009-2015, based on the NWMS, laid out the technical work and timeline needed to harmonize with the standards of the European Union. The NWMS sets out the following strategic goals and objectives:

- Harmonisation of the policy and legislation on waste management regarding the political agreement in the society and requirements of the co-operating economic environment;
- Establishment of effective institutional and organisational arrangements in all phases of implementation of the new integrated waste management system: planning, permitting, financing, operating and enforcement;

[23] http://www.moepp.gov.mk/WBStorage/Files/Waste%20Management%20Strategy%20of%20the%20RM%202008-2020.pdf

- Strengthening human resources and capacity in the public and private sector involved in the establishment process of the waste management system, as well as encouragement and engagement of knowledge, technical know-how and economic potential available in the country;
- Introduction of stable financial resources and adequate economic mechanisms to assure the full cost recovery of providing for the integrated waste management system according to the "polluter pays" principle and to the maximum effects regarding investment and operational activities;
- Raising public awareness and awareness of all stakeholders in the society from the viewpoint of understanding their roles, responsibilities and obligations in the waste management process and in the protection of the environment in order to accept significant changes of the waste management practice from collection to the final disposal;
- Establishing the data collection/ information system on the sources, nature, quantities and fate of waste streams as well as on the facilities for material/ energy recovery and final disposal of waste and assuring necessary public access;
- Establishing the contemporary technical waste management system which takes into account different technical options regarding waste avoidance, lowering their hazardous potential and reduction at sources, material/ energy recovery and utilisation of waste and safe final disposal of stabilised residues according to "best practicable environmental option" with the aim of preservation of non-renewable natural resources and minimal emissions and adverse effect of the waste treatment/ disposal processes on the living and natural environment as well as on public health;
- Application of efficient and cost-effective techniques for the management of segregated waste streams by means of private sector participation to achieve a 100% waste collection rate and optimal level for material/ energy recovery of waste;
- Introduction of landfills for hazardous and non-hazardous waste and other facilities for final disposal of waste compliant with contemporary standards to prevent the appearance of new environmental burdens;
- Progressive closing down and/ or remediation of existing municipal dumpsites and/or industrial "hot-spots" according to the inventory of environmental burdens and corresponding criteria that particularly take into account adverse effects and risks to the environment, future utilisation of physical space, costs of rehabilitation, and acceptability by the population.

The basic principles for development of the country's waste management are defined as follows:

- Solving waste problems at source;
- Separate collection of waste streams:
  - according to their hazardous characteristics;
  - according to their point-source or dispersed-source generation; and
  - according to the intention of further management, which shall be acceptable from an environmental and economic aspect.
- Waste utilisation as substitute of natural resources;
- Rational network of treatment and disposal facilities;
- The rationality of space management and preservation of natural and cultural heritage;
- Landfill of the stabilised and low volume waste residues;
- Remediation of contaminated sites -"hot-spots".

The NWMS introduces the concept of waste management on a regional level. The preparation of the priority policy and planning documents on establishment and operation of the new regional waste collection/treatment/disposal system of municipal and other non-hazardous waste is a central part of actions executed by the waste management unit/department in the first 5 years of the implementation of the waste management strategy.

According to the NWMS, the Government, in particular MoEPP shall encourage political decisions and organise the establishment of new regional bodies - enterprises and institutions - to carry out the tasks leading towards a contemporary regional waste management system, and assist in the execution of key political, re-organisation, financial, public relation and other operational activities.

It is stated that in order to achieve adequate economic thresholds for management with the municipal waste and acceptable prices for executed services, the majority of pre-treatment operations and landfill of residues shall be carried out on the regional level with more than 200.000 habitants. The central complex of the infrastructure facilities for the final disposal of residual municipal waste shall be represented by the network of landfills on the regional level of waste management, which shall be built, equipped and in operation according to the EU standards on landfill of waste. Waste management regions shall represent the obligatory association of communities for the common solving of municipal waste issues; the size of the waste management regions shall be of such a range that enables the installation of financially optimal economy of scale of regional or inter-municipality landfills and of other accompanying waste material & energy recovery and treatment plants.

Regional municipal waste management systems shall represent a link between the state and local communities and they shall take over the majority of their responsibilities and tasks, like planning, leading investments, public relations and organisation of other activities related to the municipal waste management originally addressed to municipalities, on behalf of the joint municipalities and their inhabitants with the consent or participation of MoEPP. From the administrative/organisational and financial side, such systems shall be managed by the inter-municipal boards as political representative bodies of the joint municipalities and of the managing board of the regional waste management companies (RMWMC) which provide the municipal management operations, collection, recovery and final disposal services; RMWMC may also function as the central regional agency carrying out various expert tasks like planning, investments, local regulation, organisation, cost recovery and financing executed municipal waste management operations and environmental monitoring.

3.4.1.5 National Waste Management Plan (2009-2015)

In addition to the Strategy, in 2009 MoEPP adopted the National Waste Management Plan for the period 2009 - 2015[24], which represents an amendment and supplement of the National Waste Management Plan for the period 2006-2012 as based on the National Waste Management Strategy. The National Waste Management Plan has been developed to gradually implement the required improvements of the present problematic solid waste management system in the country by setting main goals, objectives and targets in the process of establishing the waste management system, and by defining the main activities and tasks in the legal, institutional, organizational, technical, and economic fields in the over six-year period. The purpose of the National Waste Management Plan is to provide an adequate environmental policy, decision-making framework, economic basis, public participation and gradual establishment of the technical infrastructure for carrying out waste management operations in order to implement the waste management system in compliance with EU legislation and with the EU Sixth Environmental Action Programme (2002-2012), taking into account its priority in waste management, i.e. the thematic strategyon sustainable use of resources and thematic strategy on waste prevention and recycling.

The Plan foresees a complex of measures in order to eliminate or mitigate environmental impacts caused by the existing improper waste management operations, and to carry out the preparation and implementation of an integral, cost-effective and sustainable waste management system, taking into account key EU principles of waste management.

The establishment of regional waste management regions to coordinate waste management activities and operations on behalf of the member municipalities is a key recommendation of the National Waste Management Plan 2009-2015 (NWMP). The organisational concept of regional cooperation in waste management is widely established in the EU although there are many approaches to the specific legal setup, shareholding, decision-making and the division of tasks and responsibilities for waste management between the regional level and the individual member municipalities. The involvement of private

[24] http://www.moepp.gov.mk/WBStorage/Files/NWMP_2009-2015_%20of%20RM_finaL.pdf

companies in such organisations can also be found, although essentially municipal waste management is a public service and public supervision and control is essential[25].

The amendments to the LoWM established that Regional Waste Management Plans could be adopted and implemented jointly for several municipalities for establishing a regional integrated waste management system. The RWMPs have to be approved by MoEPP and adopted by all of the municipal councils of the municipalities involved.

It must be noted that according to the Law amending the Law on Waste Management (Official Gazette No. 123/12-02.10.12, article 2), the Waste Management Plan shall be issued for a period of ten years, instead of six.

The National Waste Management Plan (2009 - 2015) provides a series of targets for specific activities and waste streams.

3.4.1.6 Municipal Waste Management Plans

The municipalities are obliged to elaborate and implement Municipal Waste Management Plans in order to implement the National Waste Management Plan (NWMP) and the future Regional Waste Management Plan (RWMP). The MWMP has to be adopted by the municipal council of the municipality involved and approved by MoEPP. For implementing the Municipal plan there shall be an annual municipal programme.

In accordance with Articles 15 and 18 of the Law on Waste Management, 2004, as amended, municipalities shall adopt and implement strategic, planning and programme documents regarding waste management in order to:

- Protect the environment and human life and health;
- Achieve the objectives and guidelines laid down in the National Environmental Action Plan;
- Implement the general principles and guidelines regarding waste management;
- Establish an integrated national network of installations and plants for waste processing and disposal; and
- Fulfil the obligations with regard to waste management undertaken by the Republic of Macedonia on an international level.

The MWMPs should be prepared in accordance with the provisions of the Law on Waste Management as well as taking into account expected future development of the legislation as a result of the on-going harmonisation of legislation and practices in the country with those of the European Union.

Information was gathered at municipal level, including Municipal Waste Management Plans and Programmes. The following table presents the MWMPs and Programs which were submitted to the Project Team.

Table 3-49: Submitted MWMPs and/or Programmes in Southwest Region

#	Municipality	Submitted Municipal Plans and/or Programmes
1	Kichevo	☑ Plan 2013-2017
2	Ohrid	☑ Program 2015-2018
3	Debar	☒ didn't submit a plan
4	Struga	☑ Program 2016

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

#	Municipality	Submitted Municipal Plans and/or Programmes
5	Vevchani	☑ Plan 2014-2019
6	Centar Zhupa	☑ Plan 2009-2014
7	Debarca	☑ Plan 2015-2020
8	Makedonski Brod	☑ Plan 2014-2019
9	Plasnica	☑ Plan 2014-2018

According to an overview of the submitted Plans, the following information was provided:
- Demographic information according to Census 2002
- Waste quantities and composition, mainly estimations, according to the National Plan for Waste Management (2009-2015)
- Information according to the National Census of Agriculture 2007 resulting to estimations for agricultural waste stream
- Information regarding frequency of waste collection
- Information regarding existing landfills

Regarding the key points of the Plans, the following arose:
- Lack of monitoring system in waste management
- Lack of selective collection with some exceptions for recyclables
- Not available data on different waste streams
- Inadequate collection and transportation of waste, especially in rural areas.
- References of illegal dumping in dumpsites, river beds, and road sides, without specific information on locations
- Lack of agricultural waste information constitute a significant problem of this waste stream
- Old collection and transportation equipment

The Actions Plans proposed by the municipalities focus mainly on the rehabilitation of the existing illegal dumpsites, the establishment of a system for: separation, reuse and recycling and alternative methods of treatment. Moreover the plans include actions and measures for the improvement and expansion of coverage of the collection system and of the existing landfill facilities, the implementation of monitoring system in waste management, the supply and replacement of old collection equipment and vehicles, the introduction of home composting, the improvement of the fee collection system service and adjustment of the service cost for different fractions of waste. Some municipalities proposed the establishment of inert landfill for C&D waste. Finally, the Action Plans include public awareness campaigns to raise the public sensitivity.

3.4.1.7 Other relevant strategies and policies

i) National Strategy Sustainable Development for the period 2010-2030

Since sustainable development is a fundamental EU goal, the country, after being awarded candidate status for EU membership in December 2005, was obliged to prepare a national strategy for sustainable development. In January 2010, the Government adopted the National Strategy for Sustainable Development for the period 2010-2030, which aims at setting out a vision, mission and objectives for economically, socially and environmentally balanced development for the next 20 years.

Based on this Strategy, the Government established the National Council for Sustainable Development, No. 8/2010, which is chaired by the Deputy Prime Minister of the Government responsible for economic issues and composed of representatives of nine State bodies, the Assembly, Academy of Science and Arts, three faculties, the Economic Chamber and NGO DEM, a network of NGOs in the country. In support of the

Council's expert, logistical and technical activities, the establishment of an office for sustainable development has been envisaged, with the Ministry of Environment and Physical Planning to carry out these activities in the meanwhile.

The NSSD respects the strategic directions that have already been set in different sectors, but also provides strong cross-cutting links essential for sustainable development. It analyzes the main constraints for making the country, which are identified as:

- Limited understanding and awareness of, and commitment to, the concepts and principles of sustainable development (SD);
- Partially developed SD supporting policy framework;
- Partially developed SD supporting legal and regulatory framework;
- Weak capacity for the cross-cutting and integrated working approach that SD implies;
- Weak capacity in public organizations and institutions for SD-based strategic work, planning, administration (including processing of SD-based applications and projects), and enforcement;

  Not readily available domestic and foreign fund and investments for SD projects and activities and a weak banking sector in terms of processing SD-based projects;
- Weak engineering and construction capacity for implementing SD-based projects.

Therefore, the Strategy sets two main actions to overcome those constraints:

- Short, medium and long-term objectives, which address the important issue of EU accession in a timely fashion:
- Seven strategic thrusts, which are based on guiding principles and are designed to cover the three main pillars (economic, social and environmental sustainability), namely:

1. Ensuring EU accession, a key issue;
2. Raising awareness and commitment to sustainable development covering all walks of life;
3. Introducing E-government as the key SD implementation tool and the key booster of the commercial process;
4. Streamlining the public sector through organizational development and institutional strengthening based on the concepts and principles of SD, including cross-cutting and integrated strategic and participatory work. This is also to ensure that SD activities and projects can be processed and approved expeditiously;
5. Streamlining the banking, funding and financial infrastructure in the same context, so that investment and running costs are readily available for SD projects and activities;
6. Streamlining the private sector so that the private sector is developing based on SD principles, and that engineering, construction and other supporting private companies have the capacity to plan, design and implement/ construct projects and activities based on the principles of SD;

Identifying a number of demonstration and pilot projects early on during implementation of the NSSD. These should be used as practical demonstration of costs and benefits of SD based development. They will function as integrated and good examples in the awareness-building and commitment-raising activities. Furthermore, they will provide guidance and inspiration in relation to the municipalities and the private sector, which will have the main role and functioning in relation to the operational part of making the country sustainable.[26]

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

ii) National Strategy for the Clean Development Mechanism for the First Commitment Period under Kyoto Protocol, 2008-2012

The Government adopted the National Strategy for the Clean Development Mechanism for the First Commitment Period under Kyoto Protocol, 2008-2012 in February 2007.

The goal of the National Strategy for the Clean Development Mechanism (CDM) is to facilitate transfer of investment and technologies through CDM for implementation of projects that reduce greenhouse gas (GHG) emissions and contribute to the country's national sustainable development priorities. The Strategy outlines a course of action that the Government, together with its national and international partners, will pursue during the first commitment period of the Kyoto Protocol (2008-2012) to achieve this goal. Inter alia, one of the priority areas identified in the Strategy for implementation of CDM projects in 2008-2012 is the forestry sector.

The country has registered and implemented various CDM projects.

The country, with the necessary support of the international community, has also developed two other documents in the field of climate change:

- Strategy for Climate Change, approved by the Government in 2008;
- National Strategy for Adaptation of Health Sector to Climate Change, which is going through an approval procedure led by the Ministry of Health with the support of WHO.

iii) National Environmental Investments Strategy for the period 2009-2013

In April 2009, the Government adopted the National Environmental Investments Strategy for the period 2009-2013 (NEIS). The Strategy for Environmental Investments identifies the condition and problems in the area of environmental infrastructure, as well as priorities, measures and activities for the realization of environmental investments in the country.

The NEIS comprises three pillars:

- Definition of a funding budget from national and international sources;
- Allocation of these funds to clearly defined and agreed priorities;
- Institutional strengthening and changes to ensure efficient and effective NEIS implementation.

In the Strategy, non-investment measures are also defined as a prerequisite for smooth NEIS implementation, in relation to institutional strengthening.

iv) National Program for Adoption of the Acquis Communautaire

The National Program for Adoption of the Acquis Communautaire (NPAA) is a key document for the EU integration process. Adopted for the first time in 2001 by the Government, it is revised annually. The Plan reflects the dynamics of harmonization of national legislation with EU legislation as well as the necessary adjustments and strengthening of national institutions and resources.

NPAA is a comprehensive long-term document that defines the dynamics of the adoption of the Acquis Communautaire (EU legislation), strategic guidelines, policies, reforms, structures, resources and deadlines to be realized /implemented by the country in order to fulfil the requirements for EU membership. The core functions of NPAA are to:

- Establish plan and timescale for approximation and for adoption of the EU Acquis and determine the competent institutions and authorities for preparation and implementation thereof;
- Determine the necessary administrative structures for implementation of the EU Acquis into national legislation;

- Determine budget resources and foreign assistance funds necessary for implementation of the anticipated tasks.

The two main features of NPAA are its capability to serve as a basis for:

- Monitoring progress made by the country yearly;
- Formulating the position papers and negotiation positions of the country upon commencing the accession negotiations.

The short-term and medium-term EU priorities with regard to the process of integration are defined in the Accession Partnership, a document produced by the EU. It is a mean of realizing the European perspective of the western Balkan countries within the framework of the stabilization and association process. The concrete activities for achievement of the Accession Partnership's priorities are integrated in NPAA.

NPAA represents a control mechanism in the monitoring of the process of legislation harmonization. Chapter 27 on the Environment refers to the provisions of the Stabilization and Association Agreement (SAA), which establish the basis for obligations concerning the harmonization of national legislation, the implementation deadline, the competent body, the overview of the relevant EU legislation, as well as the overview of the existing national legislation and the planned legal acts to be adopted.

Every year, NPAA contains a list of legislation and policies that the country needs to adopt for improving its approximation to EU standards, and great efforts are made to produce and update as many documents as possible.

v) National Set of Environmental Indicators

In September 2008, the Government adopted the National Set of Environmental Indicators including 40 indicators, which was published in November 2008 in two languages. The set mainly corresponds to EEA indicators data sets, and represents the basis on which the country will assess the state of the environment and the impact of legislation and policies.

vi) 2005 Strategy on Raising Public Awareness

The 2005 Strategy on Raising Public Awareness sets short and medium-term goals as to how to structure and improve the ministries' performance in raising environmental awareness of the relevant target groups, decision-makers in industry and the general public, as well as short-term and medium-term communication goals in order to improve communication between all stakeholders in the field of environmental management with a focus on EU-MoEPP, inter-ministerial communications and communications with the ministry itself.

The strategies for strengthening the communication capacities of the Ministry and for raising awareness have been developed in parallel with the Environmental Communication Strategy. It applies a holistic approach by developing in parallel an internal as well as an external communication strategy, resulting in two different strategy papers.

vii) Vision 2008 Communication Strategy

This is a basic mid-term strategy (Mother Strategy). It has been designed for external and internal MoEPP communication, including definition of mission statement, styles of communication and guidelines for policy marketing. All strategic issues addressed in this document are the basic layer or the fundament of all awareness and promotion activities of the Ministry in a five-year period. A yearly update of this Strategy according to monitoring and implementation progress will be necessary. This Strategy in particular was related to the impacts of designing policies and communicating policies at the same time. The model entails high involvement of stakeholders from NGOs and from the private sector

Vision 2008 enables the Ministry to play a proactive role in national environmental improvement and in the upcoming EU membership negotiations and reduce institutional dependency on donor funding and external technical assistance, while at the same time enabling mobilization of domestic and external funding for environmental investments. In is intended to bring benefits in terms of improved performance of the public administration as well as the development of democracy in the country on the way to full EU membership.

viii) Awareness strategies

There are three topical strategies based on the communication and management styles defined in Strategy. Together, these four strategies constitute a comprehensive and integrated approach towards a sustained improvement in MoEPP communication capacity. The result is an integrated communication model.

ix) Environmental Monitoring Strategy

The objective of the 2006 Environmental Monitoring Strategy is to streamline MoEPP tasks with regard to environmental monitoring. This also includes the design of a monitoring system that would comply with EU monitoring and reporting requirements.

Based on the assessment of current monitoring systems and the evaluation of current data management systems, the Environmental Monitoring Strategy specifies activities which need to be pursued in order to develop effective and cost-efficient environmental monitoring and earmarks investment for environmental monitoring. In addition to the internationally accepted DPSIR model, the Strategy also deals with self-monitoring and reporting requirements, as well as the establishment of the environmental information system that is described in greater detail in the Environmental Data Management Strategy. It highlights the concept of goal-oriented monitoring; and presents planning schemes to develop the monitoring of environmental quality (water, air, biosphere, noise, nature, soil) and the monitoring of emissions, in particular wastewater, exhaust air and waste. It puts monitoring into the respective framework of legal, institutional and technical issues, and provides guidance as to references. However, the core pieces of the present Strategy are modules which specify important environmental goals for all environmental media. The purposes and objectives of monitoring are identified, aiming at the specified goals, and, the required activities are deduced.

x) Strategy on Environmental Data Management

The 2005 Strategy on Environmental Data Management provides a step-by-step plan for the implementation of a standardized architecture for software and data structures that can accommodate data from multiple regulatory programs—such as air pollution control, water pollution control, soil and noise control and hazardous waste management— and that can provide integrated (i.e. cross-program) access to data. In parallel with the technical roadmap that guides the implementation of the necessary Environmental Information System (EIS) modules, the Environmental Data Strategy addresses the human factor challenge of how to avoid frictions between the parties concerned and build cooperation while at the same time motivating users. Users will require special training in parallel with the hardware and software installation, but they must also be motivated and informed about the benefits of using EIS in their daily work. EIS sets a data management approach that promotes efficient, well-integrated data management within each environmental program area and also facilitates cross-program data viewing and multi-program retrievals.

The Strategy on Environmental Data Management provides the guiding principles and framework for implementing a national environmental data management program. Future environmental protection depends on modernized and highly unified data services to maintain reliable, secure, and efficient information-sharing in the face of the expected growth in demand for such services. The primary goal of the data management program is to provide reliable information available quickly. The achievement of this primary goal requires the following specific goals:

- The establishment of an environmental information system (EIS);
- An increase in data sharing;
- The improvement of data availability in terms of timeliness, access, and quality;
- The promotion of collaboration on data management activities;
- The provision of maximum benefit with existing data infrastructure.

xi) Spatial Plan

The 2004 Spatial Plan incorporates emphasized strategic development connotation and defines and establishes the basis and at the same time feasible goals and directions for development, especially with regard to the necessary qualitative and quantitative structural changes and the relevant and adaptable spatial planning solutions and options. This document constitutes a foundation for the organization, development, use and protection of space in the country, covering a 20-year period. The Study on the Environment and Nature Protection, carried out within the framework of the Plan, specifies the goals and planning guidelines for environment protection, as part of the overall activities in the field of spatial planning.

xii) Plan for Institutional Development of National and Local Environmental Management Capacity for the Period 2009-2014

The Plan for Institutional Development of the National and Local Environmental Management Capacity for the Period 2009-2014 aims to determine the relevant functions and to suggest an institutional development plan for central administrative bodies and bodies of local self-government with competences in the area of the environment, within the medium term. The plan sets differentiation and grouping of specific activities into a general framework of functions in competence of certain central or local bodies, so that these bodies could subsequently develop the necessary administrative capacity to carry out individual activities or, based on the workload, carry out activities using existing administrative capacity. It aims to establish a plan for an efficient national environmental management system and for the strengthening of the central administration, ensuring practical implementation of harmonized legislation and of strategic plans and programmes. The plans identifies priorities and measures aiming at facilitating the process of transfer of competences from central to local level, increasing the implementation capacity of local self-government, and developing solid ties between central government and local self-government.

xiii) National Environmental Health Action Plan (NEHAP) (1999)

This 1999 National Environmental Health Action Plan (NEHAP) recognizes the linkage between the environment and health: it formulates guidelines aimed at overcoming environmental health problems, and identifies priorities and actions that treat, among other issues, the institutional set-up, stressing the need for the establishment of inter-sectoral cooperation, reform of environmental health services and capacity-building, information systems strengthening, development of criteria and procedures for the assessment of environmental impacts on human health and their integration in decision-making processes, and establishment of control measures.

xiv) Strategy on Improvement of Energy Efficiency by 2020

The objective of the 2010 Strategy on Improvement of Energy Efficiency by 2020 (SIEE) is to develop a framework for accelerating adoption of energy efficiency practices in a sustainable fashion through implementation of a series of programs and initiatives that are linked to the reduction of import dependence, energy intensity, non-productive use of electricity, establishment of a favourable climate for maximizing the involvement of and opportunities for the private sector complementary advocacy, and training activities. The final result of achieving this objective will be the realization of over nine per cent energy savings till 2018, comparing to average consumption in the observed five-year period (2002-2006), with continued promotion of energy efficiency and monitoring and verification until 2020. This is an important task for the country on the way to sustainable development of the country's economy and fulfilment of commitments on the way to EU accession, and will serve as the first benchmark in the realization of the planned measures. With the Second National Energy Efficiency Action Plan (2018-2020) the Government will develop additional measures to reach 14.5 per cent savings in 2020, which means that the country will approach the EU target in 2020 of achieving savings of 20 per cent. The objective of the elements incorporated into the SIEE is to stimulate a progressive transformation of the market. The development of an adequate policy framework is intended to stimulate the demand for more energy-efficient technologies and services. As this demand grows, it should encourage the formation of energy service companies and companies that provide more efficient equipment and accompanying maintenance.

xv) Second National Environmental Action Plan

The first National Environmental Action Plan, adopted in 1996 as highlighted in the first EPR, was an outdated document for the needs of the country, as a result of which a recommendation was made that a new NEAP should be adopted. Unfortunately, before preparing a new NEAP the country did not carry out an assessment on the implementation status of the first NEAP.

The Government adopted the second National Environmental Action Plan in 2006. The document, prepared by MoEPP in coordination with different ministries, provides general guidelines and directions for the country in the area of environment until 2011. In addition to setting general objectives and goals in different sectors, NEAP also envisages specific order to achieve said goals.

NEAP represents the Government's approach and response to environmental problems in the country. In the area of environment, the process of EU approximation poses significant requirements for the country, in terms of not only financing but also capacity-building, institutional restructuring and strengthening. As confirmation of this, the Government, through MoEPP, has developed a roadmap for approximation of the area of environment to EU legislation.

NEAP also provides a basis for the local environmental action plans (LEAP), which are developed along the lines of NEAP, taking into consideration the local conditions of each municipality.

On the one hand, NEAP sets the principles and priorities for action by MoEPP, and on the other side it provides a solid basis for proving the relevance of proposed projects and actions for donor assistance, especially by NGOs.

Compared to the first NEAP, the one adopted in 2006 is a completely new document rather than a mere update. In particular, this document also stipulates the necessary instruments for implementation and monitoring of its goals. Despite the relevant provisions, and in particular the plan for annual reporting to the Government on NEAP implementation, there is no actual monitoring of NEAP implementation. This is partly due to a lack of human resources in MoEPP, leading to a lack of communication from relevant bodies (such as other ministries, NGOs, donors) which are supporting NEAP implementation mainly through projects. In fact, MoEPP does not have sufficient capacity to properly monitor NEAP implementation and remain abreast of any NEAP-related activity implemented by other bodies.

xvi) Local Environmental Action Plans

As of May 2016, 29plansfrom municipalities form the four regions of the project, including the City of Skopje, had been developed. Most of the four larger municipalities have greater economic and human capacity and have developed their LEAPs, while smaller municipalities are lagging behind in the preparation of this document. There are a number Plans prepared in the last three years, after the adoption of the Methodology for the preparation of LEAPs by MoEPP, based on Article 64 of the Law on Environment, such as LEAP for the municipalities within the City of Skopje, for example Aerodrom, Ilinden, Gjorce Petrov, and other municipalities, such as Novaci, Vasilevo, Brvenica. Twenty LEAPs prepared by 1998 are particularly outdated since they were developed prior to the preparation of the MoEPP Methodology for the Preparation of LEAPs, based on the DPSIR approach.

The Government and in particular MoEPP is financially supporting the municipalities in the preparation of the LEAPs. In addition to these national resources, the international donor community is active in this field. MoEPP has prepared a methodology for LEAP preparation based on the DPSIR approach (Driving forces, Pressures, States, Impacts and, Responses). The methodology is used by municipalities in preparing the LEAP, and it can be seen that in recent years, the quality of LEAPs has improved and they are becoming increasingly relevant.

3.4.1.8 Overview of requirements set by legal and regulatory framework

Current national waste management targets are presented in the following table.

Table 3-50: Current timeline for waste sector objectives and targets in the Republic of Macedonia

Objectives and targets	Source	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	…2027
Improvement of collection and source separation efficiency													
- Mixed municipal waste - Collection efficiency: 90%	NWMP												
- Segregation of hazardous and non-hazardous waste fraction (manufacturing/ service sector) Segregation efficiency: 100%	NWMP												
Landfill of waste/diversion													
- landfill of MSW on temporary facilities (after conditioning) - 100% of the collected MSW	NWMP												
- landfill of MSW on facility compliant with EU standards - 50% of the collected MSW	NWMP												
- reduction of the greenhouse gas emissions (landfills only) - Reduction for approximately 25% of CO_2 equivalent	NWMP												
- diversion of industrial hazardous waste streams from non-hazardous landfills – 100% effect	NWMP												
- reduction of biodegradable waste disposed on landfills expressed as a percentage reduction of the BMW generated in 1995	NWMP& Rules (OG No.108/2009												
2011-2017: 25%													
2011-2020: 50%													
2011-2027: 65%													
Packaging and packaging waste													
Treatment / Recovery: 60% b.w.	LoPPW												

Objectives and targets	Source	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	…2027
Recycling: (minimum 55% - maximum 80%)	LoPPW												
-22.5% plastic	LoPPW												
- 60% glass, 60% paper and cardboard, 50% metals and 15% wood	LoPPW												
Batteries/accumulators													
Collection of at least 25 % b.w.	LoBAWBA												
Collection of at least 45 % b.w.	LoBAWBA												
Waste electrical and electronic equipment													
Collection: >4kg/capita/year	LoEEEWEEE												
Cat. 1 and 10: recovery 80% and prep. for reuse/recycling 75%	LoEEEWEEE												
Cat. 3 and 4: recovery 75% and prep. for reuse/recycling 65%	LoEEEWEEE												
Cat. 2,5,6,7,9: recovery 70% and prep. for reuse/recycling 50%	LoEEEWEEE												
Gas discharge lamps - at least 80% reuse and recycling	LoEEEWEEE												
Construction and demolition waste													
Collected: 30% Recovered/ recycled: 10% Disposal: 90%	NWMP												
Used tyres													
Collection efficiency: 90% Energy recovery: 100%	NWMP												
PCB/ PCT waste													
Inventory complete (2009) Destruction	NWMP												
End of life vehicles													
Collection: 90%	NWMP												
Recovery or reuse: 70% - 85$													

3.4.2 Gap analysis OF THE CURRENT WASTE MANAGEMENT SYSTEM

The purpose of gap analysis is to comment on the gaps and weak spots identified within the assessment carried out.

Already in 2008 the European Waste Framework Directive has set specific requirements for waste management, where the most notable is the waste hierarchy. Following the waste hierarchy waste prevention is the worthwhile goal, followed preparing for re-use, recycling, other recovery, e.g. energy recovery, and lastly disposal as the last resort for waste that cannot be further treated. Therefore, a shift away from landfill in the current waste management system is crucial. The necessary changes will require the development of an appropriate infrastructure to provide an integrated network of separate waste collection, transportation, recycling facilities, recovery installation and EU conform disposal facilities. The proposed changes in the next phase should reduce the amount of waste being landfilled.

An overview of the current waste management system gaps is presented in the following table.

Table 3-51: Overview of current solid waste management system in Southwest region - identification of gaps

Where we are now	GAP and measures to be taken	Where we want to be
A. EU and national targets/ Local Policy		
Diversion of biodegradable municipal waste Currently, no specific measures for the diversion of BMW from landfill are taken. The diversion targets will be reached with the full operation of the Integrated Solid Waste Management facilities.	The proposed measures are: Activities for the separate collection of green waste from public areas will be established and this fraction will be diverted to composting plant. Home composting actions will be established. Operation of the Waste Management Centre (WMC) which will include biological treatment of the organic fraction of Solid Municipal Waste (SMW).	The LoWM (Article 87) of the Republic of Macedonia specifies the reduction of the quantity of Biodegradable Municipal Waste (BMW) landfilled, expressed as a percentage reduction of the BMW generated at 1995. By 31st December 2016 the reduction must be 25%, by 31st December 2019 the reduction must be 50%, and, by 31st December 2026 the reduction must be 65%.
Target for collection and treatment of packaging waste: paper and cardboard packaging, metal packaging, plastic packaging and glass packaging from households and other sources, if possible, when such waste streams are similar to household waste	Currently, the source separating system concerning packaging waste is very limited. Regarding the recyclable materials paper, metal, plastic and glass, the source separation of these fractions should be established in a more appropriate and organized way. Green points that are planned to be constructed will accept the recyclables. Furthermore, waste bins for recyclable waste should be placed.	According to the article 35 (*National aims for treatment of packaging waste*), paragraphs (1) b, (1) c & (1) d of Law on management of Packaging and Packaging waste the following should be fulfilled • By the end of the year 2020, a minimum of 55% and a maximum of 80% of the weight of packaging waste created on the territory of the Republic of Macedonia needs to be recycled • By the end of the year 2020, the following percentages of materials where from the packaging waste is produced need to be recycled ✓ *60% glass* ✓ *60% paper and cardboard* ✓ *50% metals* ✓ *15% wood* • By the end of the year 2018 22.5% plastic, considering only the recyclable materials in the plastic
Waste Prevention The waste hierarchy is not implemented completely, as almost no waste prevention measures are taken. According to the EU Commission[27] a waste prevention strategy can be implemented through Informational, Promotional and Regulatory strategies. Regarding informational strategies, some national public awareness campaigns have been implemented, with the majority of awareness events organized in the City of Skopje and few at regional/ local level. In the Republic of Macedonia and specifically in the region of Southwest, the level of the environmental sensitivity is assessed as low. Besides the national campaigns, such as "Macedonia free of waste" and "Integration of Ecological Education in Macedonia's Educational System", public awareness campaigns in local level involve the participation mainly of the primary level of education, such as kindergartens and primary schools. There were also campaigns on specific waste, such as waste batteries, accumulators	Drawing the public attention to waste prevention through campaigns/ training programmes. Implementation of home composting actions and involvement of the public through public consultation. Green Points that are planned can be used for education and awareness on waste prevention, promotion of reuse and repair. Information campaigns on waste prevention techniques will be promoted.	Successful implementation of waste prevention measures and public awareness campaigns regarding waste prevention. Waste prevention measures are implemented (such as home composting actions) and the public is informed and more aware of the waste issues. The stakeholders are identified and their involvement is increased in the waste prevention strategy.

[27] http://ec.europa.eu/environment/waste/prevention/pdf/Waste%20prevention%20guidelines.pdf

Where we are now	GAP and measures to be taken	Where we want to be
and waste from electronic and electric equipment. Furthermore, poor response to waste minimization (reuse/ recycling) was reported as a very serious/ serious problem in 60% of the filled/ answered questionnaires. This gives evidence of the lack of information/ awareness/ involvement of the public.		
Landfill restoration and/ or landfill closure According to the Landfills' and Dumpsites' survey that has been done during the preparation of the Assessment Report (please, see Part B of the Assessment Report) 10 municipal non-compliant landfills (active and closed) and 85 dumpsites in total were identified within Southwest region. All existing landfills according to the NWMP (2009-2015) should be remediated and closed.	Implementation of landfill restoration plan and/ or landfill closure plan. Two distinct types of closure and remediation approaches are proposed; ✓ "ex situ": removal of waste and contaminated soil and disposal of the waste at appropriate landfill. ✓ "in situ": capping (with and without construction of gas drainage systems) the waste with appropriate infrastructure to provide long term environmentally safe storage of waste.	The landfill that will be included in WMC will be constructed according to the National and EU Regulations.
B. Financial mechanisms		
Tariffs Currently, the service fee collection and disposal of municipal waste in local self-government units is calculated according to the price list of utility company. Different charging mechanisms are applied to residential and commercial users. The service fee is currently defined in different ways: according to the number of households, surface area, the quantity or volume of the container, in accordance with the Law on Waste Management. Commercial entities are charged a fee similar to flat – rate household user charge. The tariffs for individuals vary from 150 MKD/month per household or 1,800 MKD/year per household to 240 MKD/month per household or 2,880 MKD/year. The tariffs of legal entities are differing between municipalities and they are calculated by taking into account the size of property. Unusually high are tariffs in Ohrid, and these vary between 38 MKD/m2 /year to 196 MKD/m2 /year.	Residential and commercial users pay a flat fee for waste management and the charges are not proportional to the amount of generated waste. The current tariff policy does not comply with the "polluter pays" principle (PPP) and ignores individual ability to pay (affordability limits). Updating of tariff system in order to be in line with the Waste Management Law, the National Waste Management Plan (2009-2015), the Waste Management Strategy of the Republic of Macedonia (2008 - 2020) and the EU guidelines (Polluter pays principle and affordability limitation for the residential users). Awareness raising campaigns are also important to accompany the introduction of waste tariffs/fees.	The service provider shall calculate a fee for the public service in a manner which guarantees the implementation of the "polluter pays" principle, ensures an economically viable business performance and a safe, regular and high quality service consistent by taking into account affordability limits for the residential users. The most common economic instrument used to apply Polluter Pays Principle are waste tariffs charged upon different waste producers (i.e. households/commercial users), aimed at recovering the cost of building and operating the services and infrastructure required for collection, treatment and disposal of the waste they produce (full cost recovery level) Moreover tariffs for residential users will be below full cost recovery level as long as affordability limits persist. In this case as a minimum requirement, tariffs/fees should cover the operating costs and replacement cost of assets and equipment with short economic lifetime as soon as project facilities become fully operational. Affordability limits will be applied only to residential waste producers. Non-residential waste producers should be assumed to be able to pay for the full-cost recovery.
C. Technology and infrastructure		

Where we are now	GAP and measures to be taken	Where we want to be
Collection - Transportation According to the received questionnaires, the collection frequency depends on whether it is an urban or a rural area. The waste management system is based mainly on waste collection and disposal. The waste collection, transportation and disposal service is provided by Public Utility Enterprises (PUEs). According to the received questionnaires, the percentage of the population that receives a regular service ranges from 35% (Centar Zhupa) to 100% (Ohrid and Vevchani). Most of the population that does not receive any collection service lives in rural areas. The waste collection frequency varies among municipalities. In rural areas it takes place usually once per week and in urban varies from daily to once a week. Lack of collection equipment was considered a very serious/ serious problem for almost 40% of the answered/ filled questionnaires. Old vehicle equipment was considered a very serious/ serious problem for the 100% of the answered/ filled questionnaires, and lack of vehicles was considered a very serious/serious problem for almost 67% of the answered/ filled questionnaires. According to the received questionnaires, another serious problem is the lack of separate collection of recyclables (50% considered it as a very serious/ serious problem).	The total capacity of bins in the region is not sufficient for the full collection of mixed municipal waste. Regarding the vehicles, the majority of the vehicles are too old to be operative.	Smooth implementation of a separate waste collection system and increased separate waste collection rates. 100% collection coverage of mixed municipal waste. Purchase of bins and vehicles. Recycling increasing.
D. Stakeholder participation - Public awareness		
The education of the population on the obligation of separate collection of municipal waste is carried out partially by the local self-government units and NGOs in the project area. In some municipalities information of the population about the obligation and manner of separate collection takes place. In the country, Civil society organizations, such as Macedonian Green Centre NGO, have implemented awareness projects and have cooperation with the MoEPP. Regarding other stakeholders, such as the collective schemes (PAKOMAK mainly), they have organized a number of public awareness activities. Regarding the participation of the business sector, it is considered to be low.	The activities to educate the population are not performed in a systematic way, not part of a wider program, and not carried out continuously. In order to raise awareness about responsible disposal and recycling of waste, it is proposed to systematically implement actions to collect waste that will stimulate and encourage the population to actively participate in the separate collection of municipal waste. Awareness regarding the environmental protection already exists; however, the motivation to be involved in the minimization, source separation is low. The public needs to be stimulated and encouraged to use the proposed systems of separate collection containers. The public needs to be motivated to use the existing systems of deposit scheme and separate collection containers. The existing systems need to be convenient to use and the public needs to understand the value of conserving resources - through minimization, reuse and recycling.	The public should be informed and motivated on the separate collection and waste prevention systematically so there is a continuous motivation for utilizing the existing separate collection system, the established green points and home composting. Raising public awareness, awareness of all stakeholders and the establishment of a communication system regarding municipal, other non-hazardous and hazardous waste management in the country shall be one of the unavoidable and important conditions in building up citizens’ understanding, acceptance and their involvement in a successful waste management system.

3.5 WASTE GENERATION FORECAST

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

3.5.1 Population Growth

3.5.1.1 Permanent Population Growth

According the estimation from State Statistical Office of the Republic of Macedonia, the population for Southwest Region and for each Municipality, for the year 2015, is presented below :

Table 3-52: Permanent Population estimation in Southwest Region (Estimation 2015)

Municipality	Permanent Population (Estimation 2015)
Vevchani	2458
Debar	20613
Debartsa	4082
Kichevo	57107
Makedonski Brod	6331
Ohrid	52204
Plasnitsa	4866
Struga	65208
Centar Zhupa	7022
Total Southwest Region (Source State Statistical Office)	**219891**

In order to proceed with the forecasting of the permanent population the indicators regarding urban and rural population from the World Bank have been taken into consideration.

Table 3-53: Average annual Rate of Change of the Urban and Rural population

	2016-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2046
Urban	0.24%	0.35%	0.41%	0.33%	0.20%	0.09%	0.00%
Rural	-0.38%	-0.79%	-1.23%	-1.50%	-1.62%	-1.73%	-1.82%

Source: World Bank (http://esa.un.org/unpd/wup/DataQuery/)

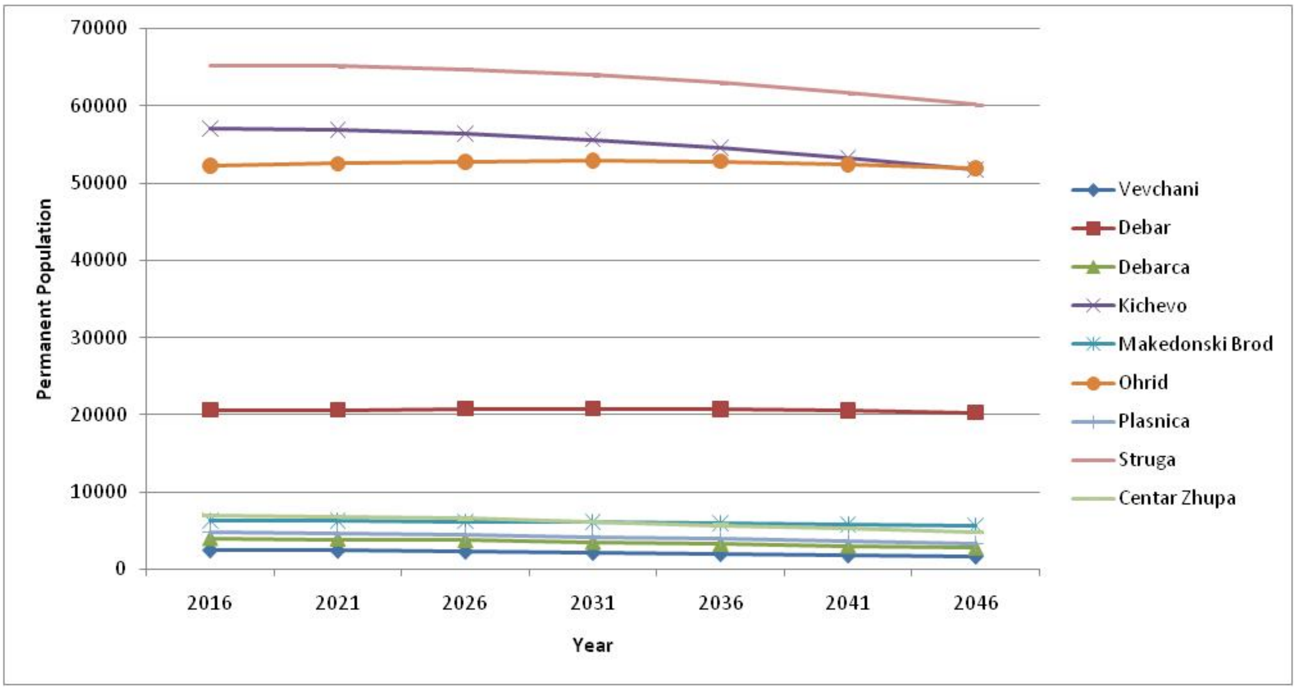
The following figure presents the forecast for the permanent population in each Municipality.

Table 3-54: Permanent population projection in Southwest Region (2016 - 2046)

Municipality	2016	2021	2026	2031	2036	2041	2046
Vevchani	2449	2393	2289	2146	1987	1830	1675
Debar	20630	20699	20773	20802	20731	20558	20300

Debarca	4066	3973	3802	3564	3301	3038	2782
Kichevo	57088	56938	56475	55668	54563	53255	51802
Makedonski Brod	6328	6303	6237	6130	5989	5827	5650
Ohrid	52257	52527	52788	52941	52843	52483	51909
Plasnica	4848	4737	4532	4249	3935	3622	3316
Struga	65202	65118	64738	64009	62944	61631	60135
Centar Zhupa	6995	6890	6622	6224	5771	5319	4874
Total Southwest Region	**219863**	**219576**	**218256**	**215733**	**212064**	**207562**	**202443**

Figure 3-33: Permanent population projection in Southwest Region



3.5.1.2 Seasonal Population Growth

According to the data from State Statistical Office of the Republic of Macedonia, the total number of overnights per municipality in Southwest Region for the year 2015, is presented at the following table.

Table 3-55: Total Number of Overnights in 2015 for Southwest Region

Municipality	Tourists Overnights
Vevchani	-
Debar	196618
Debartsa	-
Kichevo	9141
Makedonski Brod	-
Ohrid	926396
Plasnitsa	-
Struga	383957
Centar Zhupa	60000
Total Southwest Region	**1576112**

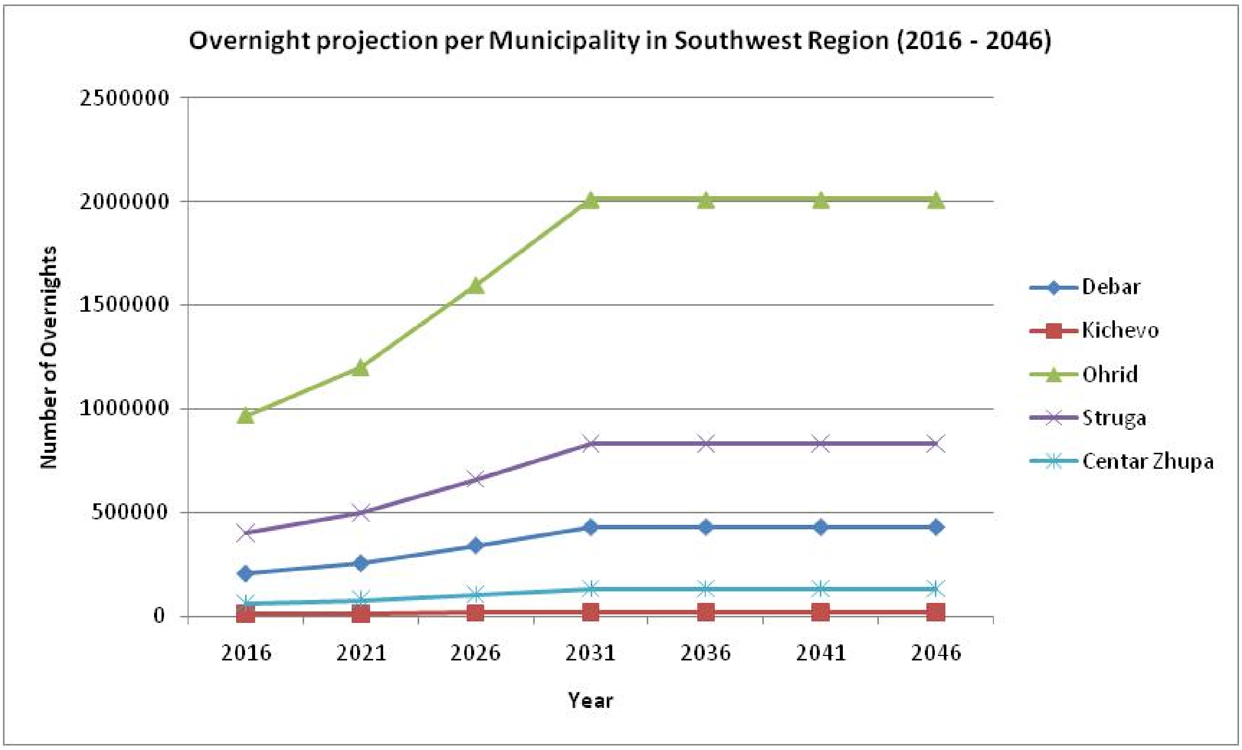
In order to calculate the forecasting of the seasonal population of Southwest Region, the indicators from the "National Tourism Strategy in Macedonia 2009-2013 (Realistic Scenario)" were taken into consideration (i.e. the average annual rate of change was calculated to be 4.40% from 2015 to 2021, 5.92% from 2021 to 2030 and constant from 2031 to 2046).

The estimation of total number of Overnights was made, for the period 2016-2046, and is depicted in the following table and figure.

Table 3-56: Overnight projection in Southwest Region (2016 - 2046)

Municipality	2016	2021	2026	2031	2036	2041	2046
Vevchani							
Debar	205272	254602	339362	427074	427074	427074	427074
Debarca							
Kichevo	9543	11837	15777	19855	19855	19855	19855
Makedonski Brod							
Ohrid	967170	1199593	1598950	2012221	2012221	2012221	2012221
Plasnica							
Struga	400857	497188	662707	833992	833992	833992	833992
Centar Zhupa	62641	77694	103559	130326	130326	130326	130326
Total Southwest Region	**1645483**	**2040914**	**2720356**	**3423469**	**3423469**	**3423469**	**3423469**

Figure 3-34: Overnight projection in Southwest Region (2016 - 2046)

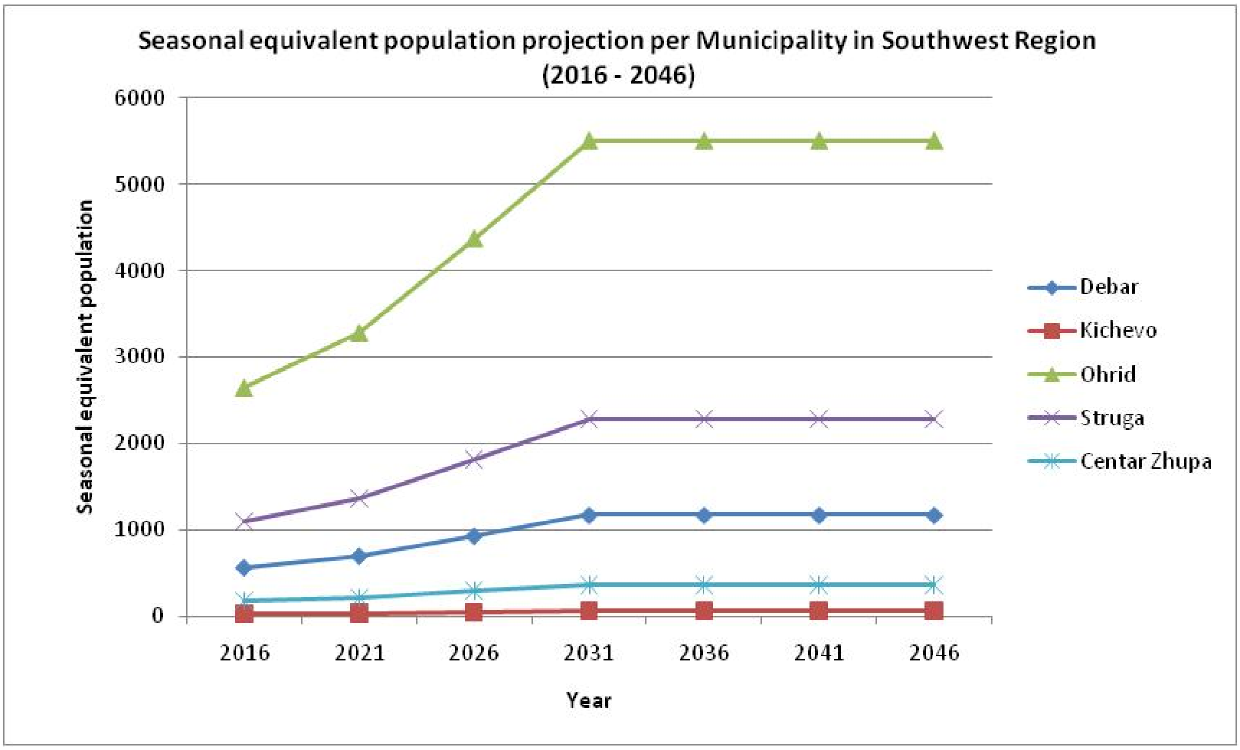


The seasonal equivalent population that corresponds to the estimated nights spent, is presented in the following table.

Table 3-57: Seasonal equivalent population projection in Southwest Region (2016 - 2046)

Municipality	2016	2021	2026	2031	2036	2041	2046
Vevchani							
Debar	562	698	930	1170	1170	1170	1170
Debarca							
Kichevo	26	32	43	54	54	54	54
Makedonski Brod							
Ohrid	2650	3287	4381	5513	5513	5513	5513
Plasnica							
Struga	1098	1362	1816	2285	2285	2285	2285
Centar Zhupa	172	213	284	357	357	357	357
Total Southwest Region	**4508**	**5592**	**7453**	**9379**	**9379**	**9379**	**9379**

Figure 3-35: Seasonal equivalent population projection in Southwest Region (2016 - 2046)



3.5.2 Waste Generation Rate Growth

3.5.2.1 Waste generation rate growth for permanent population

The following four proposed scenarios for the projection of the Waste Generation Rate (WGR) of the permanent population have been examined, based on the National Waste Management Plan 2009-2015.

Scenario 1 : Zero growth-no growth in per capita generation, waste generation grows proportionally to population

Scenario 2 : Low growth-in addition to population growth, per capita generation linked to 50% of growth in GDP followed by 2% between years 2021-2030

Scenario 3 : Medium growth-as Scenario 2 but assume GDP growth of 5% for 10 years after EU membership (projected to be in 2020)

Scenario 4 : High growth-as Scenario 3 but 100% linkage to GDP growth

The scenarios have been quantified in regional level and will be applied per municipality of Southwest Region.

For the projection of the country's GDP, data from the IMF Country Report No. 15/242 were used. Specifically, the projection of the real GDP of the Beneficiary country is shown at the table below [See also: Table 1 - FYR Macedonia: Macroeconomic Framework, 2011-2020 (Year-on-year change, unless otherwise indicated)].

Table 3-58: GDP growth according to the IMF projection

Year	2015	2016	2017	2018	2019	2020
Real GDP in Beneficiary country	3.2	3.2	3.3	3.4	3.6	3.8

In the tables that follow, the % Change in the Waste Generation rate (kg/ca/year) for each of the four (4) proposed scenarios is depicted.

According to the 1st Scenario, the % Change in Waste Generation rate is *zero*, i.e. there is no growth in per capita generation, and waste generation grows proportionally to the population.

Table 3-59: Change in per capita Waste Generation rate (%) - Scenario 1

Year	2017 - 2046
% Change in Waste Generation rate (kg/ca/year)	no growth in percapita generation

According to the 2nd Scenario, the % Change in Waste Generation rate is *low*, i.e. in addition to population growth, the 'per capita' generation is linked to 50% of growth in GDP (projected at 3% p.a.).

Table 3-60: Change in per capita Waste Generation rate (%) - Scenario 2

Year	2017	2018	2019	2020	2021 - 2030	2021 - 2046
% Change in Waste Generation rate (kg/ca/year)	1.56%	1.52%	2.94%	2.78%	0.20% per year	-

According to the 3rd Scenario, the % Change in Waste Generation rate is *medium*, i.e. similarly as in scenario 2, assuming though that the GDP growth is 5% for 10 years after EU membership (projected to be in 2012).

Table 3-61: Change in per capita Waste Generation rate (%) - Scenario 3

Year	2017	2018	2019	2020	2021 - 2030	2021 - 2046
% Change in Waste Generation rate (kg/ca/year)	1.56%	1.52%	2.94%	2.78%	0.49% per year	-

According to the 4th Scenario, the % Change in Waste Generation rate is *high*, i.e. as in scenario 3, but the linkage to GDP growth is 100%.

Table 3-62: Change in per capita Waste Generation rate (%) - Scenario 4

Year	2017	2018	2019	2020	2021 - 2030	2021 - 2046
% Change in Waste Generation rate (kg/ca/year)	3.13%	3.03%	5.88%	5.56%	0.49% per year	-

In the figures below, the Waste Generation rates for the period 2016-2046 for each municipality within Southwest region and for all 4 (four) examined scenarios, are depicted.

Table 3-63: Waste Generation rate for permanent population, Scenario 1

	WGR for Permanent Population (kg/ca/year)						
Municipality	**2016**	**2021**	**2026**	**2031**	**2036**	**2041**	**2046**
Vevchani	**170**	**170**	**170**	**170**	**170**	**170**	**170**
Vevchani urban	0	0	0	0	0	0	0
Vevchani rural	170	170	170	170	170	170	170
Debar	**315**	**316**	**316**	**317**	**318**	**318**	**319**
Debar urban	331	331	331	331	331	331	331
Debar rural	268	268	268	268	268	268	268
Debarca	**198**	**198**	**198**	**198**	**198**	**198**	**198**
Debarca urban	0	0	0	0	0	0	0
Debarca rural	198	198	198	198	198	198	198
Kichevo	**214**	**214**	**215**	**216**	**217**	**218**	**218**
Kichevo urban	233	233	233	233	233	233	233
Kichevo rural	189	189	189	189	189	189	189
Makedonski Brod	**271**	**272**	**273**	**274**	**275**	**276**	**278**
Makedonski Brod urban	298	298	298	298	298	298	298
Makedonski Brod rural	241	241	241	241	241	241	241
Ohrid	**361**	**362**	**363**	**364**	**365**	**366**	**366**
Ohrid urban	377	377	377	377	377	377	377
Ohrid rural	305	305	305	305	305	305	305
Plasnica	**309**	**309**	**309**	**309**	**309**	**309**	**309**
Plasnica urban	0	0	0	0	0	0	0
Plasnica rural	309	309	309	309	309	309	309
Struga	**174**	**174**	**175**	**176**	**176**	**177**	**178**
Struga urban	189	189	189	189	189	189	189
Struga rural	152	152	152	152	152	152	152
Centar Zhupa	**125**	**124**	**123**	**123**	**123**	**123**	**122**
Centar Zhupa urban	0	0	0	0	0	0	0
Centar Zhupa rural	125	125	125	125	125	125	125
Weighted Average WGR for Permanent Population (kg/ca/year) for Southwest Region	**247**	**247**	**248**	**250**	**252**	**253**	**255**

Figure 3-36: Waste Generation Rate projection for permanent population for Scenario 1, per Municipality

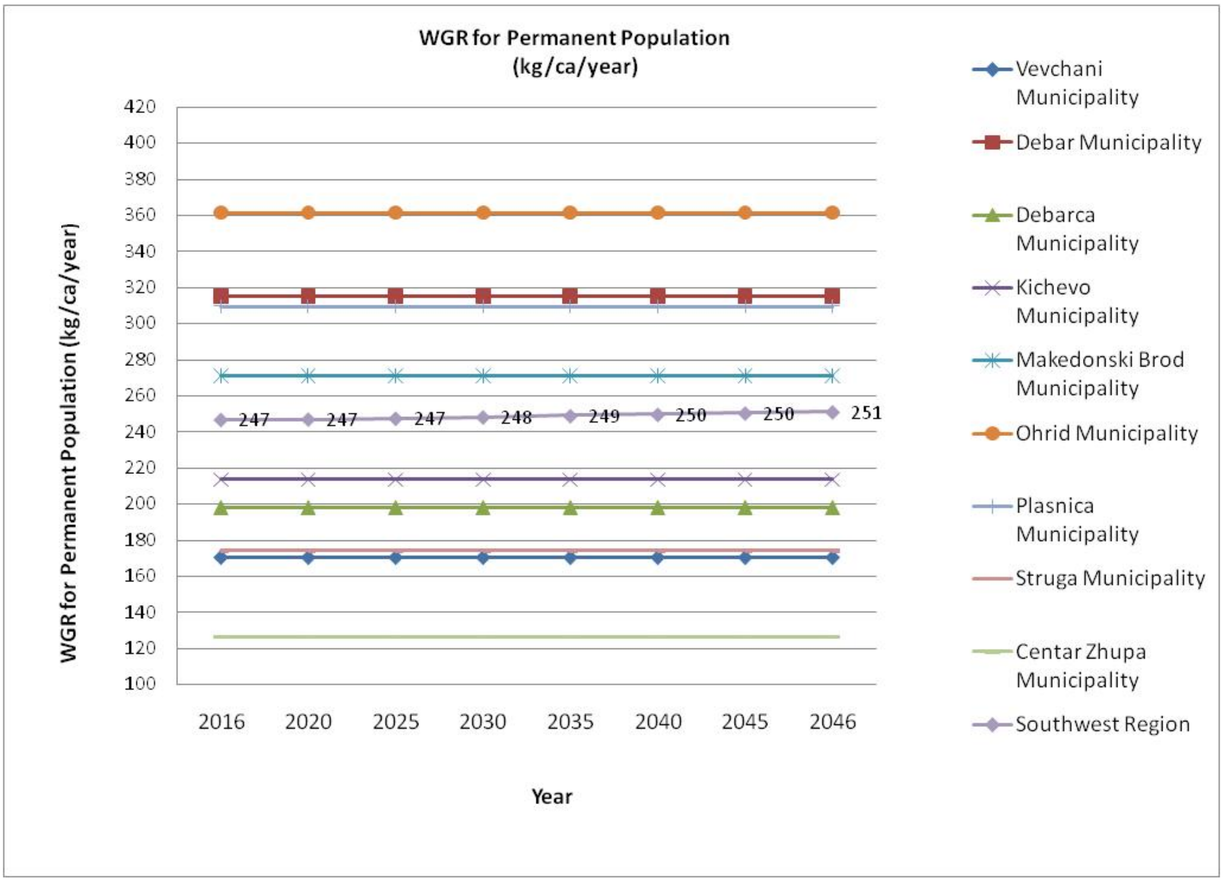


Table 3-64: Waste Generation rate for permanent population, Scenario 2

	WGR for Permanent Population (kg/ca/year)						
Municipality	**2016**	**2021**	**2026**	**2031**	**2036**	**2041**	**2046**
Vevchani	**170**	**186**	**188**	**189**	**189**	**189**	**189**
Vevchani urban	0	0	0	0	0	0	0
Vevchani rural	170	186	188	189	189	189	189
Debar	**315**	**345**	**349**	**353**	**354**	**354**	**355**
Debar urban	331	362	366	369	369	369	369
Debar rural	268	293	296	298	298	298	298
Debarca	**198**	**216**	**219**	**220**	**220**	**220**	**220**
Debarca urban	0	0	0	0	0	0	0
Debarca rural	198	216	219	220	220	220	220
Kichevo	**214**	**234**	**237**	**240**	**241**	**242**	**243**
Kichevo urban	233	255	257	260	260	260	260
Kichevo rural	189	206	208	210	210	210	210
Makedonski Brod	**271**	**297**	**301**	**305**	**306**	**308**	**309**
Makedonski Brod urban	298	326	329	332	332	332	332
Makedonski Brod rural	241	264	266	268	268	268	268
Ohrid	**361**	**396**	**400**	**405**	**406**	**407**	**408**

Ohrid urban	377	413	417	420	420	420	420
Ohrid rural	305	333	337	339	339	339	339
Plasnica	**309**	**338**	**342**	**344**	**344**	**344**	**344**
Plasnica urban	0	0	0	0	0	0	0
Plasnica rural	309	338	342	344	344	344	344
Struga	**174**	**191**	**193**	**195**	**196**	**197**	**198**
Struga urban	189	206	208	210	210	210	210
Struga rural	152	167	168	170	170	170	170
Centar Zhupa	**125**	**135**	**136**	**137**	**137**	**136**	**136**
Centar Zhupa urban	0	0	0	0	0	0	0
Centar Zhupa rural	125	136	138	139	139	139	139
Weighted Average WGR for Permanent Population (kg/ca/year) for Southwest Region	**247**	**270**	**274**	**278**	**280**	**282**	**283**

Figure 3-37: Waste Generation Rate projection for permanent population for Scenario 2, per Municipality

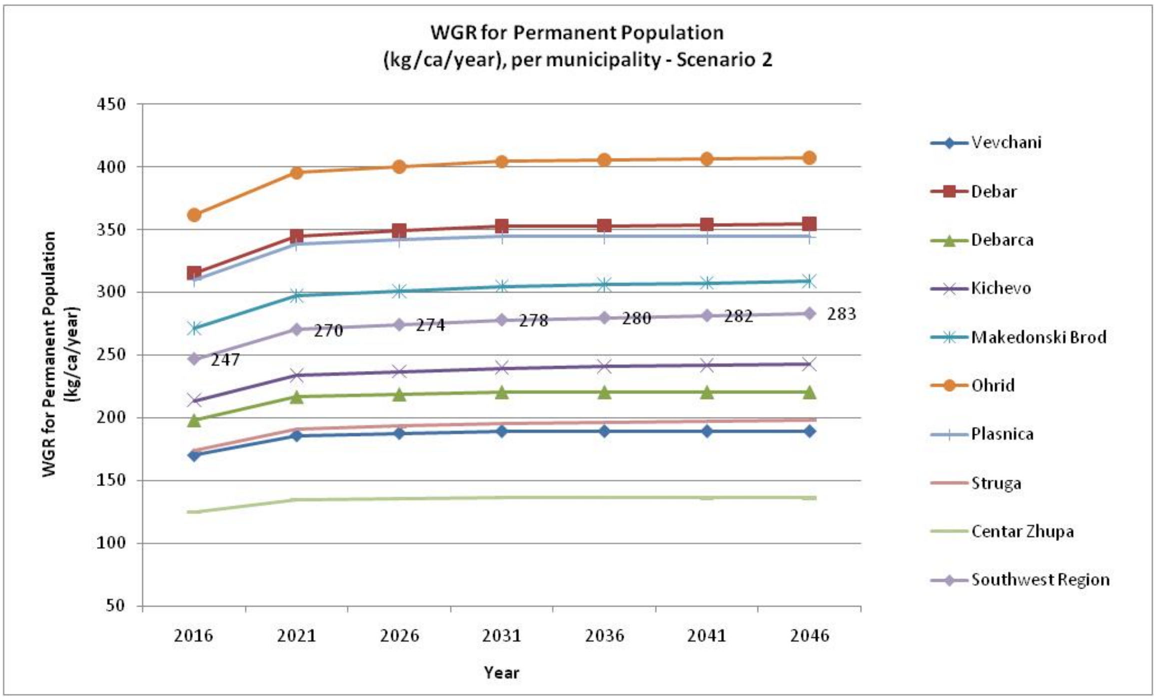


Table 3-65: Waste Generation rate for permanent population, Scenario 3

	WGR for Permanent Population (kg/ca/year)						
Municipality	**2016**	**2021**	**2026**	**2031**	**2036**	**2041**	**2046**

	WGR for Permanent Population (kg/ca/year)						
Municipality	**2016**	**2021**	**2026**	**2031**	**2036**	**2041**	**2046**
Vevchani	**170**	**187**	**191**	**195**	**195**	**195**	**195**
Vevchani urban	0	0	0	0	0	0	0
Vevchani rural	170	187	191	195	195	195	195
Debar	**315**	**346**	**355**	**363**	**364**	**365**	**365**
Debar urban	331	363	372	379	379	379	379
Debar rural	268	294	301	307	307	307	307
Debarca	**198**	**217**	**222**	**227**	**227**	**227**	**227**
Debarca urban	0	0	0	0	0	0	0
Debarca rural	198	217	222	227	227	227	227
Kichevo	**214**	**235**	**241**	**247**	**248**	**249**	**250**
Kichevo urban	233	256	262	267	267	267	267
Kichevo rural	189	207	212	216	216	216	216
Makedonski Brod	**271**	**298**	**306**	**314**	**315**	**317**	**318**
Makedonski Brod urban	298	327	335	342	342	342	342
Makedonski Brod rural	241	264	271	276	276	276	276
Ohrid	**361**	**397**	**407**	**416**	**418**	**419**	**420**
Ohrid urban	377	414	424	432	432	432	432
Ohrid rural	305	334	343	349	349	349	349
Plasnica	**309**	**339**	**348**	**354**	**354**	**354**	**354**
Plasnica urban	0	0	0	0	0	0	0
Plasnica rural	309	339	348	354	354	354	354
Struga	**247**	**272**	**281**	**290**	**294**	**297**	**301**
Struga urban	309	339	348	354	354	354	354
Struga rural	152	167	171	175	175	175	175
Centar Zhupa	**125**	**136**	**138**	**141**	**141**	**140**	**140**
Centar Zhupa urban	0	0	0	0	0	0	0
Centar Zhupa rural	125	137	140	143	143	143	143
Weighted Average WGR for Permanent Population (kg/ca/year) for Southwest Region	**268**	**295**	**304**	**313**	**315**	**318**	**320**

Figure 3-38: Waste Generation Rate projection for permanent population for Scenario 3, per Municipality

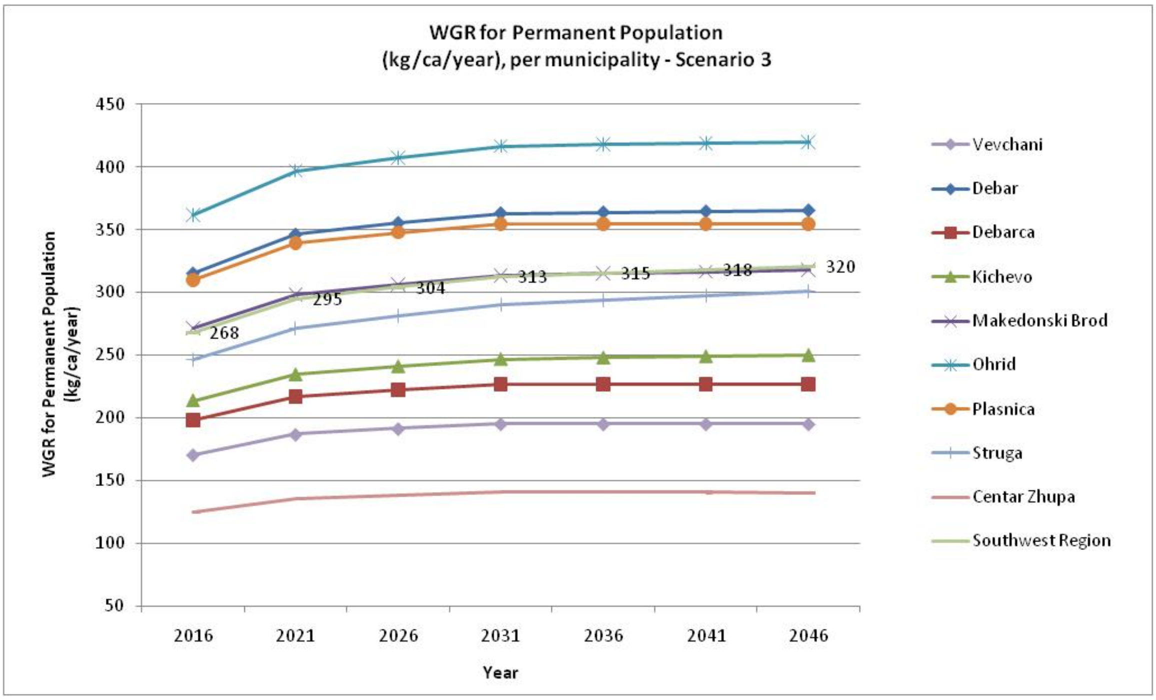
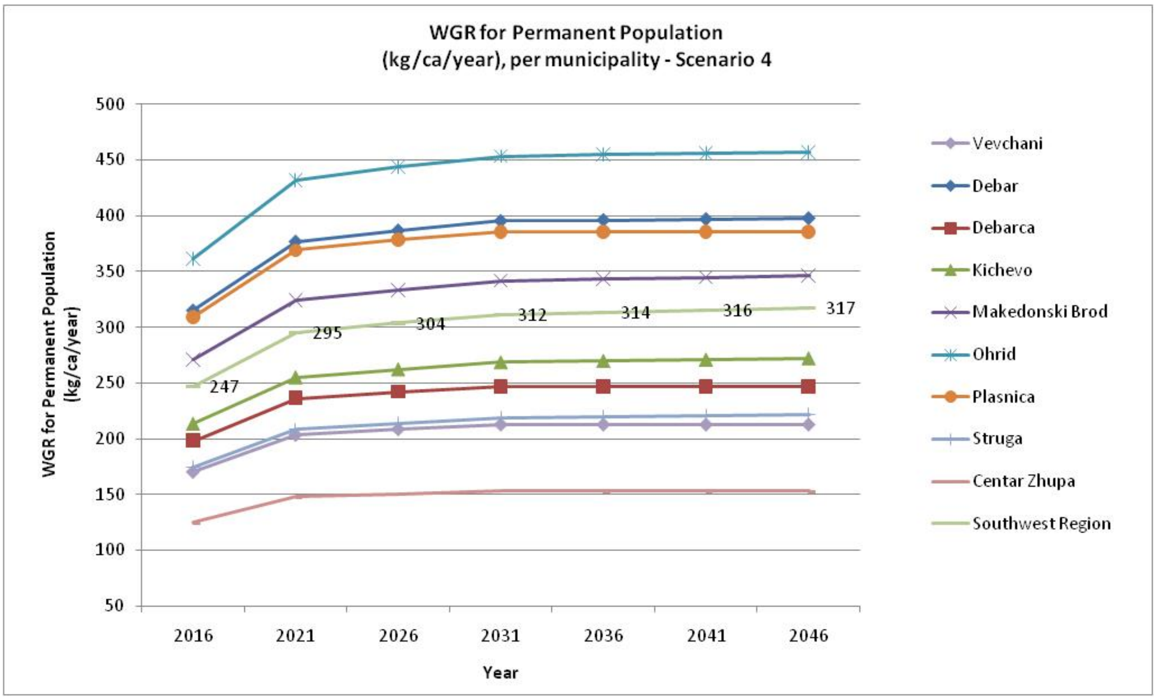


Table 3-66: Waste Generation rate for permanent population, Scenario 4

	WGR for Permanent Population (kg/ca/year)						
Municipality	**2016**	**2021**	**2026**	**2031**	**2036**	**2041**	**2046**
Vevchani	**170**	**203**	**208**	**212**	**212**	**212**	**212**
Vevchani urban	0	0	0	0	0	0	0
Vevchani rural	170	203	208	212	212	212	212
Debar	**315**	**377**	**387**	**395**	**396**	**397**	**398**
Debar urban	331	395	405	413	413	413	413
Debar rural	268	320	327	334	334	334	334
Debarca	**198**	**236**	**242**	**247**	**247**	**247**	**247**
Debarca urban	0	0	0	0	0	0	0
Debarca rural	198	236	242	247	247	247	247
Kichevo	**214**	**255**	**263**	**269**	**270**	**271**	**272**
Kichevo urban	233	278	285	291	291	291	291
Kichevo rural	189	225	231	235	235	235	235
Makedonski Brod	**271**	**324**	**333**	**341**	**343**	**345**	**346**
Makedonski Brod urban	298	356	365	372	372	372	372
Makedonski Brod rural	241	288	295	301	301	301	301
Ohrid	**361**	**432**	**443**	**453**	**455**	**456**	**457**

Ohrid urban	377	450	462	471	471	471	471
Ohrid rural	305	364	373	380	380	380	380
Plasnica	**309**	**369**	**378**	**386**	**386**	**386**	**386**
Plasnica urban	0	0	0	0	0	0	0
Plasnica rural	309	369	378	386	386	386	386
Struga	**174**	**208**	**214**	**219**	**220**	**221**	**222**
Struga urban	189	225	231	235	235	235	235
Struga rural	152	182	186	190	190	190	190
Centar Zhupa	**125**	**148**	**151**	**153**	**153**	**153**	**153**
Centar Zhupa urban	0	0	0	0	0	0	0
Centar Zhupa rural	125	149	152	156	156	156	156
Weighted Average WGR for Permanent Population (kg/ca/year) for Southwest Region	**247**	**295**	**304**	**312**	**314**	**316**	**317**

Figure 3-39: Waste Generation Rate projection for permanent population for Scenario 4, per Municipality



Finally, **Scenario 2** was chosen, and the waste production forecast was calculated as presented in paragraph 3.5.3.

3.5.2.2 Waste generation rate growth for seasonal population

The waste which produced from seasonal population have been estimated taking into consideration the assumption that an average tourist in Europe generates approximately 1,2 kg of waste per bed night

(CREM, 2000). Taking into account the overnights' projection in Southwest region, the Waste Generation Rate of the seasonal population was considered stable and equal to 438 kg/ca/year for all years within the examined period of time (2016-2046), and for all municipalities within Southwest region.

3.5.3 Forecast of Waste Production

Based on the previous calculations, a Forecast of Waste production for the years 2016-2046 was made, for each municipality, and accordingly for the whole region. The results are presented in the following table.

Table 3-67: Forecast of Waste Production for the municipalities of Southwest region (t) for Scenario 2

Year	2016	2021	2026	2031	2036	2041	2046
Vevchani	417	445	430	407	377	347	317
Debar	6,749	7,451	7,663	7,851	7,841	7,795	7,718
Debarca	805	860	831	785	727	669	613
Kichevo	12,208	13,335	13,405	13,380	13,173	12,914	12,616
Makedonski Brod	1,717	1,872	1,877	1,868	1,833	1,792	1,745
Ohrid	20,047	22,214	23,048	23,831	23,851	23,759	23,577
Plasnica	1,500	1,602	1,548	1,463	1,355	1,247	1,142
Struga	11,833	13,011	13,298	13,511	13,356	13,148	12,901
Centar Zhupa	948	1,025	1,025	1,007	944	882	820
Total Produced Waste (t) in Southwest Region	56,224	61,815	63,125	64,103	63,457	62,553	61,450

3.6 OBJECTIVES AND TECHNICAL OPTIONS FOR WASTE MANAGEMENT

3.6.1 Introduction

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

The aims and objectives of the RWMP must be framed against the numerous statutory and aspirational targets relating to waste management which have been set out in both the National Strategy and Plan. The aim of the Regional Waste Management Plan is to take the principles and priorities set out in the National Waste Strategy and Plan and develop them into a concise, deliverable framework which ensures that the Region moves to sustainable practices in the future.

The Regional Waste Management Plan (RWMP) is elaborated al the regional level and:

- represents the link between the national targets and the possibilities and options for achieving the targets at the regional and local level;
- allows the utilization of the local advantages from the region in order to achieve the national targets for the entire region;
- represents the waste management strategy synchronized at the level of all municipalities belonging to the region;
- allows the compensation for the differences between municipalities in the Region(i.e. low capacity of recycling in a municipality);
- can lead to a strategy for waste management which cannot be administrated or financed by one single municipality;

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

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

3.6.2 Vision, aims and objectives

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

Vision & Aims of the Regional Waste Management Plan
Vision: To provide a regional planning framework for the sustainable waste management and recovery of resources by developing an integrated waste management system, with the following aims:
Aim A: Minimisation of negative impacts on the environment and human health caused by the generation and management of waste.
Aim B: Minimisation of negative social and economic impacts and maximisation of social and economic opportunities.

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

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

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

Socio-Economic Objectives (Aim B)
Provision of public awareness campaigns, enhancement of public involvement
Optimization of waste collection system and minimization of local transport impacts
Employment opportunities
Waste Management system in balance with economic resources of the society

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

- The waste management hierarchy
- The Best Practical Environmental Option for each waste stream
- The principle of regional self-sufficiency
- The proximity principle

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

The perspectives for regional waste management system are the following:

Environmental

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

Economic

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

Institutional

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

Social

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

3.6.3 Waste Prevention and Minimization

Reducing the amount of waste generated at source and reducing the hazardous content of that waste is regarded as the highest priority according to the Waste Hierarchy established in the revised Waste Framework Directive (Article 4). Waste prevention is closely linked with improving manufacturing methods and influencing consumers to demand greener products and less packaging[28]. The objectives are:

- Breaking the link between economic growth and the environmental impacts associated with the generation of waste.
- Reduction of environmentally harmful impacts
- Reduction and substitution of hazardous substances
- Optimising the quantity of packaging per packaged product
- Promotion of reuse
- Raising awareness, dissemination of best practices. Integration of the principles of sustainable consumption and dematerialization into the daily behaviour of the consumers

Waste prevention is linked to the introduction of economic instruments and raising awareness among the population and waste generators. Relevant economic instruments are usually introduced on a national scale, whereas awareness-raising will be oriented and implemented at the regional and local level.

Any such initiatives at a regional and local level usually require support from a national programme, before an effective and integrated programme of actions can be delivered for the Region.
A Regional Waste Prevention Program may be elaborated separately. Awareness campaigns can start from 2015 onwards and they will be promoted to meet the long-term challenge of waste prevention and minimisation at the household and business level. Waste prevention measures shall be clearly identified

[28] EC. (n.d.). Retrieved February 14, 2014, from http://ec.europa.eu/environment/waste/prevention/

and appropriate qualitative or quantitative targets and indicators must be adopted in order to monitor and assess the progress of the measures.

3.6.4 Collection of municipal waste (services and level of coverage)

Objectives:

- Providing collection and transport services to as many waste generators as possible–setting up systems covering the entire area of waste generators
- Increasing the quantity of packaging waste collected. Implementation of separate collection system for recyclable materials to assure achievement of legal targets regarding packaging waste

Currently, collection coverage in the region is variable and incomplete, especially in the rural areas. Future realization of works will be taken into account when planning collection services and provisions for further expansion of service coverage in the urban and rural areas will be made. The best options available for waste collection and transport will be selected, in order to allow effective recovery through an optimal technical and economical configuration.

According to the NWMP 2009-2015, 90% of mixed waste should be collected by 2014. However, the target was not achieved. In Southwest Region, the percentage of the population that receives a regular service ranges from 35% (Centar Zhupa) to 100% (Ohrid and Vevhani). Most of the population that does not receive any collection service lives in rural areas. Therefore, gradual targets will be adapted.

The collection and coverage targets are set up to ensure that collection capacities are adapted to the number of inhabitants and to the quantity of generated waste. In the long run, full collection coverage must be achieved by the region, as it is a crucial element in overall management.
Furthermore, according to the NWMP 2009-2015, "*the separate collection of recyclables under the given financing patterns within the municipalities is not yet recommended, except some pilot scale recycling for selected material for which a market already exists is proposed. However, on the other hand, separate collection of selected fractions of commercial waste shall be encouraged because relatively big amounts of clean recyclable material may be collected; recovery and partly recycling may be carried out by Macedonian companies or recovered waste fractions may be exported to foreign recycling facilities*."
Green waste and WEEE will be collected separately. The separate collection of recyclables will be examined during option analysis.

Clear contractual relations and split of responsibilities between Public Utility Enterprises, private entities (licensed to collect, transport and treat the waste), collective schemes and recycling companies are required for successful operation of the system.

3.6.5 Recycling and recovery of waste

Objectives:

- Exploiting all the technical and economic possibilities for waste recovery
- Developing materials and energy recovery activities
- Improving the level of packaging reuse and recyclability
- Optimising the quantity of packaging per packaged product
- Optimising the materials recovery schemes
- Setting up and optimising energy recovery schemes for packaging waste (where materials recovery would not be "feasible")
- Promoting waste treatment in order to ensure rational environmental management

Separate laws have been adopted for packaging and packaging waste, WEEE and batteries and accumulators, setting various targets. The proposed timeframe is the same with the timeframe set in the laws. It will be guaranteed that the targets at regional level will be achieved without imposing "*unbearably*" high investment and operation costs for the regional population. The targets can be differentiated, where applicable.

3.6.6 Waste disposal, including minimization of biodegradable waste

Objectives:

- o Reducing the quantity of biodegradable waste to be landfilled
- o Construction of final disposal facilities fully compliant with EU standards.

The WFD also highlights the significance of the bio-waste stream in Article 22, which states:

> *"Member States shall take measures, as appropriate, and in accordance with Articles 4 and 13, to encourage:*
> *a) the separate collection of bio-waste with a view to the composting and digestion of bio-waste;*
> *b) the treatment of bio-waste in a way that fulfils a high level of environmental protection;*
> *c) the use of environmentally safe materials produced from bio-waste.*

In 2009, a set of targets was introduced quantifying the percentages of biodegradable municipal waste (BMW) that should be diverted from landfills. There are three milestones which need to be met by 2017, 2020 and 2027, by achieving a certain percentage reduction of BMW landfilled within a period of time starting from the year 2011. The proposed timeframe is the same with the timeframe set in the Rules[29].

3.6.7 Special waste streams

Objectives:

- o Separate collection and establishment of management infrastructure for special waste streams

According to NWMP 2009-2015, "*activation of the licensed private sector and investments in the collection, storage and process equipment for management of special waste streams and end-of -life products shall be by the setting up of (voluntary) "compliant" schemes and by earmarked taxation of selected products like used tyres, used oils and lubricants, packaging and packaging waste, waste electro-and electronic equipment, etc which assure the payment of services executed through the entire collection/recovery and disposal chain*." "*Projects related to the collection and recovery/recycling system for other special waste streams and end-of-life products shall be initiated by preparation of the necessary preliminary studies, technical, environmental and investment documentation.*"

Although those streams are not part of MSW they are indicative concerning the waste management performance of the region. Separate laws have been adopted for packaging and packaging waste, WEEE and batteries and accumulators, setting various targets. The proposed timeframe is the same with the timeframe set in the timeframe set in the laws.

[29] FYR Macedonia. (2009). *Correction in the Rules on the amount of biodegradable waste allowed to be disposed into landfill (Official Gazette no. 108/2009)*

3.6.8 Closure, remediation and after-care of municipal landfills and unregulated dumpsites

Objective:

- o Closure and remediation of unregulated dumpsites. A timeframe will be developed to address the management or remediation of remaining sites

The closure of non-compliant landfills and dumpsites is essential for minimising the environmental impacts. The risks from the uncontrolled disposal of waste regard:

- air pollution by landfill biogas and odour releases into the air
- contamination of surface water and ground water bodies by landfill leachate
- health and safety risks to humans from pathogen dispersion

According to the EC and national legislation, all non – compliant landfills and dumpsites should be closed and rehabilitated. The selection of the appropriate solution will be site specific, according to the risk assessment of site. The focus will be on addressing those sites that pose the greatest risk to the environment and human health.

3.6.9 Cost recovery

Objective:

- o Enhance cost recovery, promote cost effectiveness and ensure economic sustainability and affordability. "*Assuring revenue flows to cover full cost for executed services provided by the gradually developing waste management system (NWMP 2009-2015)*"

According to the polluter-pays principle, the costs of waste management are borne by the original waste producer or by the current or previous waste holders (Article 14 of WFD)

The NWMP 2009-2015 stipulates that „*it will be necessary in the future to move the payment system progressively towards full cost recovery for the use of public waste management services and facilities so as to ensure their long-term financial viability and sustainability, and to provide an increasing incentive for waste producers to reduce and recover wastes.*
An Economic / Financial Measures policy will be phased in over appropriate transitional periods and takes into account the ability of waste producers to respond to higher costs for managing their wastes. Specific recommendations are made to suggest, with priority, the introduction
of the following instruments:
- improvement of the cost recovery for executed services by reorganisation of the payment and control system;
- establishment of the uniform charging system for the executed MSW services (landfill and collection/transport fees) on the base of the unified methodology for setting fees and tariffs standardisation of the accounting system."

It is essential to achieve cost recovery from the operation of waste management facilities. The application of the polluter pays principle is important so as to link the creation of waste with the environmental costs.

3.6.10 Training and public awareness

Objectives:

- o The objective is education, behavioural change and promotion of best practice. Reducing the amount of waste generated, both by householders or businesses, is the highest priority. This will require that the people change the way they behave in relation to the waste materials that they produce. This will be achieved through the development and delivery of a regional behavioural change plan.

According to the NWMP 2009-2015, „*raising public awareness, awareness of all stakeholders and the establishment of a communication system regarding municipal, other non-hazardous and hazardous waste management in the country shall be one of the unavoidable and important conditions in building up citizens understanding, acceptance and their involvement in a successful waste management system. Implementation of the NWMP needs public relation activities in three main fields:*
- general informative communications to raise general awareness on waste issues
- communication to production sector
- public awareness on importance and consequences of implementation of waste
- management projects to achieve constructive public participation."

The primary function of all such campaigns will be in accordance with the waste management hierarchy.

3.6.11 Overview of Regional Waste Management Objectives and Targets

The regional objectives and targets regarding waste management are the basis for the setting up of a regional integrated waste management system.

When establishing the targets, the following have been taken into consideration:

- each objective may have one or more targets;
- the targets at regional level must be at least equal to the targets set at national level;
- the National Waste Management Plan (2009-2015) and the National Waste Management Strategy (2008-2020) in force have been approved in 2009 and 2008 respectively.

Table 3-68: Proposed timeline for regional waste sector objectives and targets

Objectives and targets	Source	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Improvement of collection and source separation efficiency											
- Mixed municipal waste - Collection efficiency: 90%	Modif/tion from NWMP										
- Segregation of hazardous and non-hazardous waste fraction (manufacturing/ service sector) Segregation efficiency: 100%	Modif/tion from NWMP										
Landfill of waste/diversion											
- landfill of MSW on temporary facilities (after conditioning) - 100% of the collected MSW	NWMP	N/A									
- landfill of MSW on facility compliant with EU standards - 50% of the collected MSW 100% of residual waste to be landfilled											
- reduction of the greenhouse gas emissions (landfills only) - Reduction for approximately 25% of CO_2 equivalent	Modif/tion from NWMP										

Objectives and targets	Source	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
- diversion of industrial hazardous waste streams from non-hazardous landfills – 100% effect	Modif/tion from NWMP										
- reduction of biodegradable waste disposed on landfills expressed as a percentage reduction of the BMW generated in 1995	Rules (OG No.108/2009										
2011-2021: 53%											
2011-2027: 65%											
Closing, remediation and after-care of existing municipal landfills and unregulated dumpsites											
Remediation of high risk unregulated dumpsites.	N/A										
Packaging and packaging waste											
Treatment / Recovery: 60% b.w.	LoPPW										
Recycling: (minimum 55% - maximum 80%)	LoPPW										
-22.5% plastic	LoPPW										
- 60% glass, 60% paper and cardboard, 50% metals and 15% wood	LoPPW										
Batteries/accumulators											
Collection of at least 45 % b.w.	LoBAWBA										
Waste electrical and electronic equipment											
Collection: >4kg/capita/year	LoEEEWEEE										
Cat. 1 and 10: recovery 80% and prep. for reuse/recycling 75%	LoEEEWEEE										
Cat. 3 and 4: recovery 75% and prep. for reuse/recycling 65%	LoEEEWEEE										
Cat. 2,5,6,7,9: recovery 70% and prep. for reuse/recycling 50%	LoEEEWEEE										
Gas discharge lamps - at least 80% reuse and recycling	LoEEEWEEE										
Construction and demolition waste											
Collected: 30% Recovered/ recycled: 10% Disposal: 90%	NWMP										
Used tyres											
Collection efficiency: 90%	NWMP										

Objectives and targets	Source	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Energy recovery: 100%											
PCB/ PCT waste											
Inventory complete (2009) Destruction	NWMP										
End of life vehicles											
Collection: 90%	Modif/tion from NWMP										
Recovery or reuse: 70%	NWMP										
Stakeholders and public awareness and participation											
Carrying out public awareness campaigns	N/A										
Elaboration of communication programs to individual waste generators	N/A										

3.7 TECHNICAL OPTIONS FOR INTEGRATED WASTE MANAGEMENT

3.7.1 Introduction in Option Analysis

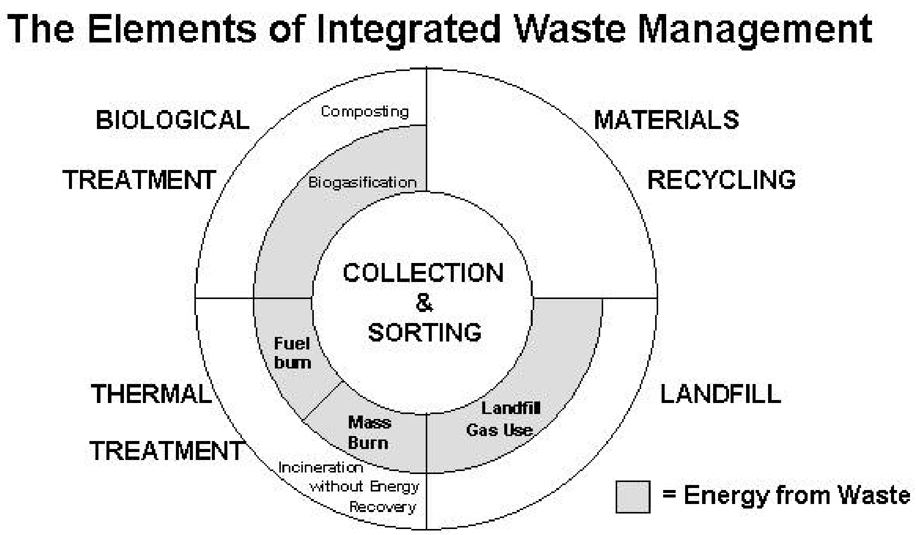
An integrated waste management system needs to be a sustainable system which is economically affordable, socially acceptable and environmentally effective.

- Economic affordability requires that the costs of waste management systems are acceptable to all sectors of the community served, including householders, commerce, industry, institutions, and government.
- Social acceptability requires that the waste management system meets the needs of the local community, and reflects the values and priorities of that society.
- Environmental effectiveness requires that the overall environmental burdens of managing waste are reduced, both in terms of consumption of resources (including energy) and the production of emissions to air, water and land.

Integrated Waste Management (IWM) takes an overall approach to this, involves the use of a range of different treatment options, and deals with the entire solid waste stream.

The following figure represents the concept of Integrated Waste Management (IWM). The IWM "doughnut" demonstrates that collection and sorting are at the centre of any successful waste management system. The four main waste management technologies surrounding the collection and sorting system are shown as equal sized quadrants to illustrate that they must be considered equally when developing a waste management strategy for any location. Flexibility in technology application for a specific location is also an essential component of the IWM concept. Data based decision support using Life Cycle Assessment tools facilitates the selection of the most appropriate waste management technologies (not necessarily all four) needed to deliver an environmentally optimized IWM system for a specific location. In combination with economic and social considerations, this approach helps for the design of a more sustainable solid waste management system.

Figure 3-40: The Elements of Integrated Waste Management



Along with the overall need for sustainable waste management, it is clear that no one single treatment method can manage all materials in Municipal Solid Waste (MSW) in an environmentally effective way. Following a suitable collection system, a range of treatment options will be required. These include materials recovery, biological treatment (composting/biogasification), thermal treatment (mass-burn incineration with energy recovery and/or burning of Refuse Derived Fuel - RDF) and land filling. Together these form an Integrated Waste Management (IWM) system.

Effective management schemes need the flexibility to design, adapt, and operate systems in ways which best meet current social, economic, and environmental conditions. These are likely to change over time and vary by location. The need for consistency in quality and quantity of recycled materials, compost or energy, the need to support a range of disposal options, and the benefit of economies of scale, all suggest that IWM systems should be organized on a large-scale, regional basis. Any scheme incorporating recycling, composting or energy from waste technologies must be market-orientated.

Whilst it uses a combination of options, the defining feature of an IWM system is that it takes an overall approach to manage all materials in the waste stream in an environmentally effective, economically affordable, and socially acceptable way.

An integrated waste management system consists of the following stages, which are deeper analyzed in the following chapters:

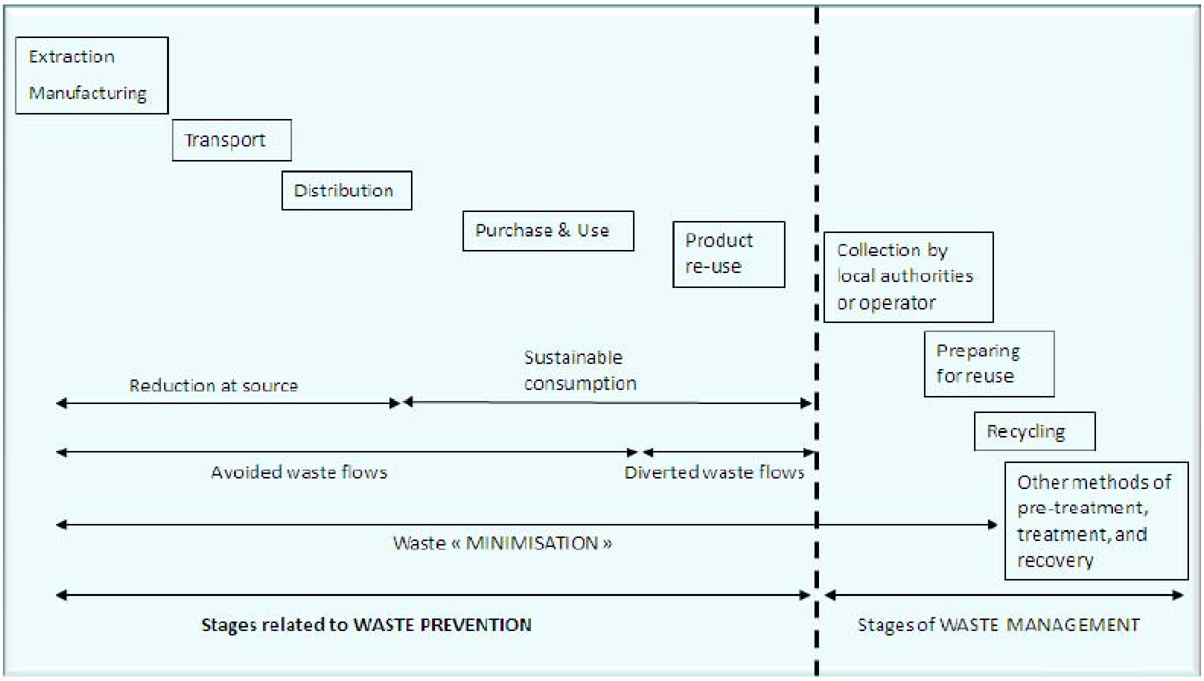
- Waste Prevention and Reuse
- Waste collection (mixed, source separated)
- Waste transportation and transfer (to transfer station, recovery and recycling facility, treatment plant or landfill)
- Waste mechanical separation (material recovery and recycling facility)
- Waste treatment (thermal, physical, chemical or biological treatment)
- Waste disposal to landfill

3.7.2 Waste prevention

Waste prevention and minimization lies at the top of the hierarchy as it preserves energy and natural resources and it is the key to sustainable development. Other than where life-cycle thinking suggests otherwise, prevention and preparing for re-use should be considered priority areas for waste management policy in future. This suggests that it is no longer sufficient for Member States to simply 'encourage' through voluntaristic measures and aspirations, pursuit of the hierarchy. Rather, the hierarchy needs to be given some force through policy and law. Indeed, the WFD sets out a requirement for Member States to develop Waste Prevention Programmes under Articles 29 to 31.

The hierarchy makes a clear distinction between 'preparation for re-use' and 're-use' (see Art. 2 (4)). One of the previous debates within the context of waste prevention related to how one should consider measures which reduce the hazardousness of waste through increasing the quantity of waste (for example, using vitrification, or stabilisation in cement). The Commission's definition appears to address this by including the clause 'measures taken before a substance, material or product has become waste' In other words, measures which reduce hazardousness after a waste has been generated would not be considered 'waste prevention'. The definition of waste prevention is illustrated in the following Figure:

Figure 3-41: Definition of waste prevention



The revised Waste Framework Directive requires the Member States to create national waste prevention programmes by 12 December 2013. The objective of these programmes is to present a coordinated national approach to waste prevention, delineating targets and policies, and aiming to decouple economic growth from the environmental impacts of waste generation. National waste prevention programmes should support Member States in decoupling economic growth from the environmental impacts of waste generation. The guidance document "Preparing a Waste Prevention Programme" - October 2012, has been published by EU, designed to support EU Member States and other interested parties to take advantage of the many opportunities in waste prevention and resource efficiency.

The waste prevention measures shall be clearly identified and appropriate qualitative or quantitative targets and indicators must be adopted in order to monitor and assess the progress of the measures. This task is by no means easy, as practical difficulties occur in how to measure 'something which is no longer there'.

Specific measures can be implemented on a national/ regional level. The measures can target different group of stakeholders or specific waste streams, as outlined in the next paragraphs:

Responsible consumer behaviour and informational programs

Waste production is typically associated to everyday consumption patterns and it is difficult to be regulated. In the past, efforts have been made by EC to stabilise waste generation per capita which were afterwards abandoned. In a flourishing consuming society, people tend to replace regularly electrical equipment long before they are out of use (cellular phones, TVs, video machines, etc) as the technology changes quickly, or simply because there is so great availability and older electrical items have no more place and become naturally "waste". A considerable amount of food waste is rejected from households. On average, preventing 1 t of food waste avoids over 4 t CO_2 equivalent[30]. Potential for waste minimisation in mass terms is probably low, however savings in terms of material/energy/fuel in the overall cycle of a product are significant; for example electrical goods contain rare constituents and multiple amounts of mining waste are "hidden" during their production.

[30] http://www.defra.gov.uk/publications/2011/06/15/pb13529-waste-hierarchy-summary/

Excessive waste generation is a symptom of inefficient production processes, low durability of goods and unsustainable consumption patterns. Authorities can motivate public to change the consumption pattern of citizens, prolong the life of goods (keep products for longer) and encourage reuse of products. People should be made aware of the measures they can take in their daily lives to reduce, reuse and recycle. Environmental advantages (better use of materials and reduction of the need for landfills) of reused products and products containing reused components and recycled material need to be emphasized so that a cleaner environment can be left for future generations.

A novel campaign was launched in UK by the WRAP (Waste and Resources Action Programme) organisation with title "Love food hate waste"[31]. A unique study into waste composition preceded, providing evidence that around one third of all food bought is thrown away, while most of this could have been eaten. It regards astonishing quantities of spoiled food and most consumers are unaware of it. The objective was to provide tips, advice and recipes for leftover food to help everyone waste less. Necessity for food waste reduction was not just attributed to the environmental implications; focus was put to the "ethic" side of good food going to waste, as well as cost for the average family as high as £420 a year. The embedded energy used to produce, package, transport and deliver the food to our homes produces the equivalent of 15 million tons of carbon dioxide every year. The campaign resulted in a fall of more than one million t of food waste in 2011 and has gathered attraction outside UK as well.
Increased awareness for sustainable living resulted in a slow uprise in interest in second-hand items. Potential exists especially for textiles and clothes, WEEE and furniture. Re-use is mostly promoted by charities or NGO organisations, such as Freecycle32 or ReuseIt Network 33. People can pass their unwanted goods, free, to others who can make use of them. What started as a fundamental idea to keep items away from landfills, has become an increasing popular environmental web community, with members in 85 countries. All kind of items change hands through the network, most of these being furniture, books, garden equipment, white goods, toys and TVs.

Relative actions are promoted by RReuse34 that regards a European umbrella for social enterprises with activities in reuse, repair and recycling. RREUSE's members are national and regional social economy networks that combine both social and environmental objectives and give them equal emphasis.

Responsible business behaviour

In the business sector, product design and manufacture should be promoted that enables easier upgrades, repair and recycling at end of life. This will prevent waste and improve sustainability by reducing the need for primary production of resources. These efforts will be targeted at products with high carbon and environmental impacts, such as food, metals, plastics, textiles and wood.

Companies that are committed to their environmental profile strive to make packaging lighter, remove unnecessary packaging and making recycling easier for consumers. Large but also smaller retailers promote multi-use bags and non packaged loose vegetables and other goods. Savings from the Super market sector are appreciable.

One key tool to encourage waste prevention is eco-design, focusing on the conception and design phase of a product. Eco-friendly products are manufactured in a resource-efficient process, made using recycled raw materials and avoid the use of hazardous substances. They are designed to consume less energy during the usage phase and should be able to be recycled once they have been discarded. Waste prevention is closely linked to improving manufacturing methods and influencing consumers so that they demand greener

[31] http://www.lovefoodhatewaste.com
[32] www.freecycle.org
[33] www.reuseitnetwork.org
[34] http://www.rreuse.org/

goods. Eco-design has especially attracted interest in the automotive and EEE sector aiming to enhanced recyclability of the whole product or particular parts of it, as well as incorporating recycled material into new cars/appliances.

Additionally, innovation techniques are developed by both producers and the recycling sector to improve the separation process and yield secondary materials with greater efficiency, per polymer type for example.

Second-hand centres

As mentioned, a potential exists for re-use or exchange especially for materials such as textiles and clothes, WEEE and furniture. These activities take place in second-hand centres, either private or owned by charities. In local communities with low incomes, very little is wasted and a number of shops function that sell or give for free second hand items including old books and CDs. Such shops also serve as places that "exchange concerns and ideas" and may help to battle poverty and long term exclusion from work.

Larger charity shops redirect materials from landfills working with a network of channels worldwide. Collected textiles are hand sorted and graded by skilled workers who are able to recognise the variety of fibre types. Once graded the clothes are weighed and press packed into bales. Bales are then sent to various destinations including developing countries where it is reused as second hand clothing and wearable shoes. Only a part of it is recycled or rejected as waste[35].

Home Composting

Home composting is considered as a waste prevention action since it is applicable on a home basis, prior to waste collection. Home composting can be practiced in most backyards in a variety of manufactured composting bins, which differ in complexity and price. The user gradually adds organic matter to the vessel and over a period of time this naturally decomposes to form compost. The high temperature will kill most weed seeds and speed up the decomposition process so that the compost may be ready in about 3 months.

Shopping centres, schools, restaurants and other institutions can also easily compost in pilot size, more engineered units. Some preparation of material such as cutting and mixing is desirable; the end product normally satisfies the Animal By-products regulations.

Figure 3-42: Example of i) home composting bin and ii) pilot composting plant

Source: www. http://massenv.com)

Bins are commercially available from a number of manufacturers in a variety of sizes from 75 to 400 lt, whereas residence time amounts to 12 weeks. Home composting requires households to separate and

[35] E. Salamone, Material Gains, CIWM Journal, July 2012

compost their own kitchen and green waste and handle compost produced in their own garden. As a strategic tool, home composting is addressed to people living in rural areas; it is not particularly feasible for those living in flats. Individuals participating are mostly "keen recyclers" as effort and commitment is required, and on a second level gardeners.

3.7.3 Options for Waste Collection

Options for mixed waste collection

Waste collection is an integral part of waste management and precondition for environmental sound management of waste. If waste is not collected properly, and no 100% collection coverage is reached, such waste will most likely be disposed of without environmental controls, illegally buried, dumped, burned or stored. Deficits in collection of waste would result in uncontrolled abandoning of waste, unused resources and severe impacts on the environment.

Waste collection in Southwest Region is currently less than 100%, as indicated in the previous chapter. The present and following chapters provide guidelines towards the future system for collection of municipal waste streams such as residual, recyclable and biodegradable waste.

The waste collection and transportation system generally consists of the following elements, which are closely interlinked and a final recommendation can be made only for complete collection and transportation systems:

- The pre-collection system, the container placement and the provided container volume; most important, the type of collection system, kerbside (door-to-door) and bring system
- The collection frequency
- The types of trucks used for the collection and transportation
- Collection shifts.

The above elements are analysed and discussed in the following sections. In regard to the types of pre-collection systems, there exist:

1) Door to door collection of
    i) plastic bags, or
    ii) individual bins (120l or 240l)
2) Bring system (street collection point system) with
    a. wheeled standard Euro-containers 0,66 or 1.1 m³ containers or
    b. fixed containers of sizes 1,8, 2,4 m³ and 3,6 m³ (Italian-Spanish system),
    c. Large collection points equipped with skips
    d. Underground container system

Systems c and are d relatively expensive and are not considered further for the region.

In bring systems, local authorities or third parties provide containers ("banks") on certain street points and residents deposit household waste. The bring system is simple to use, faster and less expensive. The same trucks can be used to collect different waste streams on different days. This system would be more suitable in urban areas (blocks of flats) where space is scarce. In high density population areas the distance to the nearest container is 50-100 m.

Kerbside collection is common method for collection of waste from single houses in rural and semi-urban areas. Residents are provided with a bin, where waste is placed for subsequent collection on particular day(s). The kerbside system may be inappropriate in narrow streets and areas with traffic congestion problems. For this reason, this system may not be suitable for urban areas. The collection in kerbside systems is labour intensive and may require more collection time. Finally, kerbside collection is related with higher investment and operational cost (more bins per household). On the other hand, it leads to greater satisfaction and greater capture rate for recyclables.

Regarding the collection frequency, there are several parameters to consider:

- In Southern European countries, the warmer climate and collection frequencies of more than once a week would cause big odour and hygienic problems. Thus usually in urban areas the collection frequency is more often than once per week. The collection frequency shall not be less than twice per month as a general rule.
- Furthermore the optimal collection frequency is also dependent on the population density. The more MW is produced in a certain area per person and day, the more economic it is to maintain high collection frequencies.
- Another possibility to obtain high MW quantities in a small area is to let the MW accumulate several days and only then to collect. However, if a container system is applied, this requires that more containers have to be placed in the area to receive the accumulated waste quantity. In this sense the frequency also becomes a cost optimisation and area requirement issue.
- No collection during Sunday or during weekend takes place. This means, that the placed container capacities are designed to cater for more than two or three days.
- For the purpose of the needs assessment, a frequency of collection of twice per week on average can be assumed. In any case the logistics and the collection frequency have to be optimized by a subsequent feasibility study or by the operator as soon as the system begins to operate.

Regarding compaction trucks, there has been a trend throughout Europe over the last 30 years that waste collection vehicles to become larger in size. That trend has been coupled with an increase in complexity and higher compaction ratios. However that increase in size has raised issues of manoeuvrability in congested streets, road safety issues, noise, and environment impact of such large trucks.

Over the last years collection trucks with greater compaction technologies, better chassis and with 6x2 or 6x4 wheelbase become largely used. Wherever the conditions allow, there is a general trend for implementing large capacity vehicles, being able to collect a payload of 8 - 10 t/trip. In the rural areas due to the longer distance between collection points it is not quite appropriate using bigger trucks as the time for collection and transportation to the new landfill is limited to 8 hours/shift.

Figure 3-43: Example of a collection truck with compaction

Given the higher payload of trucks, more time can be spent for collection and less time lost for travelling to the disposal site. This increases collection economy but only for bigger settlements where collection points are near to each other and a truck could be relatively quickly loaded. It is therefore expected, smaller trucks to operate in areas, where the large trucks cannot enter, or in family housing areas, where the pay-load capacity of the small truck is even difficult to be filled within a working shift.

The RCVs normally operate with a driver and one or two loaders. One-shift operation is proposed, whereas the implementation of two shifts can be implemented only when the existing trucks are not sufficient.

Options for dry recyclables collection

Source separation is a critical precondition for generating high-quality secondary raw material from waste and to facilitate re-use of material. The separation of specific fractions of municipal waste at the source provides for best results in recycling certain materials.

The Waste Framework Directive sets out the obligation to provide for separate collection at least of paper, glass, metal and plastic. The Packaging Directive requires specific provisions for the separate collection of packaging waste. There are different systems for separate collection applied throughout the EU. Same as in previous chapter, source separation can be done in various places at households via provision of special bags, containers etc. or at local collection points. The main infrastructural systems include kerbside collection (door-to-door) and bring systems (containers, recycling centres etc.).

Capture rates for the different materials depend on whether the systems provided are door to door services (high captures) or bring site (lower). The capture rate values shown in the following Table are typical for the two systems, but they may still be contingent on factors such as service quality, collection frequencies, residual waste charging policies etc.

Table 3-69: Dry Recycling Capture Rates for various materials

	Bring Collection	Door-to-Door
Paper & Cardboard	50%	85%
Glass	60%	85%
Metal	40%	65%
Plastic	25%	55%
Wood	15%	30%

Also, the reject rates in the MRFs are lower in door to door collection.

Figure 3-44: Examples of a) door to door collection, where car parking may cause obstruction to the vehicle route, b) collection point for multiple materials and c) multiple bin system

a) 

b) 

c) 

For both systems, a further decision on the number of individual streams for collection must be taken and several approaches have been applied:

- Collection of paper, glass, plastic and metal fractions in separate bins or bags
- Commingled collection of recyclables in the same bin
- Commingled collection of recyclables in the same bin with separate collection of glass
- Commingled collection of recyclables in the same bin with separate collection of paper

Separate collection of paper has been justified by the need to reduce the potential to bind together with other materials, satisfy the high fibre quality requested by industry standards and finally to maximise profits. Glass has been also collected on itself, in order to avoid breaking and making reprocessing less complicated. A recent UK study (WYG Environment, Review of Kerbside Recycling Collection Schemes in the UK in 2010/11) indicated that collection of recyclables in a commingled fashion yielded the highest rates in kg/household/y compared with other multiple stream collection types in 30 municipalities. This result was justified by the greater simplicity and convenience offered to the citizens.

The key issue for the successful implementation of a separate collection scheme is double-fold: one, is the highest possible participation of citizens to increase the recycling quotas; two, it regards avoiding contamination by non-recyclable materials that reduce the output quality, lower its value and damage sorting machinery at MRF. Industrial reprocessors may even reject lower quality material altogether. Decision about the collected fractions depends also greatly on the MRF. For example, certain MRFs may not accept all kind of plastic waste but HDPE bottles only.

In regard to the transportation option, double compartment vehicles (at a ratio for example of 30:70) have been developed in the last years. The merit of these vehicles lies in the ability to collect both mixed and recyclable waste in different chambers and within the same route, thus allowing for greater flexibility. The lifting mechanism is capable to lift both 120 l as well as 1,1 m^3 bins. In order to optimize transport routes, MRF and landfill must be situated in the same area. One of the problems is that one of the compartments on the vehicle may fill before the other and the vehicle would have to return to be emptied before the end of its normal round; as a result collection efficiencies may be reduced.

The suitable collection system with the associated elements must be selected depending on the local conditions, preferences, municipality needs and cost affordability.

In regard to organisation of packaging waste collection and recycling, a number of competitive Recovery Organisations have been formed in EU countries that undertake the responsibility to achieve the targets on behalf of the producers. In certain cases, one single RO is formed as opposed to multiple, with the aim to avoid inefficiency and increase traceability and transparency. Separate collection may or may not be organised by the packaging recovery organisation(s). In the former case, ROs have formal approval to organise and operate a separate collection system in the specified districts, whereas municipalities are not involved in operational issues. In the latter case, separate collection is organised by the municipality. The financing of separate collection and sorting activities is guaranteed through contracts with Recovery Organisations.

Options for biowaste collection

The main fractions of BMW which can be separately collected are paper, food waste, garden waste, textiles and wood. All aforementioned systems can be used to separately collect biodegradable municipal waste, as well as the delivery directly to civic amenity sites. There have been reports of increased public cooperation, successful diversion of organics and cost- effectiveness in the long run. There is also evidence that citizens gain a visible insight of how much food they are producing and discarding and as a result they take measures to reduce it.

Home Composting Bins

Composting is the most practical and convenient way to handle organic wastes in rural areas. Composting, nature's own way of recycling, is the controlled decomposition of organic material such as leaves, twigs, grass clippings, and vegetable food waste. Compost is the soil amendment product that results from proper composting. It can be easier and cheaper than bagging these wastes or taking them to a transfer station or to the bins of centralized waste collection system. Compost also improves the soil and the plants growing in it. In rural areas usually there are gardens, lawns, trees, shrubs, or even planter boxes and the home made compost is very useful. Anything organic can be composted. All Green wastes – yard wastes, such as fallen leaves, grass clippings, weeds and the remains of garden plants, also food waste, make excellent compost. Woody yard wastes can be clipped and sawed down to a size useful for the wood stove or fireplace or they can be run through a shredder for mulching and path-making. Used as mulch or for paths, they will eventually decompose and become compost.

Whether the composting is done on site, at the point of waste generation or in a large-scale, centralized facility, it helps to keep the high volume of organic material out of landfills and turns it into a useful product. On-site or home composting reduces the cost of hauling materials and is generally exempted from solid waste regulations.

Composting can be practiced in most backyards in a homemade or manufactured composting bin or simply an open pile (some cities do require enclosed bins). Businesses, schools, and other facilities can also easily compost. Homemade bins can be constructed out of scrap wood, chicken wire, snow fencing or even old garbage cans (with holes punched in the sides and bottom). Manufactured bins include turning units, hoops, cones, and stacking bins. There are several types of composting bins, which differ in complexity and price.

- Portable Wood and Wire Composting Bin
- Single Compartment Wood Bin
- Urban All-Wood Bin
- Wire Mesh Composting Bin
- Lath Snow Fence Composting Bin
- Wood and Wire Three Compartment Bin
- Rotating Barrel Composting Bin
- Compost Screen
- Homemade Food Waste Composting Bin
- Worm Bins
- Worm Composting Bin
- Pallet Worm Bin

Composting can be done in a style requiring more effort, with quick results – or can be done more casually. Both ways will have a positive effect on the environment and produce usable compost. It just depends on how the time needed to be spent for compost production.

Figure 3-45: Simple Compost Bin

Figure 3-46: Rotating Composting Bin

Figure 3-47: Mega Composter Home Composting Bin

Figure 3-48: Kitchen Compost Bin with Filter Lid

Figure 3-49: Urban Compost Tumbler

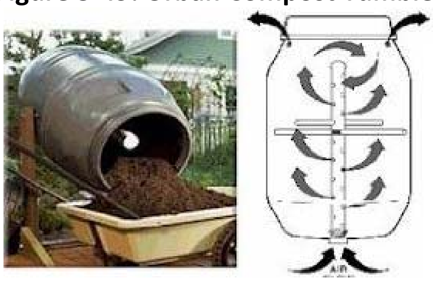


Figure 3-50: Pyramid Composting Bin

The complicated compost piles that have the right blend of nitrogen (greens) and carbon (browns) and are kept moist and fluffed regularly, will heat up to temperatures of 48o C to 60 o C . The high temperature will kill most weed seeds and speed up the decomposition process so that the compost may be ready in 2 to 3 months or less.

"Casual" compost piles are also quite workable since compost will "happen" even if you just pile on yard and food waste, water sporadically, and wait. The pile won't get as hot, so it won't decompose as quickly and may not kill weed seeds. Casual composting can take several months.

An open pile is not preferred, because of the odours and development of microorganisms, so the best way doing home composting is using any kind of composting bin.

Separate Collection of Bio Waste at the Source

Three different collection receptacles are used for the collection of the biodegradable fraction of municipal waste from households; bio bins, paper bags and to a limited extent biodegradable bags. Bio bins are generally made from plastic and are usually stored along with the collection receptacle used for storing the mixed waste fraction. The size of these bins range in general from 40 to 120 litres. Paper bags are often used for the storage of biodegradable municipal waste because the paper bag does not have to be removed prior to composting, as it will degrade during the composting process. This is usually facilitated by passing the bags through a shredder prior to the composting process. The use of biodegradable bags for the collection of BMW is gaining popularity as, like with paper bags, they can be placed directly into the composting process. An additional advantage is that they are more durable than paper bags, which tend to disintegrate when they get wet. However, biodegradable bags tend to be more expensive than plastic or paper bags.

The frequency of collection varies between municipalities but is generally weekly or alternative weeks. During the summer, the food and garden waste fraction may need to be collected at greater frequencies in order to prevent nuisances and odours. A key advantage of collection direct from households is that high participation rates are generally achieved.

Separate Collection of Bio Waste in Organic Bin

This consists of large containers which are located in close proximity to households in strategically located positions such as beside supermarkets, where householders can bring their separated waste fractions for collection. There is usually a colour-coded container designated to each waste fraction. Food waste, garden waste and textiles can all be collected in this way. In relation to food waste, householders are usually provided with bags in which they place their food waste, which they then deliver to these collection points. The frequency at which these containers are emptied varies between municipalities and depends upon the fraction of waste that they contain, for example, greater frequencies for food waste. In some countries and regions, e.g. Catalonia, the food waste containers are emptied either on a daily basis or every second day. This frequency may be increased during the summer months to minimise potential nuisances. The receptacles are cleaned at least once in every two week period. This type of collection method is particularly suitable for areas with high residential densities with limited space available for larger containers.

Collection of Bio Waste at specific points

Some guidelines are further provided in the National Strategy for reducing biodegradable waste, such as positioning the organic-bin in the last, most distanced position, providing information for the inhabitants on the acceptable material and exercising a basic control system to identify impurities.

Separate collection of bio-waste should be encouraged by the Member States (Article 22 of Waste Directive). There have been initiatives by EC on a Directive regarding the management of biowaste, however these were abandoned later (to dissatisfaction of some MS) and officially it is unknown when they will be repeated. In the mean time, requirements for separate collection were proposed in the Second Draft of the Biowaste Directive (DG ENV, 2001), for:

- food waste from households
- food waste from restaurants, canteens, schools and public buildings
- biowaste from markets, commercial, industrial and institutional sources
- Green waste from private/public parks, gardens and cemeteries.

Separate collection schemes must at least cover urban agglomerations of:
- > 100,000 inhabitants within 3 years;
- > 2,000 inhabitants within 5 years.

The separate collection of biowaste can be waived in inner cities where low level contamination of biowaste is difficult to ensure and in rural areas with a population density of <10 inhabitants/km^2. No specific date for mandatory separate collection was set in the Second Draft.

In a number of EU reports (for example "Preliminary Impact Assessment for an Initiative on the Biological Treatment of Biodegradable Waste, COWI A/S, 2004), a realistic target of 55% food and green waste separate collection is proposed. This 55% collection rate target was justified as a reasonable balance between the need to ensure a significant level of biological treatment while at the same time respecting the benefits of maintaining a certain level of flexibility for the countries in defining their unique path towards compliance with the landfill directive.

Civic amenity centers or Green Points

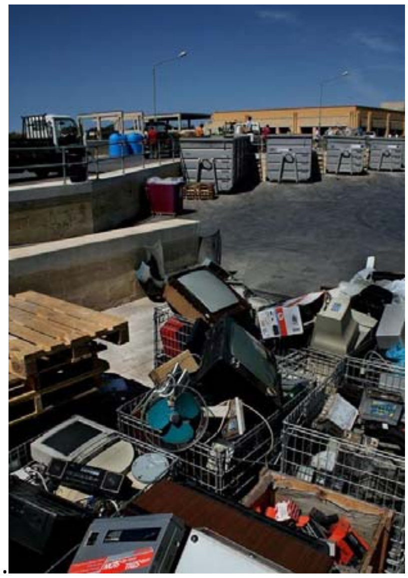
In order to achieve mandatory recycling targets and a raft of European Directives civic amenity centres up to community sector involvement are developed and implanted. Faced with mandatory recycling targets it has been recognized that the cheapest and easiest way to increase recycling is to improve facilities like Household Waste Recycling Centres, e.g. Civic Amenity Centres, which are also called "bring centres", "drop-off centres" or even "Green Points" Growing legal requirements to separate and treat biodegradables, recyclables and all specific types of hazardous and difficult wastes such as fridges, oil, tyres, batteries and waste electrical equipment present a great opportunity for local re-use schemes. The Civic Amenity Centres offer quality low-cost service for waste collection, while reducing final landfill disposal. CAC provide householders with an outlet for the disposal of a wide range of materials and in this way maximizing the recyclable rates.

The civic amenity centres (also recycling yards or green points) are designed to work as complementary facilities of other measures for collection and recycling. These centres will receive separated waste streams, which are suitable for recycling or for further suitable management. Apart from recyclables, a range of waste can be delivered such as batteries, electrical goods, bulky waste, C&D waste and biodegradable waste.

The main benefits from recycling yards is the diversion and recovery of special waste streams such as household hazardous waste, batteries, bulky items, etc., which otherwise would be disposed in ordinary landfill sites. At the same time, the recycling yards can contribute to the education of the citizens for managing the aforementioned streams.

The following pictures are indicative and present facilities within the European Union.

Figure 3-51: Civic amenity centres offering an extended number of containers

In civic amenity sites, reuse canters can also be established. Citizens may bring items, especially WEEE but also furniture and textiles, normally because they are not functioning or torn, but also because they do not want it anymore or they have replaced it with a newer one. The condition of these items is afterwards checked, being fully reusable, needing slight or significant repair, or needing disposal. In the latter case, some spare parts may be in working condition. The citizens may collect the electrical appliance after repair. If it is unwanted or for furniture/ textiles, the reuse canters function as second-hand shops.

For the region, it is interesting to note that schemes which involve preparation for re-use can be sources of employment and can provide re-training opportunities for those who have been out of work for some time. It can also target youth unemployment that can give young people practical skills and hands on experience, to be utilised at a later stage.

3.7.4 Technical Options for Transportation and Transfer

Collection Vehicles

Numerous types of collection vehicles and optional features are available. Manufacturers are continually refining and redesigning collection equipment to meet changing needs and to apply advances in technology. Trends in the collection vehicle industry include increased use of computer-aided equipment and electronic controls. Now, some trucks even have onboard computers for monitoring truck performance and collection operations.

Truck chassis and bodies are usually purchased separately and can be combined in a variety of ways. When selecting truck chassis and bodies, municipalities must consider regulations regarding truck size and weight. An important objective in truck selection is to maximize the amount of wastes that can be collected while remaining within legal weights for the overall vehicle and as distributed over individual axles. Also, because they are familiar with equipment, collection crews and drivers should be consulted when selecting equipment that they will be using.

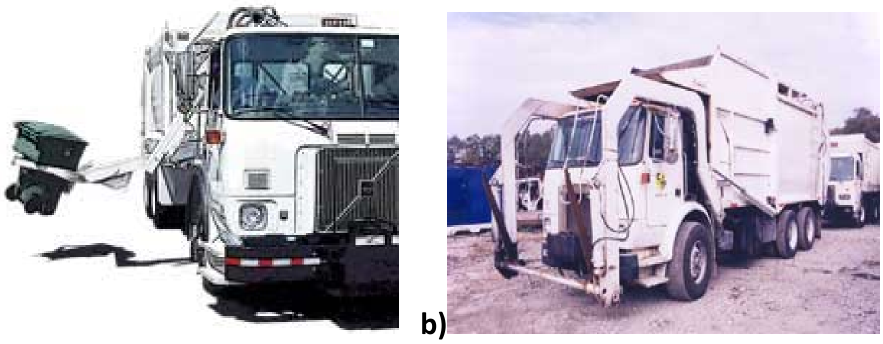
Compactor trucks are by far the most prevalent refuse collection vehicles in use. Widely used for residential collection service, they are equipped with hydraulically powered rams that compact wastes to increase payload and then push the wastes out of the truck at the disposal or transfer facility. These trucks vary in size from 7,5 to 35 cubic meters, depending on the service application.

Depending on where containers are emptied into the truck, compactor trucks are commonly classified as:

- front-loading
- side-loading
- rear-loading

Figure 3-52: Rear-loading truck

Figure 3-53: (a) Side-loading truck and (b) Front-loading truck



a) **b)**

Before compactor trucks were developed, open and closed noncompacting trucks were used to collect solid waste. Although these trucks are relatively inexpensive to purchase and maintain, they are inefficient for most collection application because they carry a relatively small amount of waste, and workers must lift waste containers high to dump the contents into the truck. Noncompacting trucks are still used for collecting bulky items like furniture and appliances or other materials that are collected separately, such as yard trimmings and recyclable materials.

Noncompacting trucks can also be appropriate for small communities or in rural areas. Recently, many new types of noncompacting trucks have been designed specifically for collecting recyclable materials.

Waste set-out requirements, waste quantities, and the physical characteristics of the collection routes are likely to be key considerations in the selection of collection vehicles. For example, suburban areas with wide streets and little on-street parking may be ideally suited to side-loading automatic collection systems. Conversely, urban areas with narrow alleys and tight corners may require rear loaders and shorter wheelbases.

For large apartment buildings and complexes, and for commercial and industrial applications, hauled-container systems are often used. The roll-off containers used with these systems have capacities of up to 40 cubic meters. They are placed on the waste generator's property, and when full, are transported directly to the transfer/disposal site. Special hoisting trucks and a cable winch or hydraulic arm are required to load the containers.

To determine specific equipment design information, hauling companies or departments should contact vendors and review existing equipment records. The following Text Boxes provide criteria that should be used to determine the most appropriate collection equipment.

Municipalities can use these criteria to outline the requirements that equipment must meet and select general equipment types that will be considered. In addition to the technical requirements listed in the above Text Boxes, the following cost data should be compared for each truck being considered:

- Initial capital cost
- annual maintenance and operation costs
- expected service life. .

Life-cycle costs should be computed using this information to compare total ownership costs over the expected life of the required vehicles.

Table 3-70: Factors to consider in selecting/specifying solid waste collection equipment

Loading Location Compactor trucks are loaded in either the side, back, or front. Front-loading compactors are often used with self-loading mechanisms and dumpsters. Rear loaders are often used for both self and manual loading. Side loaders are more likely to be used for manual loading and are often considered more efficient than back-loaders when the driver does some or all of the loading.
Loading Height The lower the loading height, the more easily solid waste can be loaded into the truck. If the truck loading height is too high, the time required for loading and the potential of injuries to crew members will increase because of strain and fatigue. Design Considerations: • *Weight of full solid waste containers.* • *If higher loading height is being considered, consider an automatic loading mechanism.* **Chassis Selection** Chassis are similar for all collection bodies and materials collected. Design Considerations: • *Size of truck body. Important for chassis to be large enough to hold truck body filled with solid waste.* • *Road width and weight limitations (also need to consider waste and truck body weight).* • *Air emissions control regulations.* • *Desired design features to address harsh treatment (e.g. driving slowly, frequent starting and stopping, heavy traffic and heavy loads) include the following: high torque engine, balanced weight distribution, good brakes, good visibility, heavy duty transmission, and power brakes and steering.*
Truck Body or Container Capacity Compactor capacities range from 7,5 to 35 cubic meters. Containers associated with hauled systems generally have a capacity range of 3,5 to 30 cubic meters. To select the optimum capacity for a particular community, the best tradeoff between labour and equipment costs should be determined. Larger capacity bodies may have higher capital, operating, and maintenance costs. Heavier trucks may increase wear and tear, and corresponding maintenance costs for residential streets and alleys. Design Considerations: • *The loading speed of the crew and collection method used.* • *Road width and weight limits (consider weight of both waste and vehicle).* • *Capacity should be related to the quantity of wastes collected on each route. Ideally, capacity should be an integral number of full loads.* • *Travel time to transfer station or disposal site, and the probable life of that facility.* • *Relative costs of labour and capital.*
Loading and Unloading Mechanisms Loading mechanisms should be considered for commercial and industrial applications, and for residences when municipalities wish to minimize labour costs over capital costs. A variety of unloading mechanisms are available. Design Considerations—Loading: • *Labour costs of collection crew.* • *Time required for loading.* • *Interference from overhead obstructions such as telephone and power lines.* • *Weight of waste containers.* *Design Considerations—Unloading:* • *Height of truck in unloading position. Especially important when trucks will be unloaded in a*

building. • *Reliability and maintenance requirements of hydraulic unloading system device.*
Truck Turning Radius Radius should be as short as possible, especially when part of route includes cul-de-sacs or alleys. Short wheelbase chassis are available when tight turning areas will be encountered.
Water tightness Truck body must be watertight so that liquids from waste do not escape.
Safety and Comfort Vehicles should be designed to minimize the danger to solid waste collection crews. Design Considerations: • *Carefully designed safety devices associated with compactor should include quick-stop buttons. In addition, they should be easy to operate and convenient.* • *Truck should have platforms and good handholds so that crew members can ride safely on the vehicle.* • *Cabs should have room for crew members and their belongings.* • *Racks for tools and other equipment should be supplied.* • *Safety equipment requirements should be met.* • *Trucks should include audible back-up warning device.* • *Larger trucks with impeded back view should have video camera and cab-mounted monitor screen.*
Speed Vehicles should perform well at a wide range of speeds. Design Considerations: • Distance to disposal site. • Population and traffic density of area. • Road conditions and speed limits of routes that will be used.
Adaptability to Other Uses Municipalities may wish to use solid waste collection equipment for other purposes such as snow removal.

Waste Transfer Stations

The primary reason for using a transfer station is to reduce the cost of transporting waste to disposal facilities. Consolidating smaller loads from collection vehicles into larger transfer vehicles reduces hauling costs by enabling collection crews to spend less time travelling to and from distant disposal sites and more time collecting waste. This also reduces fuel consumption and collection vehicle maintenance costs, plus produces less overall traffic, air emissions, and road wear. In addition, a transfer station also provides an opportunity to screen waste prior to disposal, flexibility in selecting waste disposal options, as well as an opportunity to serve as a convenience centre for public use.

Waste transfer stations also offer more flexibility in terms of disposal options. Decision makers have the opportunity to select the most cost-effective and/or environmentally protective disposal sites, even if they are more distant. They can consider multiple disposal facilities, secure competitive disposal fees, and choose a desired method of treatment and disposal.

Finally, transfer stations often include convenience canters (Civic Amenity Centres) open to public use. These canters enable individual citizens to deliver waste directly to the transfer station facility for recycling and/or ultimate disposal. Some convenience canters offer programs to manage yard waste, bulky items, household hazardous waste, and recyclables. These multipurpose convenience canters are assets to the community because they assist in achieving recycling goals, increase the public's knowledge of proper materials management, and divert materials that would otherwise burden existing disposal capacity.

Types of Transfer Stations

The type of station that will be feasible for a community depends on the following design variables:

- Required capacity and amount of waste storage desired
- Types of wastes received
- Processes required recovering material from wastes or preparing it (e.g. shred or bale) for shipment
- Types of collection vehicles using the facility
- Types of transfer vehicles that can be accommodated at the disposal facilities
- Site topography and access.

Following is a brief description of the types of stations typically used for three size ranges:

- Small capacity (less than 50 tons/day)
- Medium capacity (50 to 150 tons/day)
- Large capacity (more than 150 tons/day).

Small to Medium Transfer Stations

Typically, small to medium transfer stations are direct-discharge stations that provide no intermediate waste storage area. These stations usually have drop-off areas for use by the general public to accompany the principal operating areas dedicated to municipal and private refuse collection trucks. Depending on weather, site aesthetics, and environmental concerns, transfer operations of this size may be located either indoors or outdoors.

More complex small transfer stations are usually attended during hours of operation and may include some simple waste and materials processing facilities. For example, the station might include a recyclable materials separation and processing centre. Usually, direct-discharge stations have two operating floors. On the lower level, a compactor or open-top container is located. Station users dump wastes into hoppers connected to these containers from the top level.

Smaller transfer stations used in rural areas often have a simple design and are often left unattended. These stations, used with the drop-off collection method, consist of a series of open-top containers that are filled by station users. These containers are then emptied into a larger vehicle at the station or hauled to the disposal site and emptied. The required overall station capacity (i.e., number and size of containers) depends on the size and population density of the area served and the frequency of collection. For ease of loading, a simple retaining wall will allow containers to be at a lower level so that the tops of the containers are at or slightly above ground level in the loading area.

Large Transfer Stations

Larger transfer stations are designed for heavy commercial use by private and municipal collection vehicles. In some cases, the public has access to part of the station. If the public will have access, the necessary facilities should be included in the design. The typical operational procedure for a larger station is as follows:

1. When collection vehicles arrive at the site, they are checked in for billing, weighed, and directed to the appropriate dumping area. The check-in and weighing procedures are often automated for regular users.

2. Collection vehicles travel to the dumping area and empty wastes into a waiting trailer, a pit, or onto a platform.

3. After unloading, the collection vehicle leaves the site. There is no need to weigh the departing vehicle if its tare (empty) weight is known.

4. Transfer vehicles are weighed either during or after loading. If weighed during loading, trailers can be more consistently loaded to just under maximum legal weights; this maximizes payloads and minimizes weight violations.

Several different designs for larger transfer operations are common, depending on the transfer distance and vehicle type. Most designs fall into one of the following three categories:

(1) direct - discharge non compaction stations,
(2) platform /pit noncompaction stations
(3) compaction stations.

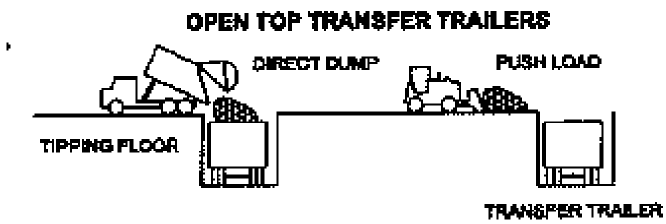
The following paragraphs provide information about each type, and the relevant boxes present the advantages and disadvantages of each.

Direct-Discharge Non-compaction Stations

Direct-discharge non-compaction stations are generally designed with two main operating floors. In the transfer operation, wastes are dumped directly from collection vehicles (on the top floor), through a hopper, and into open top trailers on the lower floor. The trailers are often positioned on scales so that dumping can be stopped when the maximum payload is reached. A stationary knuckle boom crane with a clamshell bucket is often used to distribute the waste in the trailer. After loading, a cover or tarpaulin is placed over the trailer top.

These stations are efficient because waste is handled only once. However, some provision for waste storage during peak time or system interruptions should be developed. For example, excess waste may be emptied and temporarily stored on part of the tipping floor. Facility permits often restrict how long wastes may be stored on the tipping floor (usually 24 hours or less).

Figure 3-54: Transfer Options in a transfer station

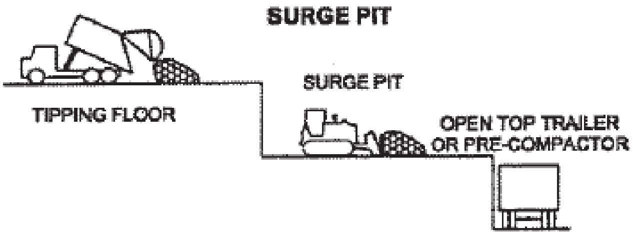


Platform / Pit Non compaction Stations

In platform or pit stations, collection vehicles dump their wastes onto a floor or area where wastes can be temporarily stored, and, if desired, picked through for recyclables or unacceptable materials. The waste is then pushed into open-top trailers, usually by front-end loaders. Like direct discharge stations, platform stations have two levels. If a pit is used, the station has three levels.

A major advantage of these stations is that they provide temporary storage, which allows peak inflow of wastes to be levelled out over a longer period. Although construction costs for this type of facility are usually higher because of the increased floor space, the ability to temporarily store wastes allows the purchase of fewer trucks and trailers, and can also enable facility operators to haul at night or other slow traffic periods. These stations are usually designed to have a storage capacity of one-half to two days' inflow.

Figure 3-55: Surge Pit in a transfer station

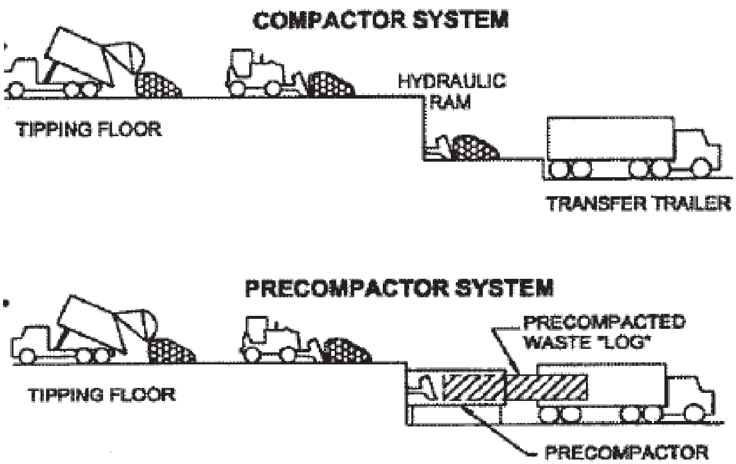


Compaction Stations

Compaction transfer stations use mechanical equipment to dense wastes before they are transferred. The most common type of compaction station uses a hydraulically powered compactor to compress wastes. Wastes are fed into the compactor through a chute, either directly from collection trucks or after intermediate use of a pit. The hydraulically powered ram of the compactor pushes waste into the transfer trailer, which is usually mechanically linked to the compactor.

Other types of equipment can be used to compact wastes. For example, wastes can be baled for shipment to a bale fill or other disposal facility. Baling is occasionally used for long-distance rail or truck hauling. Alternatively, some newer compactors produce an extruded, continuous "log" of wastes, which can be cut to any length. Bales or extruded wastes can be hauled with a flat-bed truck or a trailer of lighter construction because, unlike with a traditional compactor, the side walls of the trailer do not need to restrain the wastes as the hydraulic ram pushes them.

Figure 3-56: Compaction System in a transfer station



Compaction stations are used when (1) wastes must be baled for shipment (e.g., rail haul) or for delivery to a bale fill, (2) open-top trailers cannot be used because of size restrictions such as viaduct clearances, and (3) site topography or layout does not accommodate a multi-level building conducive to loading open-top trailers.

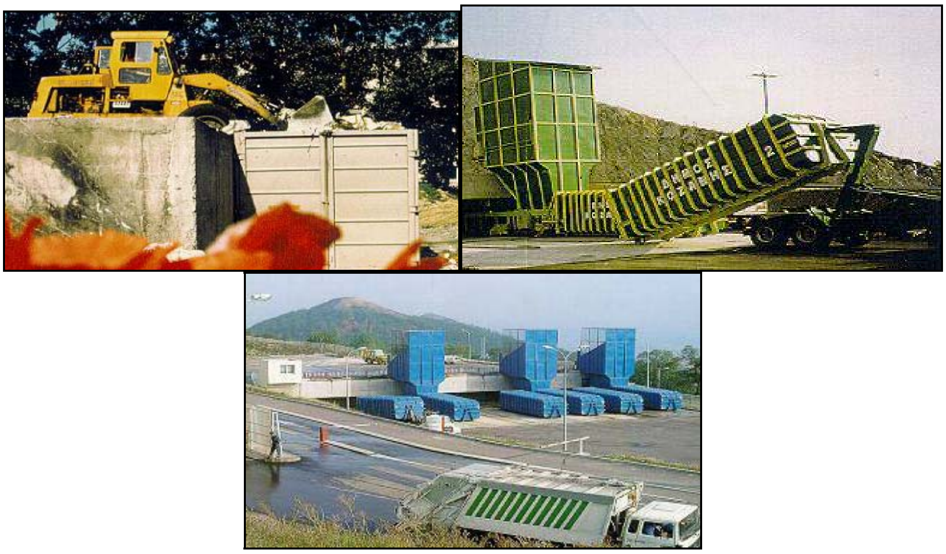
The main disadvantage to a compaction facility is that the facility's ability to process wastes is directly dependent on the operability of the compactor. Selection of a quality compactor, regular preventive maintenance of the equipment, and prompt availability of service personnel and parts are essential to reliable operation.

Table 3-71: Advantages and disadvantages of transfer stations types

Direct Dump Stations Waste is dumped directly from collection vehicles into waiting transfer trailers. Advantages: • *Because little hydraulic equipment is used, a shutdown is unlikely.* • *Minimizes handling of wastes.* • *Relatively inexpensive construction costs.* • *Drive-through arrangement of transfer vehicles can be easily provided.* • *Higher payloads than compactor trailers.* Disadvantages: • *Requires larger trailers than compaction station.* • *Dropping bulky items directly into trailers can damage trailers.* • *Minimizes opportunity to recover materials.* • *Number and availability of stalls may not be adequate to allow direct dumping during peak periods.* • *Requires bi-level construction.*
Pit or Platform Noncompaction Stations Waste is dumped into a pit or onto a platform and then loaded into trailers using waste handling equipment. Advantages: • *Convenient and efficient waste storage area is provided.* • *Uncompacted waste can be crushed by bulldozer in pit or on platform.* • *Top-loading trailers are less expensive than compaction trailers.* • *Peak loads can be handled easily.* • *Drive-through arrangement of transfer vehicles can be easily provided.* • *Simplicity of operation and equipment minimizes potential for station shutdown.* • *Can allow recovery of materials.* Disadvantages: • *Higher capital cost, compared to other alternatives, for structure and equipment.* • *Increased floor area to maintain.* • *Requires larger trailers than compaction station.*
Hopper Compaction Station Waste is unloaded from the collection truck, through a hopper, and loaded into an enclosed trailer through a compactor. Advantages: • *Uses smaller trailers than non-compaction stations uncompacted.* • *Extrusion/"log" compactors can maximize payloads in lighter trailers.* • *Some compactors can be installed in a manner that eliminates the need for a separate, lower level for trailers.* Disadvantages: • *If compactor fails, there is no other way to load trailers.* • *Weight of ejection system and reinforced trailer reduces legal payload.* • *Capital costs are higher for compaction trailers.* • *Compactor capacity may not be adequate for peak inflow.* • *Cost to operate and maintain compactors may be high.*
Push Pit Compaction Station Waste is unloaded from the collection truck into a push pit, and then loaded into an enclosed trailer through a compactor. Advantages: • *Pit provides waste storage during peak periods.* • *Increased opportunity for recovery of materials.*

• *All advantages of hopper compaction stations.*
Disadvantages:
• *Capital costs for pit equipment are significant.*
• *All other disadvantages of hopper compaction stations.*

Figure 3-57: Waste disposal in container with no compaction, hopper compaction and automated transfer station



Transfer Vehicles

Introduction

Although most transfer systems use tractor trailers for hauling wastes, other types of vehicles are sometimes used. For example, in collection systems that use small satellite vehicles for residential waste collection, the transfer (or "mother") vehicle could simply be a large compactor truck. At the other extreme, some communities transport large quantities of wastes using piggyback trailers, rail cars, or barges. The following discussion presents information on truck and rail transfer vehicles. Although smaller vehicles may also be used for transfer, their use is more typically limited to collection.

Trucks and Semi trailers

Trucks and semi trailers are often used to carry wastes from transfer stations to disposal sites. They are flexible and effective waste transport vehicles because they can be adapted to serve the needs of individual communities. Truck and trailer systems should be designed to meet the following requirements:

- Wastes should be transported at minimum cost.
- Wastes must be covered during transport.
- The vehicles should be designed to operate effectively and safely in the traffic conditions encountered on the hauling routes.
- Truck capacity should be designed so that road weight limits are not exceeded.
- Unloading methods should be simple and dependable, not subject to frequent breakdown.
- Truck design should prevent leakage of liquids during hauling.
- The materials used to make the trailers and the design of sidewalls, floor systems, and suspension systems should be able to withstand the abusive loads innate to the handling and hauling of municipal solid wastes.

The number of required tractors and trailers depends on peak inflow, storage at the facility, trailer capacity, and number of hauling hours. Most direct-discharge stations have more trailers than tractors because empty trailers must be available to continue loading, but loaded trailers can, if necessary, be temporarily parked and hauled later.

It is important to select vehicles that are compatible with the transfer station. There are two types of trailers used to haul wastes:

- compaction trailers
- non-compaction trailers.

Non-compaction trailers are used with pit or direct dump station, and compaction trailers are used with compaction stations. Non-compaction trailers can usually haul higher payloads than compaction trailers because the former do not require an ejection blade for unloading. Transfer vehicles should be able to negotiate the rough and muddy conditions of landfill access roads and should not conflict with vertical clearance restrictions on the hauling route. The following Table discusses additional factors to consider when selecting a transfer trailer.

Figure 3-58: Roll-on vehicle transferring full container onto trainer

Table 3-72: Design Considerations for Transfer Truck and Trailer Systems

Trailer Type Trailers are classified as either compaction or non-compaction. Typically, compaction trailers are rear-loading, enclosed and equipped with a push-out blade for unloading. In non-compaction trailers, the entire top is usually open for loading. After loading, top doors or tarps cover waste. Design Considerations: • *Transfer station design usually determines whether to use a compaction or non-compaction trailer.* • *Compaction trailers must endure the pressure of the compaction process; therefore they are usually enclosed and reinforced. As a result, they are often heavier than non-compaction trailers.* • *Non-compaction trailers are larger and lighter than compaction trailers. They are usually made of steel or aluminum. These trailers usually have a walking floor or a conveyor floor, or they are tipped by a hydraulic platform at the disposal facility.*
Trailer Capacity Typically, capacities range 50 cubic meters for compaction trailers to 95 cubic meters for non-compaction trailers. Design Considerations: • *Waste densities are usually 0.24 to 0.36 tn/cubic meter for compacted wastes, and 0.17 to 0.24 tn/cubic meter for non-compacted wastes.* • *Trailers are typically sized to meet legal payload and dimension requirements. Specific requirements vary depending on local regulations.* • *Weight depends on degree of compaction and composition of the material.* • *Trailers are often sized to be higher than legal height requirements when empty, but lower when full.*
Unloading Mechanisms Some trailers are self-emptying, and others require additional equipment to help with the unloading

process. The most common mechanisms are the following:
Push-Out Blade
• *Push-out blades are usually used in compaction trailers and sometimes used in noncompaction trailers.*
• *In compaction trailers, the same blade that is used to compact wastes is used to eject them.*
• *The blade is relatively simple to operate and can be powered by tractor hydraulic system or by a separate engine. However, items such as tree limbs can wedge under the blade, causing it to jam.*
Moving Floor
• *Moving floors are common in non-compaction trailers.*
• *Floor usually has two or more movable sections that extend across the entire width of the trailer; therefore, even if one section breaks, another can empty wastes.*
• *Floor can typically empty wastes in 6 to 10 minutes.*
• *Rear of trailer may be larger to expedite unloading.*
Hydraulic Lift
• *A lift located at the disposal site tips the trailer to an angle that allows discharge of the wastes.*
• *Time required for unloading operation is about 6 minutes.*
• *One disadvantage is a possible wait for use of lift. Breakdown of lift seriously impedes ability to receive wastes.*
Pull-Off System
• *A movable blade or cable slings are placed in front of the load. To empty load, auxiliary equipment (e.g., landfill dozer) pulls the waste out of the trailer.*
• *The system may require more time than self-unloading trailers because there may be a wait for auxiliary equipment.*

Rail Cars

As the distance between sanitary landfills and urban areas increases, the importance of railroads in transporting wastes to distant sites also grows. Rail transfer is an option that should be considered, especially when a rail service is available for both the transfer station and the disposal facility, and when fairly long hauling distances are required (80 km or more).

It is of high importance when evaluating a potential rail transfer system, decision makers should consider environmental impacts and potential opposition from towns between the transfer facility and the disposal facility. Rail cars should be covered and kept clean, and shipment should be scheduled to minimize en-route delays.

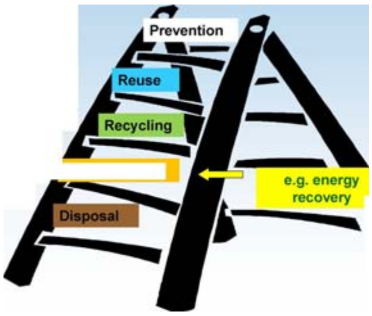
Figure 3-59: Roll-on vehicle transferring full container onto trainer

3.7.5 Options for Waste Treatment

It is estimated that from the total quantities of municipal waste generated in the Country each year a proportion of those is recycled through recovery organizations collection schemes. The remaining waste is disposed to landfills. One of the main reasons for reliance on landfill disposal has been the relative abundance of cheap landfill capacity, which has made alternative treatments uneconomic.

Changes such as the introduction of more stringent waste disposal regulations and publication of the waste strategy in recent years have improved the prospects of alternative waste treatments. These changes are supportive of the generally accepted European Community Strategy for dealing with waste where the waste minimization is the most preferred and landfill of untreated waste the least preferred option.

Figure 3-60: Most preferred options in solid waste management



Other changes, which are likely to support the introduction of alternative waste treatment options, are:

- the rising cost of landfill disposal,
- a generic move towards environmentally sustainable waste management options which also consider factors such as transport and public nuisance impacts;
- the Governments commitment to recycling domestic waste;
- the obligations imposed by Law on Waste Management.

The implementation of the Rulebook Law on Waste Management is going to have significant impacts on all waste management operations, but most significantly on wastes sent to landfill for disposal. The aim of the Law is to reduce the negative environmental impacts of wastes deposited in landfills particularly on surface and groundwater, soils and air as well as global effects such as greenhouse gas emissions. In particular, the Law is going to impact on previous practices on waste management due to the requirement for reductions in biodegradable municipal solid waste sent to landfills.

To meet the requirements of the Law, local authorities will need to implement major systems for reducing the biodegradable content of the wastes that they dispose of and it is expected that recycling, composting, and treatment of municipal waste will increase markedly. Thus, waste will require some form of treatment to reduce its negative environmental impacts.

There are many technologies that can be applied both to treat waste but local authorities and the waste management industry will need to know which technologies are available and how effective they are. Each technology will have to be assessed in terms of meeting Best Practicable Environmental Option (BPEO) requirements so that the most appropriate technology will be employed to reduce environmental impacts at an acceptable cost.

This chapter identifies all the technology options currently available in European Countries and provides a brief technical description of each. The technologies considered are physical, biological or thermal processes and for each technology, a number of issues are considered such as state of the technology and its current deployment, implementation of the technology and how use of the technology can contribute to targets and policy objectives.

The technologies under discussion are:

- Materials recovery facilities
- Aerobic Composting
- Anaerobic digestion
- Mechanical Biological Treatment (MBT)
- Incineration
- Pyrolysis and gasification

An Integrated Waste Management Plant usually employs a combination of these technologies in order to achieve a sustainable facility which is environmental and economical accepted on local level.

3.7.6 Materials Recovery Facilities and Recycling

Material Recovery Facilities (MRFs) are places where wastes are deposited and then sorted and separated. The main purpose of a MRF is to sort and separate materials to produce products that meet defined specifications and so can be marketed. This is achieved, particularly in a clean MRF, by sorting the collected material into various products and removing contaminant materials.

MRFs can be classified either as clean MRFs, which treat source separated material and recover recyclables, or dirty MRFs which recover recyclable materials and/or a biodegradable fraction directly from unsorted dustbin waste. The size of a MRF is clearly related to the amount of material it is designed to process, and this can typically range from 10000 tons per year to 50000 tons per year or even higher.

The following table provides information regarding the different types of MRFs.

Table 3-73: MRFs options

Technology	Clean MRFs	Dirty MRFs
Concept	Clean MRFs can handle material collected through civic amenity centers, as well as from kerbside collection schemes. As a clean MRF can only treat source separated material, it is important that it is able to process all the material that is collected. A clean MRF can be designed to either handle a single stream of materials, i.e. paper is mixed with other materials during collection, or can be designed to process paper separately from other materials. The design of a clean MRF is usually based on one of two approaches: ✓ A low-technology MRF where virtually all sorting is done by hand (plants may have a magnet extraction unit to remove steel cans). This approach has a low capital cost, but high labour costs ✓ A high-technology MRF, which makes as much use as possible of mechanical sorting equipment, e.g. equipment to separate glass bottles from plastic containers. This results in a higher capital cost, and although labour costs are lower, some hand-pickers are still required to meet quality requirements The potential advantage of the low technology approach is that it is much easier to respond to changes in market conditions. For example, hand pickers can be instructed to sort alternative materials, whereas equipment designed for one purpose cannot easily be modified (and will still incur costs even if there is no market for the material it is designed to separate). The method of collection of the recyclables will also affect the design of the MRF. The number of products that a clean MRF can produce is based on the number of materials collected and the level of sorting undertaken at the MRF.	A dirty MRF treats 100% of the collected waste stream and as with clean MRFs, the design of dirty MRFs can be either simple or complicated. The main advantage of a dirty MRF is that there are no additional collection costs, and the recovery/recycling rate is determined by the efforts of the sorters at the plant, rather than by the willingness of the public to participate in a source separation scheme. However, the main disadvantage is that the recovered materials are not as clean as those recovered from source separated wastes because they have been in contact with other materials, particularly food scraps, in the dustbin. A number of dirty MRFs have been built in the USA, but this is because dustbin waste in the USA has a low proportion of food scraps due to the extensive use of kitchen waste disposal units. The higher organic content of dustbin waste in Europe means that it is unlikely that a dirty MRF will be a suitable approach for recovering clean recyclables in Europe. Dirty MRFs can also be used in order to recover biodegradables and produce compost. However the compost is of low quality which limits the potential market for the product. An alternative form of dirty MRF which could be considered is a plant which produces refuse derived fuel (RDF), as this is able to recover metals and still produce a reject stream which could be composted. These kinds of plants are also called MBT (Mechanical –biological Treatment Plants) and are also discussed on the following paragraphs.
Technology Status	**A. Development** The technology for separating materials by material type for clean MRFs is well developed. Recently optical systems (NIR detection) have been developed for sorting plastics by polymer type and this has increased the sorting capabilities in several. Consequently clean MRFs that have identified suitable markets for the materials they recover, have a high degree of commercial success.	**A. Development** Although technologies for dirty MRFs which recover recyclable materials have been developed, and a number of dirty MRFs appear to be operating satisfactorily but problems are still existing in identifying markets for the produced materials at least with commercial prices.

	Clean MRF	Dirty MRF
	B. Deployment Clean MRFs operate successfully in many countries.	**B. Deployment** A number of dirty MRFs have been constructed in the USA and in Southern European Countries, as Spain, France, Italy, Greece, Cyprus, etc. Dirty MRFs, which separate a fine fraction, which is then composted, are also operating satisfactory in a number of countries.
	C. Costs It is difficult to give a good estimate of either the capital or operating cost of a "typical" MRF, as every MRF is different in design and the way it operates. A clean MRF can range from a simple low-technology (hand-picking) system constructed in an existing building to a high technology (mainly mechanical sorting) system constructed in a new building which may well include other facilities, education centres, etc. The size of the MRF (in terms of the tons of waste processed per day) will influence the amount of sorting equipment required and hence the capital costs. Operating costs will be affected by the numbers of different waste materials to be processed. Investment in a MRF, even the largest is unlikely to exceed €5-6 million but it is quite possible to equip a low-technology MRF for €500,000. **D. Performance - Availability and Experience** Both clean and dirty MRFs have a high availability (estimated at 85%) but MRFs can and do suffer breakdowns, which reduce their availability. Spare parts are generally readily available for dirty MRFs and on-site maintenance staff is able to quickly complete repairs. Where a MRF has automated sorting equipment (such as equipment to sort plastic by polymer type) repairs may well take longer because of the need for specialized repair staff from off-site. Although the availability of specialized sorting equipment will be lower than that for the simpler equipment such as conveyors and screens, the design of the MRF must allow it to process the bulk of material if the specialized sorting equipment is not operational.	
Implementation issues	**A. Financing** Financing the capital cost of a MRF is likely to be undertaken by a private sector company and the financial risks will be assessed within usual commercial constraints. The main advantage to a Local Authority of private sector financing is that they do not have to provide any funding for the MRF, or for any further development that might be required. The sale of sufficient product and the revenue obtained from these sales clearly helps to reduce the net operating cost of the MRF. Consequently, the financial risk can be reduced if the MRF is able to produce good quality products and achieve a satisfactory income from them.	
	B. Quality of products It is important that the MRF produces high quality material to maintain its markets for the recovered products. For a clean MRF, this will require good quality control during collection to minimise the amount of contaminants that need to be removed from the recovered products. There are also well established standards and specifications for recovered paper and metals, which help to ensure a consistent quality of product.	**B. Quality of products** Materials recovered from a dirty MRF will be of lower quality and more variable because of the level of contaminants which cannot easily be separated when the material is recovered.

	Materials recovered from a clean MRF will be of high quality and easy to sell provided there are sufficient markets for the recovered products. Markets are readily available for paper and metal recovered through clean MRFs although the revenues obtained may be low.	
	C. Stability of markets for recyclate/products The main materials which MRFs recover are paper, metals and plastics, although glass and textiles are recovered to a lesser extent. There are numerous markets for metal and paper and so consequently the stability of these markets is generally very high. The stability of markets for plastics is low, whilst those for glass and textiles are highly variable.	
Planning issues	**A. Land requirements** The amount of land required by the MRF would depend on the type of MFR, the size of the building, the wastes collected and the storage area required. For a typical plan of 30.000-40.000 tn/year a building of 2.000 – 3.000m2 is generally required.	
	B. Public participation Clean MRFs require the public to participate by separating out materials that the clean MRF can process. Source separation schemes will only be successful if the public participates fully. The main factor affecting the amount of material recovered is the number of participating households. The results from a number of studies where participation rates have been measured (for voluntary schemes) show that: ✓ 20% are highly unlikely to participate ✓ 20% are highly likely to participate ✓ Publicity material should target the remaining 60%, who are more likely to participate if they receive clear instructions (with regular reminders), and regular information on how well the scheme is performing.	**B. Public participation** A dirty MRF does not require public participation to be successful as whole bin wastes are treated. However, contamination of potentially recoverable materials reduces the quality of the recovered products and may lead to a lower level of income from sales of the products. Organic wastes contaminate recoverable products, particularly paper, and so initiatives to reduce the organic waste in dustbins could be beneficial to the operation and to the amount of material recovered by a dirty MRF.
	C. Education needs Educating the public to separate out the materials to be collected reduces the amount of sorting required at the kerbside. It also reduces the amount of reject material produced from the MRF when processing mixed recyclables. The public has accepted recycling schemes for dry recyclables although there are still concerns about the locations of some MRFs. Good education has, for example, allowed the public to accept fortnightly collection of organic waste.	
Environmental impact issues	**A. Odours** Odours should not be an issue for a clean MRF that only accepts particular waste streams and especially if the amount of reject material is low.	**A. Odours** There may be more of an odour problem for a dirty MRF which accepts unsorted waste material, but this can be overcome by careful sitting of the MRF and control measures to minimise odour impacts.
	B. Dust	

Dust can be controlled through ensuring effective ventilation of the MRF both to protect workers and the general public. One aspect of dust that is starting to be of concern is the generation of biologically active dusts, bioaerosols, which pose a potential hazard to workers, but may be dispersed to affect neighbours of the plant.

C. Water/leachates	C. Water/leachates
Clean MRFs processing source-segregated, dry recyclable materials should not have problems with leachate run-off from the processing.	Dirty MRFs are processing mixed wastes containing a high level of organic contaminants, there may be potential problems from leachate generated by the decomposing organic wastes. This can be collected and treated prior to discharge from the MFR.

D. Solid residues/hazard

Up to 15% of input material going to a MRF may be rejected and require disposal at a landfill. Reject material consists of material which either cannot be separated by, for example, a MRF or which is too contaminated to recover in a dirty MRF. Better education of the public could reduce the amount of material rejected by the MRF.

Handling of rejects and solid residues requires health and safety issues to be considered. If unwanted materials such as glass are found in the waste streams coming into a clean MRF that is not designed to separate glass, then there may be problems handling the glass. The hazards associated with handling and disposing of items such as needles must be considered for dirty MRFs.

E. Noise

Noise complaints from the public are not likely to be a problem if the MRF is situated at a landfill, or in an industrial area where other activities in the area also create noise, provided the MRF is operating within acceptable noise levels. There may be problems with complaints about traffic noise, even if the MRF is in an industrial area. Traffic movements to and from the MRF are likely to be higher than for a typical factory due to the number of vehicles arriving with waste for sorting.

3.7.7 Options for Treatment of Biodegradables – Aerobic Composting Technology

Biological treatment of the organic fraction of municipal wastes can be performed by composting. Composting is the aerobic decomposition of biodegradable material to produce a residue termed compost with the emission of predominantly water and carbon dioxide.

In technical terms, modern composting is a thermophilic, bio-oxidative degradation process. This means that the process operates at temperatures in the thermophilic range (45-60°C) and is a biological process that oxidises the organic matter to break it down to a more simple form.

The organisms that carry out composting are ubiquitous in the environment and seldom require introduction to the process. In practical terms, the composting operations must ensure that the microorganisms are kept supplied with moisture, oxygen, food and nutrients and that the conditions such as temperature remain in the optimum range. A large number of procedures and engineered solutions have been developed to achieve these objectives for the treatment of organic wastes.

The use of composting in waste management is carried out either by the householder on their premises as home composting or in a centralised system, where collected materials are processed at a purpose built facility. The following types of composting processes can be used

- Home composting
- Centralized composting plants which can be (i) Open (non-reactor) composting systems, (ii) Turned windrow composting, (iii) Aerated static pile composting, (iv) Reactor composting systems

Waste treated by composting

Only the organic biodegradable fraction of municipal waste can be treated by composting. This is primarily kitchen and garden wastes, but paper and fines fractions can be treated to an extent, although the degree of degradation achieved is very dependent on the system used.

Essentially there are two forms of feedstock for composting, source separated and un-segregated wastes. Source separation systems rely on the waste being collected separately from the other household waste and can be achieved through civic amenity sites or through kerbside collections in a separate container. Un-segregated waste for composting can range from the whole waste stream without any removal of recyclables to the composting of processed materials that have had the majority of the contamination removed by mechanical means.

There are differences between source separation methodologies that have implications for the composting process. Source separation in the UK is carried out either at civic amenity sites where the green waste is mainly larger prunings, leaves and garden waste, or by kerbside collection schemes, which consist of smaller, fleshier materials rather than the larger woody materials, and kitchen wastes. This results in the kerbside collected materials being generally higher in moisture, nutrients and rapidly degradable materials but low in the woody components. This leads to a greater propensity for rapid degradation and hence odour generation and the lower woody component gives rise to a less open structure unless mixed with woods chips or green waste. The greater amounts of plant matter will give rise to a higher nutrient content and this will have value in some applications.

Feedstock requirements for composting plants are principally governed by the product quality requirements. However, the performance of the composting process and the quality of the resultant compost are also dependant on factors such as carbon to nitrogen ratio, nutrient availability, moisture content, porosity, degradability etc. To achieve the required performance and compost properties may need the mixing in of materials other than household waste such as sewage sludge, commercial waste or woodchips. This is normally the case with source separated materials rather than un-segregated composting due to the more stringent requirements of the compost product.

Products and residues

Source separated feedstock

The main product from the composting of waste is compost. This stabilized organic material consists of the refractory and slowly degradable cellulosic materials. The main use of this compost is as a soil improver. The quality of the compost is largely determined by the feedstock provided to the process. Relatively uncontaminated feedstocks will give rise to uncontaminated products and these are generally composted from source separated materials.

The residues from the composting process are those materials that do not readily degrade, such as wood and these can either be returned to the front of the process to be shredded or they can be disposed of. This material can represent up to 25% of green waste feedstock. Contaminants from source separated systems will be relatively low, for example in green waste it will be less than 2% of the feedstock. For kerbside collection schemes contamination can be higher and ranges from 1% to over 10% dependent on a wide range of factors associated with the operation of the collection scheme. The composition of these contaminants will vary with the scheme and will contain almost anything that could be in the mixed waste stream, but will have high concentrations of plastics from plastic sacks used to store/transport the waste and from plastic flowerpots and other plastic garden products.

Mixed waste processing

The primary product from mixed waste processing is the stabilisation of the waste. The composting process will remove the readily biodegradable carbon and the resulting residues will degrade slowly in the environment.

In some circumstances the composted waste can be further sorted to generate a low quality soil improver. The eventual use of this material will be limited to landfill cover or other land restoration projects.

Mixed waste processing will generate a large amount of residues such as the non-organic materials rejected by the sorting process and will mainly consist of metals, glass and plastics. There will be some potential to recycle small proportion of this material, but this will be limited to the ferrous and non-ferrous metals. Materials going into the composting process will consist of paper, kitchen and garden wastes and fines. Sorting after the composting process will remove the materials that have not been decomposed sufficiently and these rejects will contain larger proportions of paper and woody materials but also additional glass and plastics. It would be expected that all of these rejects would be either landfilled or incinerated.

Composting plant size

Composting is not a particularly staff intensive operation as the bulk processes occur when the waste is in piles or in the vessel. Estimates of staffing levels vary between different employers, but plants less than 25000 tons per year capacity tend to employ between 2-4 staff, giving staffing rates of between 10 and 1 staff per 10000 ton per year capacity. As plants get larger than this the staffing levels can be estimated from a level of 1 staff member per 10000 ton per year capacity. There appears to be little evidence from the published data to suggest any differential between the various types of composting plant.

Technology

Three waste composting options are considered as generic examples of composting technology. The following table provide information regarding these three types of waste composting options.

Table 3-74: Composting options

Technology	Whole waste composting	Green waste composting (turned windrow)	Green waste composting in-vessel system
Concept	The composting of whole waste is carried out to stabilize the solid waste and divert biodegradable material away from landfill as low-grad compost. The system operates by sorting the waste prior to composting to remove the non-compostable components. The degradation is assisted by the addition of water. After homogenization, the material is screened to remove the materials that have not broken down. These are principally textiles, plastics and metals, although there are some organic materials mixed with these rejects but the proportion is small and this material is landfilled. The screened material is then placed in windrows. The windrows are positioned under a covered area to reduce the effects of rainfall on the composting process. The windrows are turned on a programme that initially turns the piles twice a week for the first few weeks and reduces to weekly turning after the initial high-activity phase. The process takes approximately 16 weeks to complete, whereupon the composted waste is screened again to remove more contaminants and may undergo air classification or air tabling to remove glass and plastics depending on the end use of the compost. The reject fractions from these sorting phases will be landfilled. The compost will then be used in an extensive application such as land restoration or potentially agriculture if the compost quality is sufficient.	The composting of this material is a simple process. The first stage is visual inspection to remove larger contaminants such as plastic bags, metal items and un-process able large items such as tree stumps. Then the waste is shredded. The shredders are of several basic types; screw shredders, shear shredders, tub grinders and the horizontal shredders. The benefits and weaknesses of the various shredder types are well covered by the manufacturers. The main point is that the shredding process increases the surface area of the waste to allow microbial attack and hence degradation. The shredded green waste is then placed in windrows. The length of the windrows is dependent on the site topography and the quantity of waste to be processed. The temperature in the pile rises rapidly and the piles are turned several times during the process. Turning of the windrows is performed by either normal waste handling equipment or specialist turning machines. The choice of the type of turning machine is an economic one and is largely controlled by the scale of operation, larger facilities can effectively use a specialist machine, whilst smaller plant require the flexibility of multi-use vehicles. The overall purpose of the turning process is to introduce oxygen in to the composting mass and thus encourage the composting process. Large amounts of steam and heat are released in the process and this acts as a control on the temperature.	In-vessel composting is the same biological process as describe above but enclosed in a vessel or building. There are many designs but essentially four basic types; batch tunnel, progressive tunnel, sequential bay and vertical units are used. The differences between them are minor and related to the engineering rather than any fundamental differences in processing. The basic operation of the in-vessel systems is to control the ventilation of the composting material and to agitate or mix the material as required. The air used in the composting process is contained and thus allows the control of any odours or bio aerosols emitted during the main composting process. Obviously, the loading and unloading operations will have the potential to release odours and bio aerosols. The basic principal of the in-vessel systems can be demonstrated by the batch tunnel system in the Figure. Here the waste is placed in a large container with a perforated floor. Air is blown through the waste to facilitate the composting. Air is recirculated or sent to the bio filter for treatment and fresh air introduced depending on the composting temperature and oxygen content of the air. The process is often computer controlled. As the material composts it will compact increasing the resistance to air passage and will require turning to introduce porosity and to open up new surfaces for composting. In continuous systems, this is an

		The product compost is then sold to the users in bulk or bagged for sale to domestic customers. The oversize reject fraction can be either sent to landfill as a waste or returned to the start of the process for another stage of composting.	aspect of the mechanical system and in batch systems the waste is taken out of the tunnel and turned with a shovel loader before being returned to the tunnel. The turning process may be repeated several times depending on the feedstock. The waste will require windrow composting for several weeks after the initial intense composting phase in the composting unit. The feedstock to the process will predominantly be green wastes but the inclusion of kerbside collected biowaste can also be incorporated in to the system. The enclosed nature mitigates many of the problems that higher levels of kitchen wastes introduce such as increased potential for odours, leachate generation and attractiveness for vermin.
Development	This is a system from the past, which is now finding a new niche in the waste management market. Mixed waste composting has a lot of applications in Europe either producing compost for particular agricultural market (i.e. vine growing) or as a pre-treatment option to landfill (mechanical biological pre-treatment).	Composting of green waste is predominant across Europe. Although source separation at the household is increasing, the quantities collected and composted are currently less than the quantity of green waste composting.	The development of the technology is limited, comparing to other systems. The deployment of in-vessel systems in several countries. Germany, Austria, Belgium and the Netherlands have the large proportion of their plants operating with in-vessel systems, whilst many countries have only a few or no in-vessel composting plant.
Cost and performance	The cost of operation and construction of these plants is highly variable depending on the level of complexity of the sorting plant and the desired quality of the compost product. An EU report suggested that the capital cost for mixed waste composting plants ranging from €180 per ton of capacity for smaller plants (6,000 t/year) down to €100 per ton of capacity for plants up to 20,000 t/year. For lower grade composts operational costs of €30,0 to €50 per ton were typical but could rise as high as €80 per ton for more refined compost products.	The cost of open windrow is one of the least expensive process options for treating waste. Gate fees often quoted range between €20 to €30 per ton. The costs are heavily influenced by the scale of operation and the marketing opportunities for the compost. Essential revenue to the plant will be the sale of compost. Prices obtained for the compost can be as high as €50 per ton for bagged material sold to the public, but bulk sales	

	The performance can be considered in two ways: (i) the diversion of material away from landfill or (ii) the production rate of useable compost.	which comprise the majority of the material sold will rarely achieve an average higher than €50 per ton.
Financial risks	The financial risks of the plant predominantly centre on the gate fee that can be charged and the value or use of the products. The operational costs and capital costs once a project is operational are moderately stable and thus are not "risk" factors. The income from the gate fee is susceptible to competition from alternative disposal options that can either siphon off waste that would have otherwise been processed or result in the gate fee having to be adjusted to remain competitive. In either case, revenue is affected. These risks can be mitigated through design of contracts for the waste supply. The risks to the product revenues/costs are more uncertain. Source separated waste composting: The largest uncertainties will be the sale value of the finished compost and to a lesser extent the quantity and cost of disposal of the rejects. The markets for compost are at present limited to existing landscape and horticultural uses. Therefore alternative markets will need to be developed and agriculture is the most likely market with sufficient capacity to deal with the quantities that will be produced. Mixed waste composting: The financial risks for MBT will be lower than for source separated composting as the main cost elements will be the landfill of the residue. While prices for landfilling are expected to rise with time, the risk will be predictable to an extent hence, reducing the uncertainty (and hence risk) to plant operation.	
Operational/Technical Risks	Source separated waste composting: The principal risk to the green waste compost plant operations also come through break down of plant equipment, shredders, loaders etc. This is a manageable process that is controlled by ensuring sufficient capacity on site, ensuring that adequate maintenance is performed and that suitable back-up arrangements are made for inevitable breakdowns. As with other waste operations, plant is based on an availability of 85%, which ensures that there is sufficient stack in the system to deal with mechanical problems. The technical risks are reduced by the use of the in-vessel system in that the variability of the product is reduced and susceptibility to weather influences is removed. This has benefits for product marketing as the sanitization can be more easily verified and guaranteed and the product is more consistent, an important parameter for professional users. The potential for mechanical problems is higher due to the use of a mechanical system. However, most plants have several process lines and so mechanical problems are likely to only affect a proportion of the feedstock. Product quality: Green waste is the least contaminated feedstock, although it will still contain contaminants that will require removal. Levels of contaminants can be kept low through good education and supervision of the deposit points at civic amenity sites. The main problem item is plastic film, in which the public often brings the waste to the site. The only effective removal technique is hand picking prior to shredding and screening after composting. This poses little risk to the process, as the product quality is generally high. There is the potential for garden chemicals to be disposed of with the garden waste, which may pose a threat to the performance of the final soil improver. However, the quantities of domestic garden chemical that could get into the process are unlikely to be large. Given that there is significant mixing in the process, this reduces the concentration to a low level. In addition, the composting process will degrade many chemicals thus reducing the risk to product quality still further. Mixed waste composting: The operational risks are manageable given that mixed wastes may contain almost anything and hence the plant has to be constructed to withstand the full rigours of waste handling. There are the typical risks due to breakdown and maintenance requirements and it is normal to set plant availability predictions at 85%. Product quality: Mechanical separation of the contaminants from the compost is never complete and the final compost is contaminated with a glass, plastics and metal fragments that limit the application of the compost from mixed waste. Suitable applications vary depending on the national regulations relating to soil quality and the agricultural needs. In France, Portugal and Italy, compost from mixed waste is used on a number of crops, but particularly	

	in the wine growing areas. In Germany and Austria the use of the compost is limited to landfill cover materials. The range of uses could be expected to be for land restoration purposes, as well as for vine growing. The presence of heavy metals in compost has been an issue for many years and the setting of appropriate limit levels has been difficult. As a general rule, the greater the degree of segregation of the waste the lower the heavy metal contamination is. Thus, mixed waste processing will have the highest metal levels when compared to either green waste or source separated household organic wastes derived composts.
Planning issues	Planning of any waste site is problematical in that public opposition is based on a perception of waste being dirty, causing pollution and affecting house prices. The principal issues are odour, bio aerosols and traffic movements. As with all planning issues they have to be resolved on a case by case basis but the principal method of mitigating the problems is to use sites that are sufficiently distant from housing. It is not possible to guarantee that there will be no odour or bio-aerosol releases, although, good operational practice can minimise these. In-vessel composting significantly reduces these emissions as the emissions are captured and treated. Other planning issues centre on the amount of land required for the composting operations. A typical estimate for open windrow systems is 1 m^2 per 1.5 m^3 per ton capacity. In-vessel systems have a much lower demand for land and depending on the degree of complexity systems occupy between 0.25 and 0.5m^2 per ton capacity. Obviously, local conditions and the topography of the site affect this.
Environmental impact issues	Emissions from mixed waste composting plants are similar to those from green and bio-waste composting plants. The emissions of concern have been identified as bio-aerosols, VOCs, odours and dust. Bio-aerosols are emitted by all waste management facilities and composting is no exception. Open windrow systems will provide a larger emissions source during the turning operations. Emissions from turned windrow operations have been reported to reach in excess of 690 x10^6 cfu m^{-3}, of bacteria and 2.7 x 10^6 cfu m^{-3} fungi. Estimates from enclosed systems are currently not available but would be expected to be significantly lower. The air emission that causes the most complaints is the odour from the composting waste. This can be minimized through good management of the composting process to ensure that the material remains aerobic. However, there are occasions where odour is generated. In open turned windrow systems mitigation is not possible although there are some proprietary spray systems (based on surfactants and oils) that claim to reduce the problem when used in a perimeter spay. Alternatively, the windrows can be covered with geotextiles to reduce the odour problem. In-vessel systems and aerated piles that suck rather than blow the air can treat the odorous air through biofilters or chemical scrubbers to eliminate the odour. Obviously, treatment of the odour will also mitigate the VOC emissions. In relation to other forms of composting, mixed waste composting will have a higher potential to generate odours, but as in most cases the process will be contained this will allow control of the problem that is unavailable to open windrow systems used for green waste composting. **Water:** Leachate from composting can be a potential hazard to surface or groundwater if it is accidentally released without treatment. Mixed waste composting has a significant demand for moisture, which is used in the initial pulverisation stage and then evaporated in the composting stage. Thus, any leachate produced can be utilized within the process. Composting of green waste and kitchen wastes has the potential to generate greater amounts of excess liquor especially if conducted in the open. The runoff and leachate has the potential to contaminate surface or groundwater. There is a need for all composting processes to be performed on impermeable surface as escape of the runoff and leachate could potentially contaminate surface or groundwater. **Soil:** The contamination of compost derived from green waste is generally low with inert contaminants (glass, plastics, metals) removed through a combination of visual inspection and screening. Kerbside collected organic waste feedstocks will contain slightly greater proportions of contamination, but will still be within the capabilities of systems to remove them. Mixed waste systems will require extensive sorting to remove the inert contamination and significant amounts will remain. This will result in the composts from mixed waste will only be able to be used in the lowest quality applications such

	as landfill cover or land restoration. Heavy metal contamination is an issue with all waste based composts, but green waste is likely to be the least contaminated feedstock and mixed waste the most contaminated. **Noise:** There are two main noise sources on compost sites, the shredders and the reversing signal for the loading shovels. The noise made by shredders can be up to 90 dB, which is particularly a problem for open systems. However, the windrows can be used as effective sound barriers and appropriate positioning of the shredding operations and windrows can reduce noise complaints to a minimum. The choice of reversing warning signal is vitally important on compost sites as the vehicles spend almost half their time going backwards. Removing the signal altogether has implications for health and safety issues but there are "smart" signals that vary the volume depending on proximity of people and verbal warnings, which are not so penetrating as the high frequency signal fitted to many vehicles. **Pathogen kill:** Heat released during composting elevates the compost temperature of the compost. If uncontrolled, the temperature can rise to 80°C or more, but it is normal to limit the temperature to about 50-60°C. This represents a compromise between the optimisation of the speed of composting and the sanitisation of the compost product. Guidance on the precise conditions required for adequate sanitisation vary but range between maintaining the temperature above 55°C for three days and five days at over 60°C. These guidelines are based on the operation of turned windrow systems. Mixed waste composting is most likely to be performed in an enclosed system and these systems offer improved sanitization due to the greater confidence that all of the waste is exposed to the time-temperature conditions. Thus, this provides greater confidence that the process kills pathogens (both plant and animal). However, mixed waste will contain a wider range of pathogens and thus this increases the need for security in pathogen kill. Overall, mixed waste compost is unlikely to be exposed to the public and thus health risks will be low.
Contribution to targets and policies	The key target for municipal waste in the Landfill Directive is the requirement to reduce the amount of biodegradable waste landfilled. The precise targets are to reduce the biodegradable municipal waste landfilled to 25%, 50% and 65% of the 1995 quantities by 2010, 2013, 2020 respectively (old EU Member States). For mixed waste systems that treat the whole of the waste stream, the compost product can be considered as non-biodegradable and hence the only biodegradable material will be the material in the reject fractions that are sent to landfill. Thus, using this estimate mixed waste composting would provide 90-95% diversion of biodegradable material from landfill. However, the process would only divert approximately 60% of the total weight of waste from landfill, as there is no significant effect on the non-biodegradable materials. Source separated composting will use the compost product outside of landfill and thus diversion will be, again, limited to the reject fractions. The biodegradable fraction of the rejects from source separated waste will be limited and be less than 5% of the biodegradable content of the supplied waste. Composting of source separated wastes contributes towards both the recycling and recovery targets. However this will depend on the compost being used in a beneficial way. Under normal circumstances all of the material directed to source separated composting facilities will count towards the recovery and recycling target.

3.7.8 Options for Treatment of Biodegradables – Anaerobic Digestion Technology

The principal biological technology used to recover energy from organic waste is Anaerobic Digestion (AD). AD involves the conversion of biodegradable organic matter to energy by microbiological organisms in the absence of oxygen. The biogas produced in the process is a mixture of methane and carbon dioxide, and can be used as fuel source for heating and/or electricity production. The treatment of waste leaves behind residues, generally in the form of semi-solid or liquor called digestate that can be used as bio-fertiliser.

Whilst previously open windrow and in vessel composting systems were dominant in the treatment of food and garden wastes across Europe, AD has now become the preferred technology in many countries, due to the additional benefit of energy generation that AD can provide.

The following table summarized information concerning anaerobic digestive.

Table 3-75: Anaerobic Digestion (AD)

Technology	Anaerobic Digestion
Concept	Anaerobic digestion (AD) involves the conversion of biodegradable organic matter to energy by microbiological organisms in the absence of oxygen. There are three main stages in the digestion process: • Hydrolysis – conversion of insoluble molecules into fatty acids, amino acids and sugars; • Acidogenesis – conversion of products of hydrolysis into simple organic acids, carbon dioxide and hydrogen; and • Methanogenesis – production of methane. The biogas produced in the process is a mixture of methane and carbon dioxide, and can be used as fuel source for heating and/or electricity production. Varying degrees of cleaning need to be applied to the biogas, depending on its use. The treatment of waste leaves behind residues, generally in the form of semi-solid or liquor called digestate that can be used as bio-fertiliser.
Low solids AD	A low solids digestion system is one that is operated at total solids content of less than 15% and is particularly suited to treating low solid feedstocks such as animal slurries and/or sewage sludge. The feed to the digester could comprise much higher solids content, but fed at a rate that dilutes it down to the operating condition of the digester. Low solids digesters are usually designed so that the contents are completely mixed and may be operated either in the Mesophilic (30 - 40°C) or Thermophilic (50 - 60°C) temperature ranges. Low solids systems are the most common form of AD process. They provide an effective and robust means of treating low solid content waste, or high solid waste that has been adjusted to below 15% total solid content. They are therefore the most versatile, and are able to exploit a variety of wastes, whose quantity and quality may vary seasonally or more frequently.
Dry or High solids AD	A high solids digestion system is one that is operated at total solids content of between 15% and 40% and is particularly suited to treating high solid feedstocks such as municipal food waste. At the higher solids content, the fermenting wastes usually move in plug flow inside the digester. These systems are often operated at thermophilic temperatures, due to the lower water content that provides a favourable heat balance and because bacterial activity is greatly increased - together they lead to a more intense AD process, with higher organic loading rates. Mechanical mixing is generally required to mix the incoming wastes with the fermenting biomass; alternatively, it may be designed with a high recycle rate of the digester content to provide mixing along with the addition of fresh feed, in a controlled manner.
Multi stage AD system	A multi-stage AD system is one that uses two or more digesters in order to optimise conditions for the different populations of bacteria that carry out the different stages of the digestion process. Two-stage systems are most common, where conditions in the first digester are optimized for hydrolysis and acidification (and some degree of acetogenesis), and the second stage being optimised around methanogenesis (with some degree of acetogenesis also occurring).
Commercialization	AD technologies are widely demonstrated, although those at small scale are considered rather expensive for wide scale applications and require effort to commercialise them for wide scale applications
Size per installation	AD can be carried out in small scale systems located at a farm scale and operated by farmers, or in large centralised systems, operated as commercial concerns. The latter deal with a variety of wastes ranging from food wastes from household and C&I premises to livestock slurries from farms within the locality.
Energy recovery	Energy recovery is achieved by combustion of biogas in engines, or upgrading and cleaning the gas for use a transport fuel.
Input/Feedstocks	The types, quality and mix of feedstock are a fundamental aspect of running an AD plant. The design of the digester will often be dictated by the types of feedstock available. Some types of feedstock produce a lot more biogas than others. For example, animal slurries yield relatively little biogas in comparison with silage or food waste.
Feedstock pre-treatment	The type of pre-treatment needed will depend on the feedstock. Food waste from C&I sources may need depackaging. Mechanical treatment may be needed in order to remove contaminant from feedstock, and to reduce particle size and/or mix and condition the feedstock. Chemical pre-treatment can be used to improve the digestibility of the waste stream and to increase biogas yield. A pasteurisation step may be used to increase pathogen destruction. Thermal or biological hydrolysis can be used to pre-treat the feedstock and reduce digester residence time.
Outputs	Biogas, heat, digestate

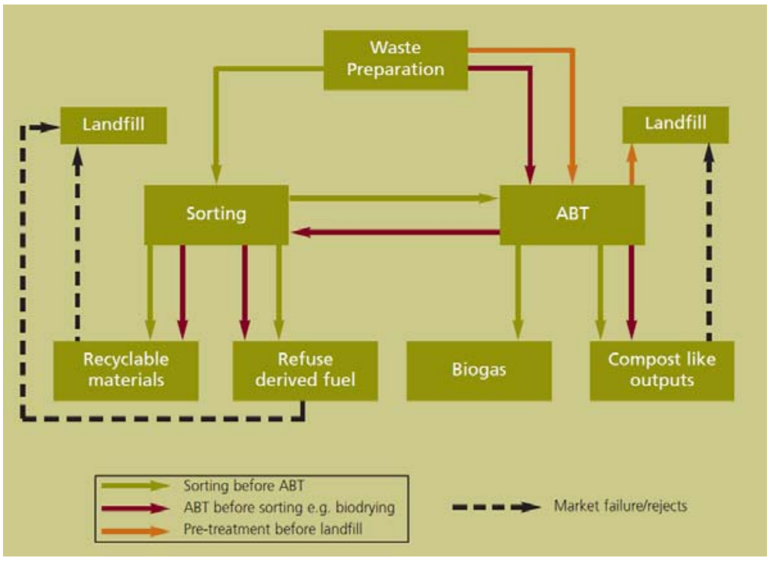
3.7.9 Mechanical Biological Treatment Facilities (MBT plants)

Mechanical Biological Treatment (MBT) is a general term for a combination of mechanical sorting and biological treatment of MSW or similar waste streams, and which may be configured to produce a variety of outputs.

During the mechanical part of MBT, waste particles are reduced in size and/or waste is separated into various fractions based on screens sizes. Specific fractions may be removed e.g. ferrous metals by magnets. The main aim is to remove valuable recyclables, remove materials unsuitable for biological treatment and homogenise the physical and chemical properties of the remaining fraction. The mechanical treatment may involve a wide range of process stages, including manual removal of recyclable materials, screening, shredding, magnetic separation, mixing using conveyors, eddy current separators, drums, shredders, air knives, hammer mills, flays and other size reducing equipment, screening for different sized components and other tailor made systems.

The biological stage may include aerobic decomposition, anaerobic decomposition or both, depending on the process output requirements. Composting in MBT systems typically takes place in in-vessel systems, although final maturation of partially stabilized waste may be carried out in open windrows. A number of factors dictate the composting process including particle size, moisture, temperature and oxygen. An alternative option for the biological treatment stage is AD. These AD systems will produce energy from the biogas that typically offsets much, but not all, of the energy required to operate the MBT facility.

Figure 3-61: Schematic of a potential MBT option



Source: Defra, Mechanical Biological Treatment of Municipal Solid Waste

The following table summarized information concerning Mechanical Biological Treatment Plants.

Table 3-76: Mechanical Biological Treatment (MBT)

Technology	Anaerobic Digestion
Concept	MBT can be a combination of several processes found in other waste treatment technologies such as Material Recovery Facilities (MRF) and composting or AD. MBT is neither a single technology nor a complete solution to waste treatment. The process complements existing treatment infrastructure by leading to improved recycling rates through the extraction of suitable materials from the residual waste stream. In addition, the process may produce a biologically stabilised waste or residues appropriate for end markets (e.g. RDF, SRF, stabilised for landfill disposal or combustion). MBT is used as a pre-treatment to comply with the landfill acceptance criteria or to enhance the calorific value for incineration.
Configurations	The design of the MBT plant can be configured to reflect the final use of the outputs. Six generic MBT configurations are generally considered as operational: - MBT with RDF production and composting; - MBT with RDF production and anaerobic digestion; - MBT with anaerobic digestion and recovery of recyclable fractions; - MBT with biodrying for SRF production; - MBT with rapid composting and recovery of recyclable fractions; and - MBT with biostabilisation.
Commercialization	MBT has provided a substantial contribution to EU waste management practices since the 1990's. There are an estimated 330 major MBT facilities in the EU, mainly in Spain, Italy and Germany
Size per installation	MBT systems are typically modular in design and can be switched from processing mixed MSW to processing source separated organic waste if collection systems change from a mixed waste collection to a source segregated collection.
Input/Feedstocks	Sites processing both mixed/residual MSW and to an increasing extent separately collected bio-waste are often known as "double duty" sites, these sites, are quite diffused across Europe, and may provide a flexible answer to the need to tackle changes in schemes and of local strategy.
Outputs	Assuming inputs of MSW and C&I wastes, the principal outputs from an MBT process are: - Biostabilised' output which can be sent to landfill; - RDF or SRF to be used in energy production; and - Compost-like output (CLO) to be used in land restoration projects

3.7.10 Options for Thermal Treatment of Waste

Conventional combustion

The technology types of conventional combustion encompass those processes where the waste feedstock undergoes complete oxidation in a furnace, releasing heat into the gaseous and solid combustion products. Energy recovery is achieved by using the hot combustion gases to heat water to produce steam, which is then expanded through a steam turbine to generate electricity.

This technology type is well established, with a large number of technology providers offering a wide variety of different furnace configurations. Principle furnace types include:

- Moving grate
- Fluidized bed and
- Rotary kiln

The following table summarizes some general characteristics of the furnace types of conventional combustion.

Table 3-77: Furnace types of conventional combustion

Technology	Combustion in a moving grate furnace	Combustion in a Fluidized bed	Combustion in a Rotary Kiln
Concept	Moving grate technologies are widely used, and in particular for the combustion of Municipal Solid Waste. Waste is fed on to a grate, which uses either reciprocating, rocking, travelling or rolling movement to conveyed the waste through the combustion chamber, and which also transfers the unburned material or ash, out of the chamber. Waste is burned in an excess of air. Primary air is fed through the grate, with secondary air introduced above the grate to create turbulence. Moving grate incinerators are suitable for processing non-homogenous and low calorific value waste streams.	In this technology, waste is suspended and burned in a hot bed of material typically consisting of sand, ash or other inert materials. The fixed bed of fine solids is transformed into a liquid-like state through contact with an upward flowing gas. The hot bed material acts to dry and ignite the waste. It is effective on fuels with relatively low heating values. Historically, fluidized bed technology has been applied to the combustion of a wide variety of fuels, including biomass, MSW, and Commercial and Industrial Waste.	A rotary kiln incinerator consists of rotating combustion chamber, set on a slight incline to the horizontal. The waste is introduced to the kiln at the higher end, with the resulting ash discharged through a grate at the lower end. Temperatures in the kiln can reach 1800°C depending on the application, and the versatility of this technology means that it is often used in the treatment of hazardous and difficult waste streams such as medical waste, sludges and contaminated soils.
Commercialization	Moving grate technology is the oldest form of incineration technology.	Used extensively in Japan for smaller throughputs.	Are widely used for the treatment of hazardous waste, sewage sludge and waste water sludge incineration.
Energy recovery	Steam turbine. Power efficiency up to 30% CHP can reach > 70%	Steam turbine. Power efficiency up to 25% CHP can reach > 70%	Steam turbine. Power efficiency up to 25% CHP can reach > 70%
Inputs/Feedstocks	MSW, RDF, Wood, Hazardous waste, clinical waste. Flexible plants with regards to feedstock requirements.	MSW, C&I. Waste particle size < 200 mm	Industrial and hazardous waste. Flexible technology that can process solids, liquids and sludges.
Feedstock pre-treatment	Pre-treatment is not normally required for combustion in moving grate furnaces. Pre-treatment may simply include the removal of bulky items, and mixing within a waste bunker to homogenise the composition of waste.	Fluidized bed furnaces will generally require material to be of a particular particle size in order to achieve complete combustion and so will require some pre-treatment. This may involve sorting and removal of bulky items and metals. Particle size will be reduced by crushing and/or shredding. It is for this reason that fluidized bed furnaces tend to use RDF and SRF as feedstock.	Pre-treatment of waste is not generally necessary for rotary kiln furnaces although bulky items may need to be shredded.
By products	Bottom ash and Air pollution control residues	Bottom ash and Air pollution control residues	Bottom ash and Air pollution control residues

Advanced Thermal Treatment technologies

Gasification and Pyrolysis processes are collectively referred to as Advanced Thermal Treatment processes or Advanced Conversion Technologies. Gasification refers to the process where a feedstock is heated in the limited presence of an oxidising agent whereas pyrolysis refers to the application of heat to a feedstock in a reducing atmosphere.

Both processes cause the feedstock material to chemically degrade to form a synthesis gas composed of carbon dioxide, hydrogen, carbon monoxide, methane and steam. Furthermore, pyrolysis processes can generate a combination of condensable vapours that, upon cooling, form a mixture of oils, tars and waxes known as pyrolysis oil.

The following table summarizes some general characteristics of the advanced thermal technologies.

Table 3-78: Furnace types of conventional combustion

Technology	Gasification	Pyrolysis
Concept	Gasification is the process of converting solid or liquid feedstock into a partially oxidised gas, known as syngas. Typical temperatures required for gasification range between 500-1800°C. Syngas can be used in a number of ways, including combustion in an engine, boiler or for conversion into a transport fuel.	Pyrolisis is similar to gasification except that the feedstock is thermally degraded in the complete absence of oxygen. Conventional pyrolysis is characterized by low heating rates and long residence times, whereas fast pyrolysis is characterized by very high heating rates and short residence times. There are different configurations of pyrolysis equipment, including fluidized bed, moving bed and rotating cone. The design of the pyrolysis process will impact the on the characteristics of the process outputs.
Commercialization	Gasification has historically been used for the processing of oil, coke and petroleum products but in more recent years attempts have been made to apply the technology to MSW and other waste derived fuels.	Pyrolysis is also a mature technology in terms of its application to coal, peat and liquid fossil fuels, however there is limited examples in its application to waste derivate fuels. There is some experience of slow pyrolysis in MSW, but these still tend to be in development stages, and there are several examples of project failures. Succesful examples of pyrolysis tend to be those plants using homogenous waste streams such as tyres and wood chips.
Energy recovery	Steam turbine, gas engine or gas turbine. Power efficiency up to 23% CHP can reach up to 81% using steam turbine	Steam turbine, gas engine or gas turbine. Power efficiency up to 23% CHP can reach up to 81% using steam turbine
Inputs/Feedstocks	The range of feedstock properties is much narrower than for conventional combustion due to the chemistry and thermo-dynamics of gasification being more sensitive to variations in composition, ash content, moisture content	As with gasification, pyrolysis is sensitive to variations in feedstock characteristics and waste may need an element of processing to ensure it is suitable feedstock.
Feedstock pre-treatment	Non combustibles such as metals and glass must be removed. For some types of gasification system, the particle size will be a critical parameter and therefore will need to be shredded to the required particle size. Moisture content may need to be reduced for some systems. The amount of pre-treatment required means that gasification is suited for integration with a waste treatment technology such as MBT.	Pyrolysis systems may require extensive pre-treatment of the waste stream, depending on the feedstock type and system design. This may involve removing non-combustible materials, shredding or grinding and drying. Pyrolysis systems are also more widely used on homogenous feestocks as opposed to mixed wastes.
Outputs	Syngas can be utilized to generate electricity via boilers, gas turbines or engines	Syngas can be utilized to generate electricity via boilers, gas turbines or engines
By products	Inorganic materials are converted to either bottom ash (low temperature gasification) or a vitreous slag (high temperature gasification)	Gases, predominantly primarily carbon monoxide, hydrogen, methane, CO_2, short chain hydrocarbons Pyrolysis oil comprising low volatile hydrocarbons up to tars and Solid residues (mixture of coke and inert ashes)

3.7.11 Options for Landfilling

Introduction to Landfilling

Although waste disposal is the least preferred option, it still regards a necessary part of an integrated waste management system. The technical requirements for the construction, sitting, operation and aftercare of landfill sites have to conform to the Landfill Directive (1991/31/EC) and the respective national legislation, in order to assure sound environmental and health safeguards. Sanitary landfills provide an adequate high level of environmental protection by a reduced impact (low odours, animals and risk of fire), health risks and a better control over waste; they require a significant degree of engineering in order to configure the site & cells and control emissions.

Initially, suitable candidate locations for a landfill must be sought, that take into consideration requirements relating to:

(a) the distances from the boundary of the site to residential and recreation areas, waterways, water bodies and other agricultural or urban sites;

(b) the existence of groundwater, coastal water or nature protection zones in the area;

(c) the geological and hydrogeological conditions in the area;

(d) the risk of flooding, subsidence, landslides or avalanches on the site;

(e) the protection of the nature or cultural patrimony in the area.

Planning and permitting has to comply with Article 7, containing for example the description of the types and total quantity of waste to be deposited, the proposed capacity of the site, the operation, monitoring and control plan, the methods for pollution prevention and abatement, an impact assessment, a financial security provision, etc. In the design phase, three stages should be considered:

- The construction stage, when barriers and networks for the safe management of pollutants are installed (membranes, lining systems, leachate and biogas collection systems)
- The operation stage, when daily cover of disposed waste takes place, while monitoring the environmental impacts related to waste deposition
- The Closure and aftercare stage, when the application of the top cover takes place for the minimization of the environmental impacts related to the deposited waste. Also, the monitoring of the environmental impacts related to the landfill continues for several years, while activities for the utilization of the site take place (i.e. golf courses, sport facilities)

Bottom sealing

The main component of the landfill is the sealing system, the purpose of which is to minimise or eliminate the negative environmental impact of waste deposit (e.g., infiltration of leachate). The system must be designed so as to meet the necessary conditions for preventing pollution of the soil, groundwater or surface water and ensuring efficient collection of leachate. Protection of soil, groundwater and surface water is to be achieved by the combination of a geological barrier and a bottom liner during the operational/active phase.

The geological barrier is determined by geological and hydrogeological conditions below and in the vicinity of a landfill site providing sufficient attenuation capacity to prevent a potential risk to soil and groundwater. The landfill base and sides shall consist of a mineral layer which satisfies permeability and thickness requirements with a combined effect in terms of protection of soil, groundwater and surface water at least equivalent to the one resulting from the following requirements:

- Landfill for hazardous waste: k ≤ 1,0 x 10^{-9} m/s; thickness ≥ 5 m;
- Landfill for non-hazardous waste: k ≤ 1,0 x 10^{-9} m/s; thickness ≥ 1 m;
- Landfill for inert waste: k ≤ 1,0 x 10^{-7} m/s; thickness ≥ 1 m.

Where the geological barrier does not naturally meet the above conditions it can be completed artificially and reinforced by other means giving equivalent protection. An artificially established geological barrier should be no less than 0,5 meters thick. The bottom sealing consists of the following:

- ground base level and compaction to a 20cm depth
- Layer of 0,5 m of compacted non permeable clay, with permeability coefficient of k≤1,0x10^{-9} m/s. The geological barrier will be compacted with a vibrating roller, assuring a surface as smooth as possible.
- Watertight HDPE membrane, 2 mm thick placed over clay layer;
- Protective geotextile of 500 g/m^2, thickness of 2,5 mm, in order to prevent any damage of geomembrane by coarse particles of the drainage layer;
- Leachate drainage layer of minimum 0,5 m, placed above the geotextile, with drainage pipe system for collection and transport of leachate towards the leachate treatment facility.

In case that there is no source of impermeable clay with the set permeability characteristic at close distance, there are two options for consideration:

a) The excavated clay or clay soil will be mixed with bentonite on the site, or

b) The excavated soil will be compacted to form a layer of 50 cm and on top of this a geosynthetic clay layer (GCL) will be laid.

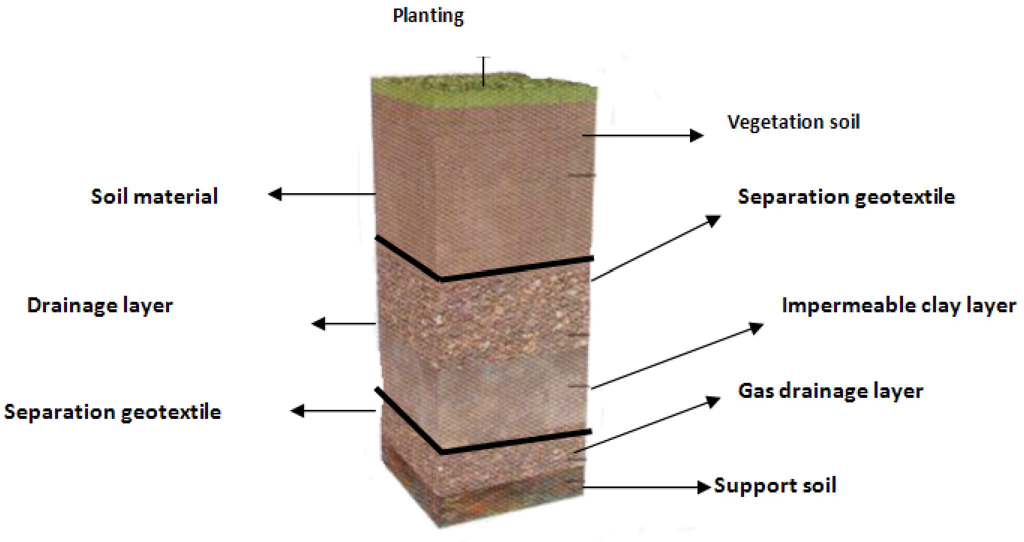
Geotextiles are used for protection of the polymer liner against tear and wear during the installation works and against damages from particles in the drainage layer. The geotextile shall be a non-woven geotextile of UV-stable polypropylene, polyethylene or polyester capable of resisting exposure to the sun for minimum two years. The weight of the geotextile shall be indicatively 500 g/m^2.

<u>Final cover</u>

After the cell is filled, it has to be covered with a final surface sealing in order to prevent any impact on public welfare and the environment. Construction of the final surface sealing system consists of (from the bottom up):

- Support compacted soil layer of 0,20 m thickness
- Gas drainage layer made of gravel material 8/32 mm 0,30 m thickness with k >1x10^{-4}
- Separation geotextile (recommended), 200 g/m^2
- Impermeable clay layer of a minimum thickness of 0,50 m and k< 5x10^{-9} m/s. Alternatively, a Geosynthetic Clay Liner can be laid, having an equivalent permeability value
- Rainwater drainage layer made of granular materials of minimum thickness 0,50 m and k > 1x10^{-3} m/s. Alternatively, an artificial drainage layer can be laid, achieving an equivalent permeability value
- Separation geotextile (recommended), 200 g/m^2
- Top soil cover of a 1,0 m thick, of which the upper 0,30 m layer is vegetation soil.

Figure 3-62: Construction of top cover layers



Flood protection

Flood protection works are constructed in the site, in order to avoid storm water entering the landfill and mixing with waste and leachates, structural stability of landfill and protect the buildings and the roads from water erosion. Rain water must be drained and diverted outside the landfill. The flood protection works of the site consist of the following:

- Ditches in the perimeter of the landfill cells
- Ditches for the protection of facilities and embankments
- Ditches for the protection of internal road network
- Drainage well of ditches and sewers.

Leachate collection

The formation of leachate in a sanitary landfill is mainly caused by the percolation through the waste mass of water from precipitation. In contact with the decomposing waste, it becomes loaded with various substances and degradation products and moves slowly to the base of the landfill.

Leachate collection is done at the landfill bottom via perforated leachate pipes HDPE preferably DN310 or higher. The inclination of the landfill base must ensure safe leachate drainage to the lowest point. Leachate wells are placed periodically, in order to ensure easy maintenance and cleaning (flushing) of the pipes. The leachate is directed to the leachate treatment plant.

Auxiliary facilities

The landfill must be equipped also with a number of auxiliary facilities for its proper operation. These include:

- Main entrance
- Fencing
- Security house
- Weighbridge
- Tyre wash

The sanitary landfill site will be entirely fenced. The security house is located next to the main entrance of the facility and is equipped with the necessary electronic equipment for control.

After passing the entrance gate, incoming vehicles pass from the weighbridge for recording and weighing. The incoming trucks will be directed to the unloading areas.

Before leaving the site and entering the public roads, all vehicles will undergo tyre cleaning. The purpose of the wheel washing system is to wash the tyres of transportation vehicles from mud and waste residues. The washing water contains a disinfectant solution.

Buildings

A. Administration: this building serves the project administration, the personnel and the visitors. Next to it, parking area for personnel and visitors is envisaged.

B. Maintenance: The building is planned to cover the maintenance and lubricating purposes of the trucks and other mechanical equipment. For the proper operation of the project, a fuel station to serve mobile equipment is proposed.

C. Washing facility for vehicles: it serves the purpose of washing of collection vehicles and mobile equipment.

D. Garage – parking space for vehicles.

E. Energy Building: it will host Transformer, Emergency Power Generator and Electric Panel rooms. It can be also "kiosk" type.

Leachate treatment

Once collected, the leachate has to be treated and discharged according to regulations. Possibilities for leachate treatment can include:

- Preliminary treatment of leachate with recirculation to landfill and disposal to the municipal sewer system.
- Full treatment and discharge to the nearest surface water recipient

The second option allows discharge of wastewater into a local water body. The first option requires the wastewater to be transported to a connection point where it can be inserted into the sewer system. This transport may be done by a pipe line or a truck.

A range of technologies have been applied for leachate treatment, including (i) biological methods (ii) physical and iii) chemical methods (see Table 5). However, in order to meet stricter quality standards allowing treated leachate to enter a surface acquifier, a combination of chemical, physical and biological steps, would be required.

Table 3-79: Leachate treatment technologies

Treatment	Applicability (removed components)
Physical treatment processes	
Air stripping	Methane stripping – the use of diffused air to strip out or reduce the dissolved methane content of leachate is commonly used. Ammoniacal-N removal – is depended on pH and temperature, to be effective it may be necessary to raise the pH and heat the leachate. Stripping of other volatile contaminants – is dependent on the contaminants present and is unlikely to remove all contaminants completely
Reverse osmosis	Has been used to treat leachate in a number of European countries. The reverse osmosis process generates a high quality effluent.
Solids removal	Sedimentation and Settlement – this is currently the most common method of reducing the suspended solids content of leachate. If the particle sizes are colloidal it may be necessary to add a flocculent.

Treatment	Applicability (removed components)
Physical treatment processes	
	Sand filtration – Occasionally used if the solids are very fine or colloidal. Sand filtration has a high initial capital cost and requires a high degree of control. Dissolved air flotation – This is sometimes used when available land does not allow the construction of settlement tanks. Leachate usually requires conditioning prior to treatment and there are high capital costs associated with this method of treatment.
Activated carbon adsorption	Powdered activated carbon (PAC) – Is sometimes used as an absorbent particularly for the removal of organic compounds in the final polishing after biological treatment, however the consumable costs can be high. Granular activated carbon – has the same uses but may be generated and although its use is associated with higher capital costs than PAC the operational costs may be lower than those for PAC.
Ion exchange	Resins typically made of synthetic organic material remove ions from solution by the exchange of anions or cations. The very high concentrations of anions and cations within leachate means that the use of this process is currently limited.
Evaporation/concentration	This process can be used to dispose of concentrates from the reverse osmosis process but is currently not very common.
Chemical treatment processes	
Chemical oxidation processes	Ozonation – ozone is sometimes used to oxidise complex organic constituents that do not easily biodegrade. It is also used as a sterilising agent. Ozone is highly toxic and requires rigorous implementation of safety procedures. Hydrogen Peroxide – hydrogen peroxide has been principally used to oxidise sulphide. It can also be used to treat phenols, sulphite, cyanide and formaldehyde. As a strong oxidising agent it should be stored and handled with care.
Precipitation/coagulation/ flocculation	Chemical precipitation of metals – Heavy metal concentrations in leachate from landfills accepting primarily domestic waste tend to be low when compared to raw sewage and can be reduced using oxidation and normal settlement processes. Consequently chemical precipitation is not widely used. Coagulation and flocculation – Flocculants can be used to remove particles that do not readily settle out. It is currently rarely applied in the UK to raw leachate treatment and only occasionally to biological retreated effluents.
Aerobic biological treatment processes	
Suspended growth systems	Aerated lagoons – These are generally effective for only relatively dilute leachate. Low water temperatures during the winter can reduce performance. Activated sludge – Is the most widely used aerobic biological process. It can provide a high degree of treatment for high strength leachate. Sequencing batch reactors (SBRs) – This uses the principles of activated sludge but with the biological treatment and final settlement all taking place within the same vessel. Tank based systems are less effected by seasonal temperature variations. Membrane bioreactors (MBRs) – This is an advanced form of the traditional activated sludge process that uses a membrane to capture the solids in preference to gravitational settlement.
Attached growth systems	Percolating filters – This process is rarely used for leachate treatment. Rotating biological contactors – Have been used historically in the UK for leachate treatment. However they can suffer from the problems associated

Treatment	Applicability (removed components)
Physical treatment processes	
	with percolating filters in that high concentrations of metals particularly iron can adhere to the media inhibiting biological activity. Biological aerated filters / submerged biological aerated filters – These are occasionally used for treating leachate but are susceptible to toxic materials adhering to the media inhibiting biological activity. Biofilm reactors – These are high rate reactors capable of high carbonaceous removal.
Anaerobic biological treatment processes	
Upflow anaerobic sludge blankets	Upflow Anaerobic Sludge Blankets (UASB) – This system is not very common.
Aerobic/ Anaerobic biological treatment processes	
Engineered wetlands	Horizontal flow reedbeds – Frequently used to provide tertiary treatment to reduce Biochemical Oxygen Demand and solids. Vertical flow reedbeds – These require less land area than horizontal flow reedbeds and are more efficient at reducing ammonia. Wetland ponds – Pond systems can combine gravitational settlement, gravel filters and marginal plants that can provide tertiary treatment.

The hydraulic load, m^3/day, of the leachate treatment system is calculated from meteorological data and the surface of landfill cell. To this, the other sources of wastewater (washes, etc) are added. In particular, sanitary wastewater (personnel sewage) and washes from vehicle cleaning will be pumped via a standard prefabricated PE pumping pit also to WWTP, as the WWTP is compatible with any kind of biodegradable wastewater. At the same time it will provide with a source of phosphorous. In case that the length of pipe is uneconomically long, sewage can be alternatively temporarily stored in septic tanks and emptied periodically by trucks.

Landfill gas collection and treatment

Landfill control systems are employed to prevent unwanted release of landfill gas into the atmosphere or soil. Recovered landfill gas can be used to produce energy or to be flared under controlled conditions to eliminate the discharge of greenhouse gases to the atmosphere.

Landfill gas is composed of a number of gases, but mainly methane (CH_4) and carbon dioxide (CO_2) at approximate percentages of 55% and 45% respectively. It also has other minor components such as hydrocarbons, hydrogen sulphide (H_2S), ammonia (NH_3), oxygenated and halogenated organic compounds. The principal gases are produced from the decomposition of the organic fraction of MSW. The landfill gas management system consists of the following:

- Gas extraction wells
- Gas collection and transmission system including pipe work, dewatering unit and gas sub-station
- Flare system (including gas booster).

The gas extraction system contains numerous gas wells and gas pipes to the collection stations (containers) with the gas collections beams from which the gas will be led to the flare to be finally burned. The flare shall be a closed-type, allowing high efficiency with combustion at least at 1.000 °C and 0,3 s residence time to ensure compliance with the emission regulations. In this case the estimated peak gas quantity for landfill is 400 m^3/h. The gas flare must be designed with a 15-20%

safety factor, as well as to allow combustion of variable gas flow rate at a typical ratio 1:5 or 100 - 500 m^3/h.

During the first five to eight years of operation, the landfill gas will be flared, as the landfill gas production is too poor in quantity and quality to be used for energy production purposes. After the amount and quality of the landfill gas is stable, corresponding studies may be carried out in order to test the feasibility of installing a landfill gas conditioning unit and a unit for co-generation of heat and electricity.

Figure 3-63: Sample landfill gas treatment facility at landfill

Design Considerations

Landfill design requires a significant degree of engineering in order to shape the cells, control emissions and minimize potential environmental effects. In the design phase, three stages should be considered:

The construction stage, when barriers and networks for the safe management of pollutants are installed (membranes, lining systems, leachate and biogas collection systems)

- The operation stage, when daily cover of disposed waste takes place, while monitoring the environmental impacts related to waste deposition
- The Closure and aftercare stage, when the application of the top cover takes place for the minimization of the environmental impacts related to the deposited waste. Also, the monitoring of the environmental impacts related to the landfill continues for several years, while activities for the utilization of the site take place (i.e. golf courses, sport facilities)

The successful operation of the landfills depends on:

- Good sitting: the location of the landfill should be selected according to technical, financial, regulatory, political environmental and social criteria.
- Consideration of the following parameters:

- Bottom liner
- Leachate collection/treatment system
- Landfill gas collection/utilization/combustion system
- Top cover
- Environmental monitoring features
- Rainfall / storm water management measures
- Onsite facilities

- Good operation of the landfill: including compaction of the waste and daily coverage and waste building in cells in a systematic and well-organized way as well as monitoring of the necessary environmental parameters.

Figure 3-64: Illustration of a landfill setup

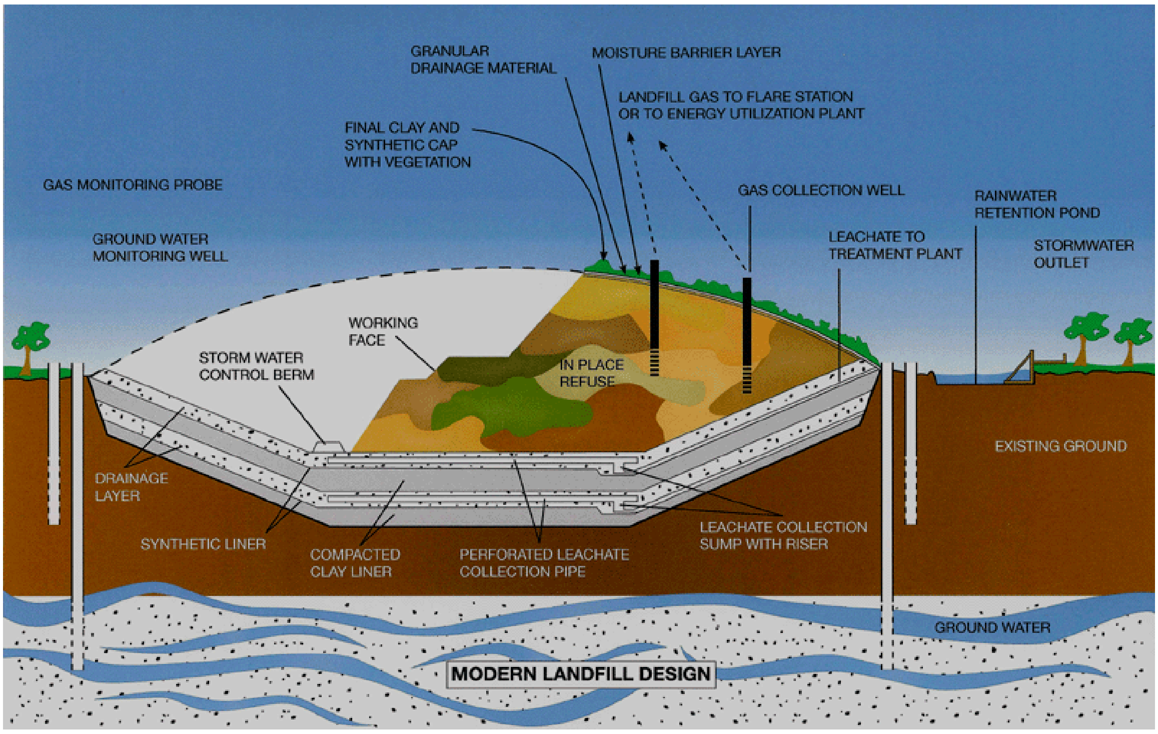


Figure 3-65: Modern Landfill scheme

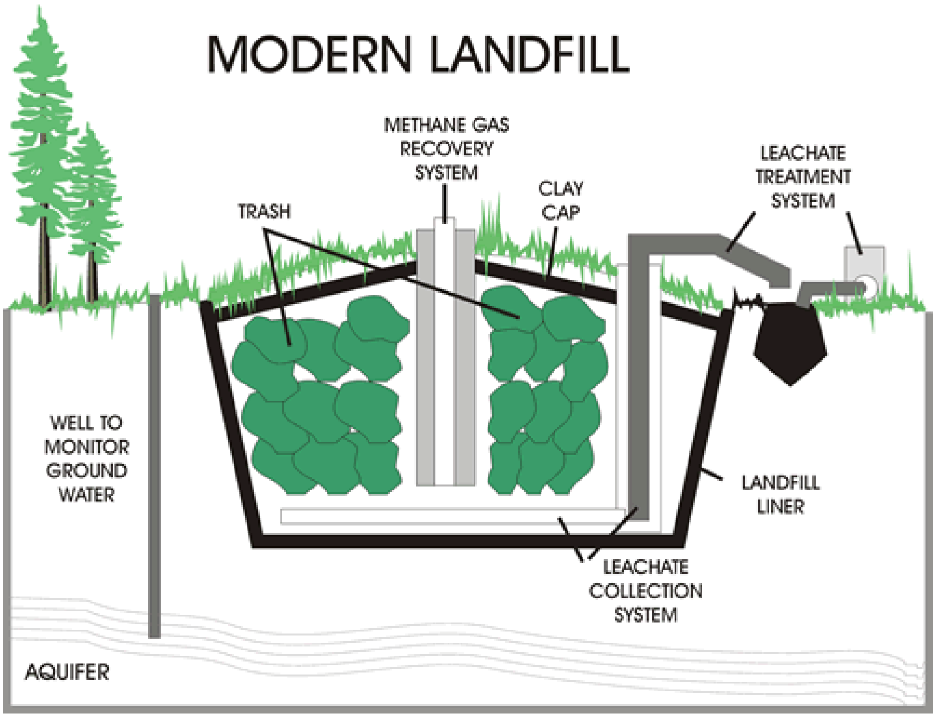


Figure 3-66: Monitoring intersection scheme

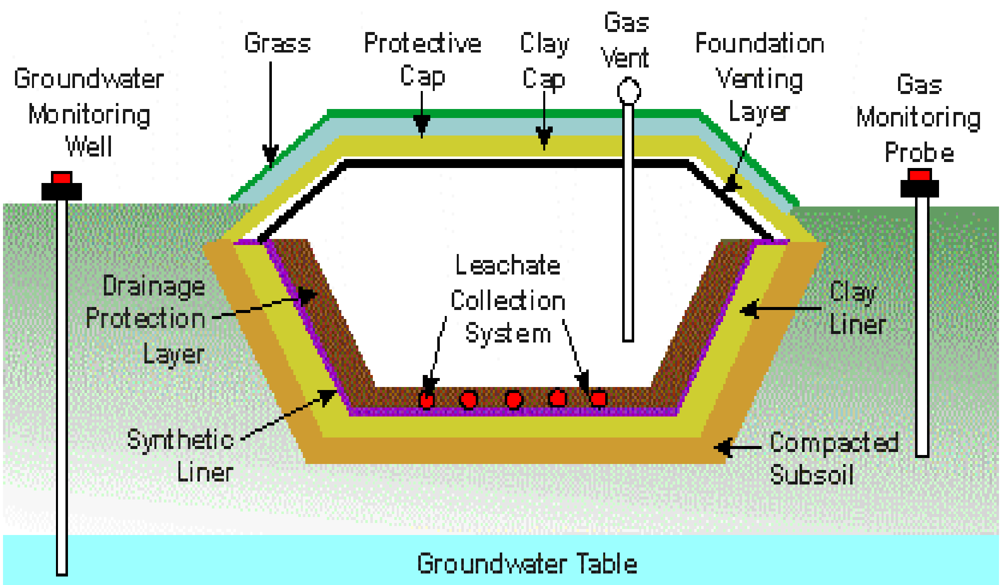
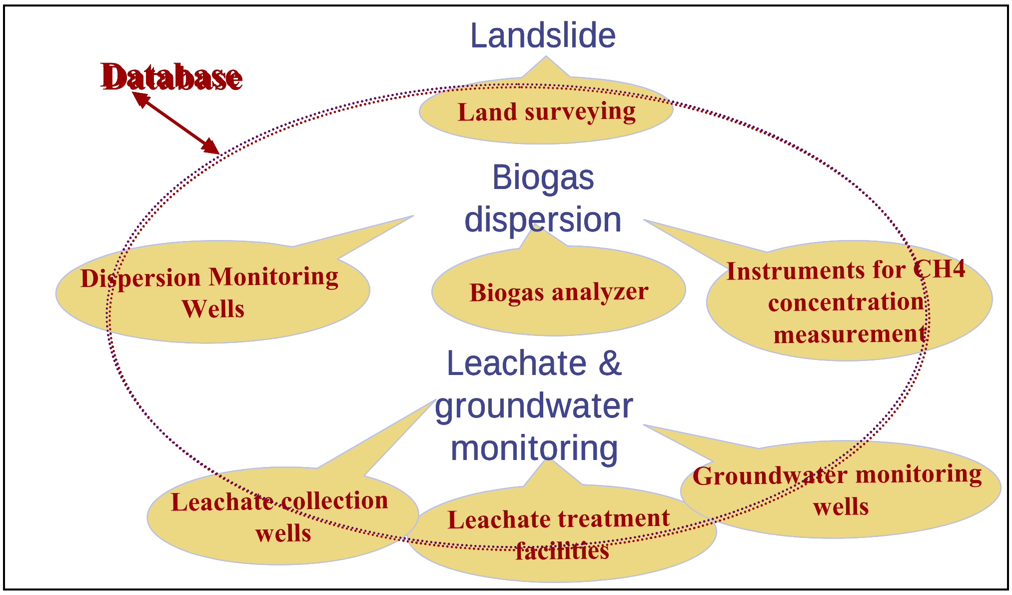


Figure 3-67: Environmental monitoring of landfills

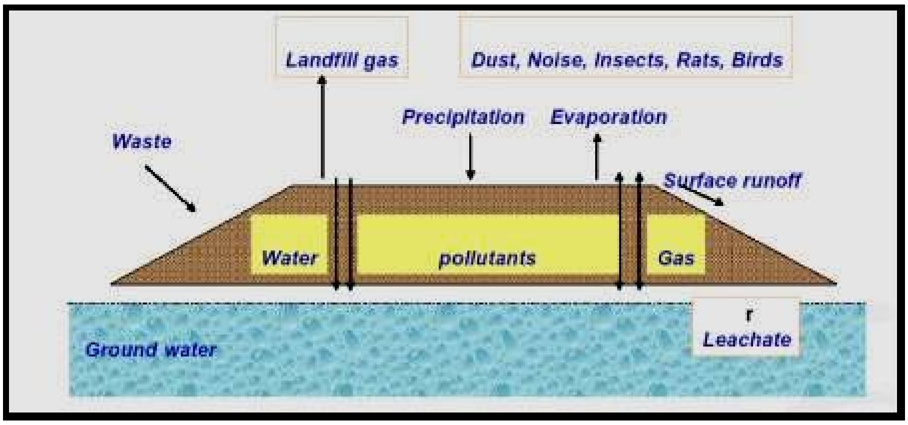


Landfill closure and aftercare: using the following methods:

- Top cover technology
- Macro – encapsulation
- On site secure land burial
- Landfill mining
- Extraction and off site treatment

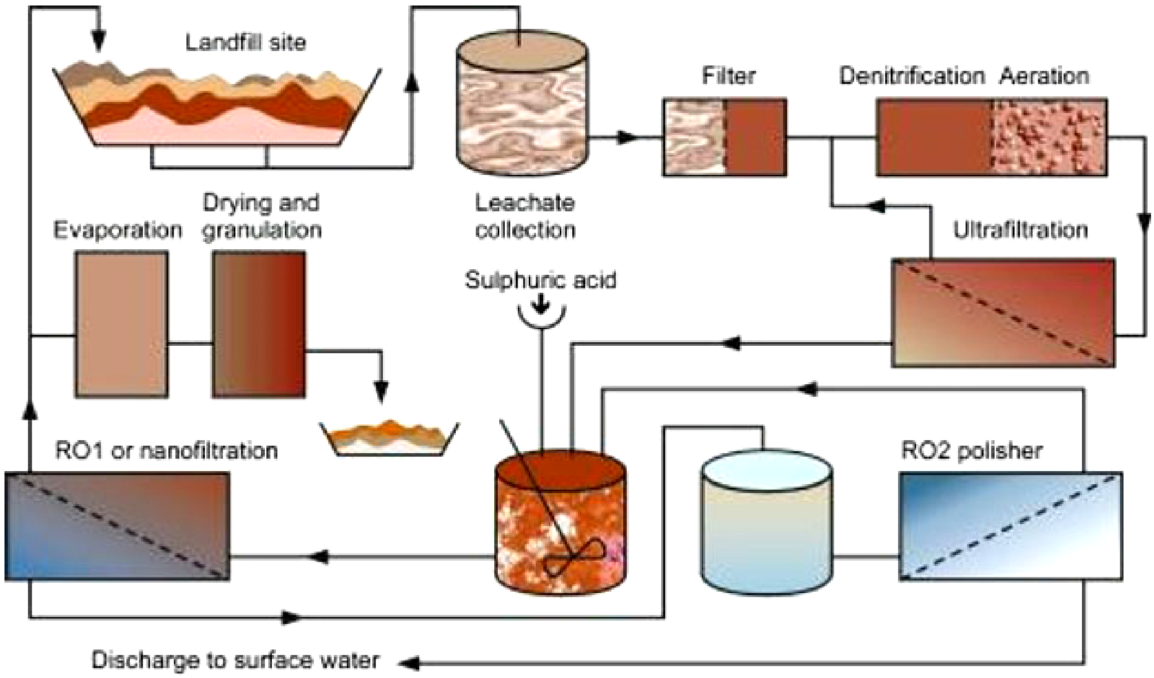
The following scheme indicates the main forms of environmental pressures related to landfills

Figure 3-68: Environmental impacts related to landfill



Special emphasis should be given in the collection and treatment of leachate and biogas. The alternative treatment routes for leachate include:

Figure 3-69: Leachate treatment

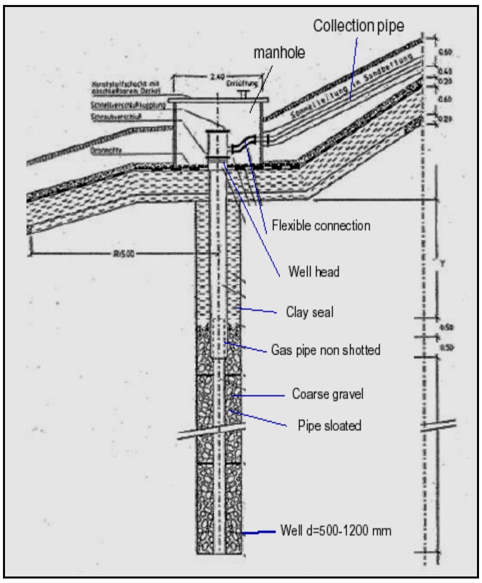


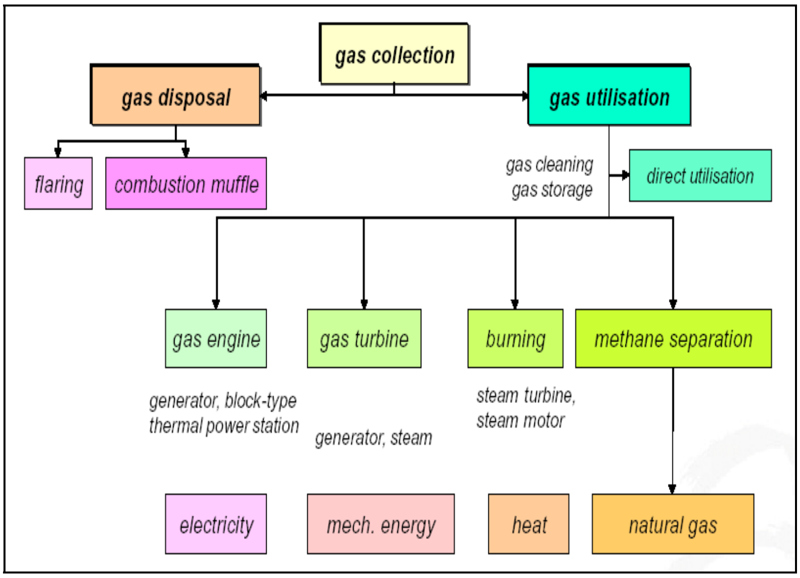
Typical problems related to the generation of the landfill gas include:

- Methane contributes 21 times more than carbon dioxide to greenhouse effect and climate change
- Methane is flammable at concentrations between 5 and 15% in air, potentially leading to fire and explosion risks if allowed to accumulate in confined spaces
- Landfill gas is odorous and corrosive

The biogas may also be utilized for the recovery of energy or disposed via combustion, as follows:

Figure 3-70: (a) Biogas collection and (b) Biogas utilization





Significant environmental impacts are also connected to the transportation of the waste to the landfills by heavy trucks.

3.7.12 Options for Landfill Restoration

Regional waste management approach envisages closure and remediation of all MSW landfills and dumpsites which pose danger to environment and health and safety of general population and does not fulfil technical and legal requirements for waste disposal facilities.

Optimal closure and remediation approach should provide long term protection of environment around waste disposal facility with minimal costs and resources engaged. In general terms the remediation measures should prevent, further contamination of the surface and groundwater, prevent soils direct and indirect pollution, prevent direct contact with disposed waste materials and prevent air pollution through sequestration of landfill gas after the waste disposal facility closure. In general closure and remediation approach of existing MSW landfills and dumpsites is based on Environmental Risk Assessment procedure and goals set. As explained in the chapter above, Environmental Risk Assessment procedure was associated with each of the waste disposal facilities identified, includes evaluation of source parameters, pollutants pathways and receptors influenced.

According to the national regulations (Rulebook on technical conditions for the landfills constriction, Official Gazette of R. of Macedonia, No.78/2009) and best engineering practices in Europe, existing landfills are usually capped in order to prevent contaminated material from leaving the area and to prevent human or animal contact with the contaminated materials.

Capping could include: surface armouring, soil/clay cover, soil enhancement to encourage growth, geo-synthetic or asphaltic cover system, polymeric/chemical surface sealers, revegetation, concrete and synthetic covers. The cost of caps can range from low (e.g., planting grasses) to high (e.g., synthetic caps) depending on the cap selected. The cap may or may not be effective in achieving multiple performance objectives, for example; a cap designed to minimize erosion, however, may not be an effective cap to minimize infiltration and vice versa. Usually the capping require landfills surface and slopes reshaping in order to provide necessary conditions for cap construction. In some cases this could involve significant earthworks and increase the remediation costs. General requirements for capping are summarized in the table below.

Table 3-80: General requirements for landfills/dumpsites capping

Gas Drainage Layer	Obligatory for landfills with capacity above 100000 m^3
Synthetic Impermeable Layer	Not obligatory
Mineral impermeable layer	Obligatory
Drainage Layer – 0,5 m	Not obligatory
Reclamation layer of soil and humus ≈ 1,0 m	Obligatory

Based on the legal requirements and specifics of each of the waste disposal facility identified, remediation will in general include following activities:

- reshaping of the landfill in order to assure long term slope stability and provide for capping construction;
- construction of surface waters capture and sequestration system;
- construction of gas drainage system (if needed);
- construction of impermeable capping (layer of clay/bentonite mats);
- construction of ground masses for reclamation layer;

In most cases and especially for the landfills assessed to pose high risks, additional site investigations are necessary in order to define optimal closure and remediation approach. Those investigations should in general include:

- precise site survey in order to define exact shape, area and volume of the landfill and provide basis for future engineering design of remediation activities;
- hydrological and hydrogeological investigations in order to determine surface and ground water quality and quantity as much as ground water levels and flow directions in the landfill and surrounding area;
- determination of soil quality and substrate (rock base) through sampling and excavation;
- assessment of gas emissions and need for their treatment;
- development of full monitoring program in the landfill area including sensitive receptors.

Small landfills or dumpsites, without any engineering or other control measures for environmental protection are usually created in areas where no organized waste collection services are available or unknown perpetrators trying to avoid disposal costs. Although small in size (area and volume) due to different types of wastes sometimes including biological waste, chemicals or even industrial wastes (sludge’s) they can pose great risks to surrounding environment.

The main environmental risks from uncontrolled dumpsites include but are not limited:

- pollution of the surrounding areas from the water leachate and wind dispersion of light waste fractions;

- pollution of surface waters in the vicinity of the landfill by direct disposal of waste and / or contaminated landfill leachate;
- contamination of groundwater;
- direct contact with dangerous waste materials.

Therefore unregulated dumpsites should be closed as soon as possible for obvious environmental reasons. But in order to avoid further generation, a proper collection services should be in parallel extended to all settlements and use of the containers encouraged through visibility and support programs. In the meantime programs for monitoring of the surrounding environment and tracing the origin of unregulated waste disposal should be reinforced.

Due to small quantities, unregulated dumpsites are usually cleaned and waste collected is disposed according to legal requirements. In general closure process or cleaning involves:

- removal of all waste including contaminated soil below the dumpsite;
- disposal of the waste and contaminated soil at MSW landfill in line with legal requirements or at the landfills under the closure process;
- rehabilitation of the dumpsite area (reshaping, re-vegetation).

Closure and Remediation approach

Having in mind technical requirements and best engineering practices, as much as the identified landfills and dumpsites specifics, two distinct types of closure and remediation approaches are proposed;

⇒ The first one is securing waste "ex situ" and assumes cleaning of the site (removal of the waste and contaminated soil) and disposal of the waste at appropriate landfill according to legal requirements.

⇒ The second is securing the waste "in situ" and assume capping the waste with appropriate infrastructure to provide long term environmentally safe storage of the waste. This approach includes two options, capping with and without construction of gas drainage systems.

Selected closure and rehabilitation approaches (models) for different types of landfills and dumpsites are summarized in the table below.

Table 3-81: Summary of closure and rehabilitation approaches (models)

Closure&Rehabilitation approach ID	Type	Application	Description
CR model A – Site cleaning	Ex situ	For small landfills and dumpsites < 5000 m^3 ranked as a low, medium and high risks	Excavation and re-deposition of the waste and contaminated soils on the municipality landfill in whose territory they are.
CR model B – capping without gas collection	In situ	For landfills marked as low and medium risks and volume up to 100000 m^3, ranked as medium and high risks	Construction of capping layer, soil cover and surface water control systems (diversion channels)

CR model C – capping with gas collection	In situ	For landfills ranked as high risks and volume above >100000 m^3 and medium and high risk and volume above >500000 m^3.	Construction of capping layer, soil cover, gas collection systems and water systems (diversion channels)

As mentioned, selection of remediation approach of MSW landfills and dumpsites identified is based on individual Risk Screening procedure and goals set. However data at this stage are only indicative and final selection of closure and rehabilitation approach especially for high risks landfills and dumpsite can be performed only after additional investigations (geotechnical data, soils and groundwater), which are not within the scope of this project.

Closure and Remediation Model "A" – Site cleaning

Closure and Remediation Model "A" or site cleaning is applicable for remediation of small dumpsites with a approximate volume up to 5000 m^3. Complete removal of waste material and contaminated soils below and around the dumpsite can have significant benefits, including:

- fast removal of pollution sources and prevention of further pollution of affected areas;
- fast recovery of land for alternative use;
- cost efficiency (reduced closure and aftercare costs).

This approach can be applied to all landfills and dumpsite regardless of risk ranking (high, medium and low risk) and in all time plans (long, medium and short term). The only limitation is the volume of waste disposed.

Closure and remediation activities for this model are very basic and include:

- removal of disposed waste which in current pricing conditions, can be performed with a bulldozer/front end loader or excavator at a cost price of 1,5 EUR/m^3;
- waste ttransport and re-disposal to existing municipality landfill (distance up to 50 km) at a cost price of 15 EUR/m^3;
- waste compaction with roller at cost price of 1,1 EUR/m^3;
- re-vegetation (grassing) on areas cleared of waste at cost price of 0,6 EUR/m^2;

Closure and remediation Model "B" – capping without gas collection

This approach is t is proposed for remediation of landfills with disposed waste volume up to 100000 m3, and ranked as medium and high risk sites and in all time plans (long, medium and short term). This approach assumes construction of capping system with following components/layers;

⇒ the surface layer, at least one meter thick, and the upper layer 0,4 m containing organic matter (humus) are suitable for grass ;

⇒ separator usually geotextile 400 g/m^2);

⇒ mineral drainage - minimum 0,5 m (gravel, min. $\kappa > 10^{-4}$ m/s);

⇒ sealing or impermeable layer (2 x 25 cm mineral insulation with min. $\kappa > 10^{-9}$ m/s or equivalent bentonite mat);

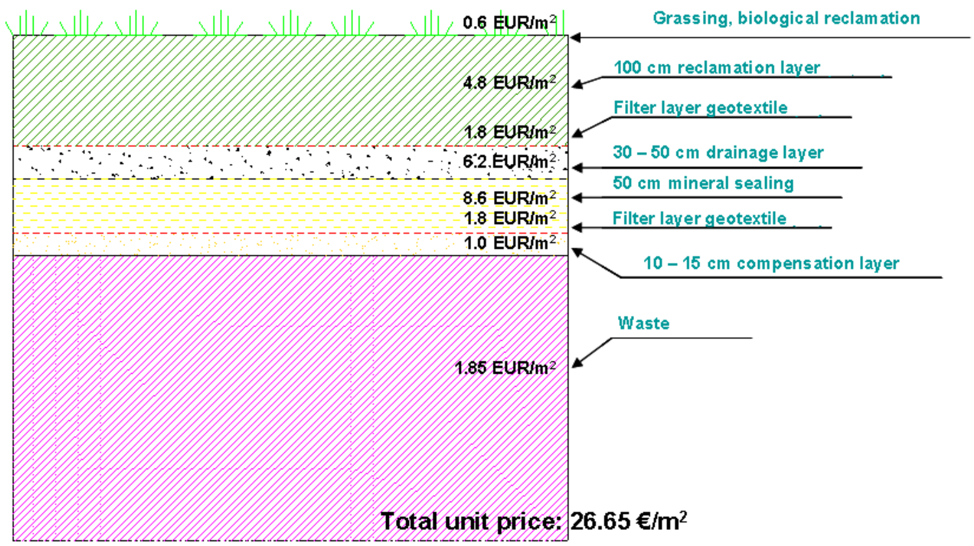
⇒ gas drainage and gas collection layer (gravel);

⇒ household waste.

Closure and remediation activities for Model B with associated cost estimation are presented bellow;

- profiling of waste deposited, spreading and leveling with a bulldozer at cost price of 1,85 EUR/m^2;
- laying leveling layer of ground masses with thickness 0,1 – 0,15 m at cost price of 1,0 EUR/m^2;
- laying the geotextile separator (300 - 400 g/m^2) at cost price of 1,80 EUR/m^2;
- construction of mineral layer (compacted clays 0,5 m or 2 × 25 cm thick, k = 1×10^{-9} m/s) at cost price of 8.6 EUR/m^2) or hydro geomembrane (at cost price of 10,50 EU/m^2);
- laying drainage layer of washed river gravel fraction 12/35 for removal of infiltrated water with k>10^{-4} m/s (0,5 m) at cost price 6,2 EUR/m^2;
- laying geotextile separator (300 - 400 g/m^2) at a cost price of 1,80 EUR/m^2;
- construction of remediation layer with thickness of 1m at cost price of 4,80 EUR/m^3;
- landfill monitoring (for landfills with volume of deposited waste above 15000 m^3);
- biological remediation of landfill-grass (at cost price of 0,6 EUR/m^2 with cultivation activities), construction of protective belts (at cost prices of 1,2 EUR/m^2).

Figure 3-71: Capping cross section with cost estimation for C&R model "B"

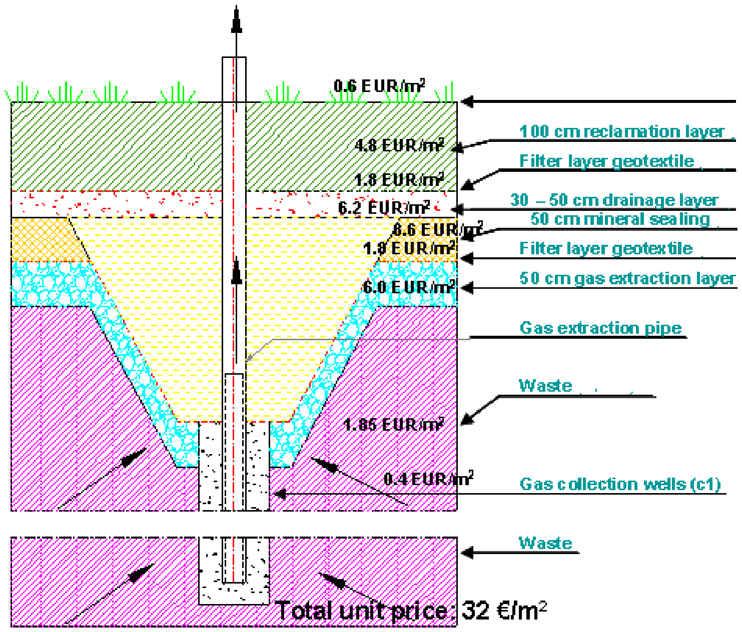


<u>**Closure and remediation Model "C" – capping with gas collection**</u>

Model C approach is proposed for remediation of landfills ranked as a high risk and waste volume above 100000 m^3 in a short time plan. It is also applied for landfills with significant volume of disposed waste (above 500000 m^3) and medium and high risks in a short term. Closure and remediation activities for Model C with associated cost estimation are presented bellow;

- profiling of deposited waste, spreading and leveling with a bulldozer at cost price 1,85 EUR/m^2;
- laying leveling layer of ground masses with thickness of 0,1 – 0,15 m with cost price of 1,0 EUR/m^2
- construction of gas drainage system (drainage blanket of gravel) at cost price of 6,0 EUR/m^3;
- construction of gas drainage and gas venting system:
  - for flaring of the captured gas emissions from landfill (model C1 - used for landfills with volume of deposited waste from 100000 to 500000 m^3) – 120 EUR/m;
  - for utilization of landfill gas emissions (model C2 - used for landfill volume of waste disposed of over 500000 m^3) at cost price of 60 000 EUR;
- laying of geotextile separator (300 - 400 g/m^2) at cost price of 1.80 EUR/m^2);
- construction of mineral layer (compacted clays 0,5 m or 2 × 25 cm thickness, k=1×10^{-9} m/s) at cost price of 8.6 EUR/m^2) or hydro geomembrane (at cost price of 10,50 EUR/m^2);
- laying drainage layer of washed river gravel fraction *12/35* for removal of infiltrated water with k > 10^{-4} m/s (0,5 m) at cost price 6,2 EUR/m^2;
- laying of geotextile separator (300 - 400 g/m^2) at cost price of 1,80 EUR/m^2;
- construction of remediation layer with thickness of 1 m at cost price of 4,80 EUR/m^3;
- biological remediation of landfill - grass (at cost price of 0,6 EUR/m^2 with cultivation activities), construction of protective belts (at cost prices of 1,2 EUR/m^2);
- landfill monitoring (for landfills with volume of deposited waste above 15000 m^3).

Figure 3-72: Capping cross section with cost estimation for C&R model "C"



After care and monitoring

International best practice requires proper after care and monitoring of closed landfills. Aftercare measures are usually focused on vegetation support and occasional facilities maintenance (channels cleaning) and in case on proper design and construction those activates are minimal. On the other side, and in order to assure environmental performance of remediation measures, long term monitoring programs are planed involving periods of minimum 30 years after the landfill closure. Monitoring programs should involve all environmental media under risk, including air, soils, and ground and surface waters.

In general, monitoring programs may involve all or some of the following activities;

- runoff quality and quantity monitoring,
- leachate and quantity monitoring,
- surface water quality,
- ground water (including of site),
- gas emissions (quality/content and quantity)
- slopes stability (survey of slope inclination and shape)

Estimated average monitoring costs for models B and C are summarized in the table below.

Table 3-82: Average after care monitoring program costs

Model B			Model C		
Monitoring activity	**Cost(€)/year**	**Total (€) for 30 years**	**Monitoring activity**	**Cost(€)/year**	**Total (€) for 30 years**
Runoff Q/Q	500	15000	Runoff Q/Q	500	15000
Leachate Q/Q	/	/	Leachate Q/Q	1000	30000
Surface water Q/Q	500	15000	Surface water Q/Q	500	15000
Ground water Q/Q	500	15000	Ground water Q/Q	500	15000
Gas emissions	/	/	Gas emissions	1000	30000
Slope stability	500	15000	Slope stability	500	15000
TOTAL	2000	60000	TOTAL	4000	120000

Urgent measures for MSW landfills

In order to reduce environmental impacts until closure and remediation operation are started and fill the data gaps necessary for proper design of closure and remediation measures of high and medium risks landfills, a set of urgent measures are proposed. Urgent measures for MSW landfills include:

- development and launch of monitoring programs;

- complete construction or restoration of fences around landfills;
- permanent entrance control in the active landfills area;
- placing warning signs for forbidding: waste incineration, landfilling outside designated areas;
- marking the landfills approach with warning signs for permitted waste disposal;
- informative campaigns for general population of unauthorized access (outside the specified time for disposal) to active landfill.

Monitoring programs for data gaps filling, will generally involve similar parameters as after care monitoring;

- runoff quality and quantity monitoring,
- leachate and quantity monitoring,
- surface water quality,
- ground water (including of site),
- gas emissions (quality/content and quantity)
- size survey.

The costs are estimated based on landfill size as follow:

Table 3-83: Monitoring for data provision

	Landfill volume (m^3)		
Monitoring activity	**15000 to 100000**	**100000 to 500000**	**>500000**
Runoff Q/Q	2000	2000	3000
Leachate Q/Q	2000	4000	6000
Surface water Q/Q	2000	2000	6000
Ground water Q/Q	2000	2000	3000
Gas emissions	2000	4000	6000
Slope stability	2000	4000	4000
TOTAL in €	12000	18000	28000

Closure and remediation for dumpsites in Southwest region

Summary of closure and remediation approach and associated cost estimation for landfills and dumpsites in Southwest region is given in tables bellow. All landfills and dumpsites are grouped according to closure and remediation model selected.

Based on site visits and risk screening data, Model A (site cleaning) in medium term should be applied for following dumpsites in Southwest Region: RAIL001, RAIL002, RAIL004, RAIL005, RAIL006, RAIL007, RAIL008, RAIL009, RAIL011, RAIL013, RAIL015, RAIL016, RAIL017, RAIL018, RAIL020, RAIL022, RAIL023, RAIL025, RAIL027, RAIL029, RAIL032, RAIL034, RAIL035, RAIL036, RAIL037,

RAIL038, RAIL039, RAIL040, RAIL041, RAIL043, RAIL044, RAIL046, RAIL047, RAIL048, RAIL049, RAIL051, RAIL052, RAIL053, RAIL054, RAIL055, RAIL056, RAIL057, RAIL058, RAIL060, RAIL061, RAIL062, RAIL063, RAIL064, RAIL065, RAIL066, RAIL067, RAIL068, RAIL069, RAIL070, RAIL071, RAIL072, RAIL074, RAIL075, RAIL076, RAIL078, RAIL079, RAIL080, RAIL081, RAIL082, RAIL083, RAIL084 and RAIL085 and RAIL086 (ranked as high risk), as well as municipality landfill RALL008 (Centar Zupa).

Same approach (site cleaning) should be applied in short term should be applied for Plasnica municipality landfill (RALL002) ranked as high risk.

Same approach (site cleaning) should be applied in the long term for following dumpsites: RAIL003, RAIL012, RAIL014, RAIL019, RAIL021, RAIL024, RAIL026, RAIL028, RAIL030, RAIL031, RAIL033, RAIL042, R AIL050, RAIL059 and RAIL073.

Closure and remediation costs associated with dumpsites cleaning (Model A approach) in Southwest Region are given below.

Table 3-84: Closure and remediation indicative costs associated with dumpsite cleaning (Model A approach) in Southwest Region

Region	Municipa-lity	Settlement	Landfill No.	Area [m²]	Volume[m³]	Closure and rehabilitation activities for model "A" (site cleaning) for dumpsite medium and high risk - Southwest Region												TOTAL [€]
						Cleaning with loader/excavator			Transport to municipality landfill			Redisposed, including choppers and compaction			Grassing			
						Quantity [m³]	Unit price [€/m³]	Sum [€]	Dist. to landfill	Unit price [€/m³]	Sum [€]	Quant. [m³]	Unit price [€/m³]	Sum [€]	Area [m²]	Unit price [€/m²]	Sum [€]	
Southwest	M.Brod	M.Brod	RAIL001	500	500	500	1.5	750	50	15	7500	500	1.1	550	500	0.6	300	9100
Southwest	M.Brod	Trebino	RAIL002	100	50	50	1.5	75	50	15	750	50	1.1	55	100	0.6	60	940
Southwest	M.Brod	Trebino	RAIL003	150	75	75	1.5	112.5	50	15	1125	75	1.1	82.5	150	0.6	90	1410
Southwest	M.Brod	Suvodol	RAIL004	100	100	100	1.5	150	50	15	1500	100	1.1	110	100	0.6	60	1820
TOTAL for Municipality Makedonski Brod				**850**	**725**	**725**		**1087.5**			**10875**	**725**		**797.5**	**850**		**510**	**13270**
Southwest	Plasnica	Plasnica	RALL002	1500	2200	2200	1.5	3300	50	15	33000	2200	1.1	2420	1500	0.6	900	39620
Southwest	Plasnica	Plasnica	RAIL005	100	150	150	1.5	225	50	15	2250	150	1.1	165	100	0.6	60	2700
Southwest	Plasnica	Plasnica	RAIL006	100	400	400	1.5	600	50	15	6000	400	1.1	440	100	0.6	60	7100
Southwest	Plasnica	Plasnica	RAIL007	500	250	250	1.5	375	50	15	3750	250	1.1	275	500	0.6	300	4700
Southwest	Plasnica	Plasnica	RAIL008	50	25	25	1.5	37,5	50	15	375	25	1.1	27.5	50	0.6	30	470
TOTAL for Municipality Plasnica				**2250**	**3025**	**3025**		**4537.5**			**45375**	**3025**		**3327.5**	**2250**		**1350**	**54590**
Southwest	Ohrid	Ohrid	RAIL009	300	300	300	1.5	450	50	15	4500	300	1.1	330	300	0.6	180	5460
Southwest	Ohrid	Ohrid	RAIL010	50	25	25	1.5	37.5	50	15	375	25	1.1	27.5	50	0.6	30	470
Southwest	Ohrid	Ohrid	RAIL011	50	25	25	1.5	37.5	50	15	375	25	1.1	27.5	50	0.6	30	470
Southwest	Ohrid	Ohrid	RAIL012	100	150	150	1.5	225	50	15	2250	150	1.1	165	100	0.6	60	2700
Southwest	Ohrid	Ohrid	RAIL013	60	60	60	1.5	90	50	15	900	60	1.1	66	60	0.6	36	1092
Southwest	Ohrid	Ohrid	RAIL014	200	200	200	1.5	300	50	15	3000	200	1.1	220	200	0.6	120	3640
Southwest	Ohrid	Ohrid	RAIL015	50	50	50	1.5	75	50	15	750	50	1.1	55	50	0.6	30	910
Southwest	Ohrid	Ohrid	RAIL016	10	5	5	1.5	7.5	50	15	75	5	1.1	5,5	10	0.6	6	94

Southwest	Ohrid	Ohrid	RAIL017	500	500	500	1.5	750	50	15	7500	500	1.1	550	500	0.6	300	9100
TOTAL for Municipality Ohrid				**1320**	**1315**	**1315**		**1972.5**			**19725**	**1315**		**1446.5**	**1320**		**792**	**23936**
Southwest	Debarca	Botun	RAIL018	300	300	300	1.5	450	50	15	4500	300	1.1	330	300	0.6	180	5460
Southwest	Debarca	-	RAIL019	40	40	40	1.5	60	50	15	600	40	1.1	44	40	0.6	24	728
Southwest	Debarca	Belchishta	RAIL020	70	70	70	1.5	105	50	15	1050	70	1.1	77	70	0.6	42	1274
Southwest	Debarca	Leshani	RAIL021	70	70	70	1.5	105	50	15	1050	70	1.1	77	70	0.6	42	1274
Southwest	Debarca	Mesheishta	RAIL022	150	150	150	1.5	225	50	15	2250	150	1.1	165	150	0.6	90	2730
Southwest	Debarca	Volino	RAIL023	100	100	100	1.5	150	50	15	1500	100	1.1	110	100	0.6	60	1820
Southwest	Debarca	Trebenishta	RAIL024	200	100	100	1.5	150	50	15	1500	100	1.1	110	100	0.6	60	1820
Southwest	Debarca	Orovnik	RAIL025	1000	1000	1000	1.5	1500	50	15	15000	1000	1.1	1100	1000	0.6	600	18200
TOTAL for Municipality Debarca				**1930**	**1830**	**1830**		**2745**			**27450**	**300**		**2013**	**1830**		**1098**	**33306**
Southwest	Struga	Struga	RAIL026	600	600	600	1.5	900	50	15	9000	600	1.1	660	600	0.6	360	10920
Southwest	Struga	Struga	RAIL027	100	100	100	1.5	150	50	15	1500	100	1.1	110	100	0.6	60	1820
Southwest	Struga	Struga	RAIL028	200	200	200	1.5	300	50	15	3000	200	1.1	220	200	0.6	120	3640
Southwest	Struga	Struga	RAIL029	400	200	200	1.5	300	50	15	3000	200	1.1	220	400	0.6	240	3760
Southwest	Struga	Kalishta	RAIL030	500	500	500	1.5	750	50	15	7500	500	1.1	550	500	0.6	300	9100
Southwest	Struga	Kalishta	RAIL031	200	200	200	1.5	300	50	15	3000	200	1.1	220	200	0.6	120	3640
Southwest	Struga	Kalishta	RAIL032	250	250	250	1.5	375	50	15	3750	250	1.1	275	250	0.6	150	4550
Southwest	Struga	Struga	RAIL033	200	200	200	1.5	300	50	15	3000	200	1.1	220	200	0.6	120	3640
Southwest	Struga	Struga	RAIL034	100	50	50	1.5	75	50	15	750	50	1.1	55	100	0.6	60	940
Southwest	Struga	Struga	RAIL035	500	500	500	1.5	750	50	15	7500	500	1.1	550	500	0.6	300	9100
Southwest	Struga	Struga	RALLC001	5000	5000	5000	1.5	7500	50	15	75000	5000	1.1	5500	5000	0.6	3000	91000
TOTAL for Municipality Struga				**8050**	**7800**	**7800**		**11700**			**117000**	**7800**		**8580**	**8050**		**4830**	**142110**
Southwest	Kichevo	Kichevo	RAIL036	100	100	100	1.5	150	50	15	1500	100	1.1	110	100	0.6	60	1820
Southwest	Kichevo	Kichevo	RAIL037	50	50	50	1.5	75	50	15	750	50	1.1	55	50	0.6	30	910
Southwest	Kichevo	Kichevo	RAIL038	100	100	100	1.5	150	50	15	1500	100	1.1	110	100	0.6	60	1820
Southwest	Kichevo	Kichevo	RAIL039	40	20	20	1.5	30	50	15	300	20	1.1	22	40	0.6	24	376

Southwest	Kichevo	Kichevo	RAIL040	30	15	15	1.5	22.5	50	15	225	15	1.1	16,5	30	0.6	18	282
Southwest	Kichevo	Kichevo	RAIL041	30	15	15	1.5	22.5	50	15	225	15	1.1	16,5	30	0.6	18	282
Southwest	Kichevo	Kichevo	RAIL042	250	400	400	1.5	600	50	15	6000	400	1.1	440	250	0.6	150	7190
Southwest	Kichevo	Kichevo	RAIL043	15	7	7	1.5	10.5	50	15	105	7	1.1	7.7	15	0.6	9	132.2
Southwest	Kichevo	Kichevo	RAIL044	400	200	200	1.5	300	50	15	3000	200	1.1	220	400	0.6	240	3760
Southwest	Kichevo	Oslomej	RAIL046	500	750	750	1.5	1125	50	15	11250	750	1.1	825	500	0.6	300	13500
Southwest	Kichevo	Oslomej	RAIL047	1000	1500	1500	1.5	2250	50	15	22500	1500	1.1	1650	1000	0.6	600	27000
Southwest	Kichevo	Oslomej	RAIL048	5000	5000	5000	1.5	7500	50	15	75000	5000	1.1	5500	5000	0.6	3000	91000
Southwest	Kichevo	Oslomej	RAIL049	100	150	150	1.5	225	50	15	2250	150	1.1	165	100	0.6	60	2700
Southwest	Kichevo	Drugovo	RAIL050	40	40	40	1.5	60	50	15	600	40	1.1	44	40	0.6	24	728
Southwest	Kichevo	Drugovo	RAIL051	20	6	6	1.5	9	50	15	90	6	1.1	6.6	20	0.6	12	117.6
Southwest	Kichevo	Drugovo	RAIL052	1000	1500	1500	1.5	2250	50	15	22500	1500	1.1	1650	1000	0.6	600	27000
TOTAL for Municipality Kichevo				**8675**	**9853**	**9853**		**14779.5**			**147795**	**9853**		**10838.3**	**8675**		**5205**	**178617.8**
Southwest	Debar	Debar	RAIL053	300	200	200	1.5	300	50	15	3000	200	1.1	220	300	0.6	180	3700
Southwest	Debar	Konjari	RAIL054	400	300	300	1.5	450	50	15	4500	300	1.1	330	400	0.6	240	5520
Southwest	Debar	Konjari	RAIL055	30	6	6	1.5	9	50	15	90	6	1.1	6.6	30	0.6	18	123.6
Southwest	Debar	Kosovrasti	RAIL056	300	300	300	1.5	450	50	15	4500	300	1.1	330	300	0.6	180	5460
Southwest	Debar	Kosovrasti	RAIL057	100	50	50	1.5	75	50	15	750	50	1.1	55	100	0.6	60	940
Southwest	Debar	Mogorche	RAIL058	1000	1500	1500	1.5	2250	50	15	22500	1500	1.1	1650	1000	0.6	600	27000
Southwest	Debar	Debar	RAIL059	350	100	100	1.5	150	50	15	1500	100	1.1	110	350	0.6	210	1970
Southwest	Debar	Debar	RAIL060	1000	2000	2000	1.5	3000	50	15	30000	2000	1.1	2200	1000	0.6	600	35800
Southwest	Debar	Dzepchishte	RAIL061	754	30	30	1.5	45	50	15	450	30	1.1	33	754	0.6	452,4	980,4
Southwest	Debar	Otishani	RAIL062	50	100	100	1.5	150	50	15	1500	100	1.1	110	50	0.6	30	1790
TOTAL for Municipality Debar				**4284**	**4586**	**4586**		**6879**			**68790**	**4586**		**5044.6**	**4284**		**2570.4**	**83284**
Southwest	Centar Zupa	Pareshi	RALL008	500	3000	3000	1.5	4500	50	15	45000	3000	1.1	3300	500	0.6	300	53100
Southwest	Centar Zupa	Gorenci	RAIL063	15	15	15	1.5	22.5	50	15	225	15	1.1	16,5	15	0.6	9	273
Southwest	Centar Zupa	Gorenci	RAIL064	30	60	60	1.5	90	50	15	900	60	1.1	66	30	0.6	18	1074
Southwest	Centar Zupa	Broshtica	RAIL065	200	500	500	1.5	750	50	15	7500	500	1.1	550	200	0.6	120	8920
Southwest	Centar Zupa	Broshtica	RAIL066	100	200	200	1.5	300	50	15	3000	200	1.1	220	100	0.6	60	3580

Southwest	Centar Zupa	Broshtica	RAIL067	200	300	300	1.5	450	50	15	4500	300	1.1	330	200	0.6	120	5400
Southwest	Centar Zupa	Balanci	RAIL068	50	10	10	1.5	15	50	15	150	10	1.1	11	50	0.6	30	206
Southwest	Centar Zupa	Golem Papradnik	RAIL069	100	100	100	1.5	150	50	15	1500	100	1.1	110	100	0.6	60	1820
Southwest	Centar Zupa	Golem Papradnik	RAIL070	30	15	15	1.5	22.5	50	15	225	15	1.1	16.5	30	0.6	18	282
Southwest	Centar Zupa	Mal Papradnik	RAIL071	20	10	10	1.5	15	50	15	150	10	1.1	11	20	0.6	12	188
Southwest	Centar Zupa	Ziteni	RAIL072	500	2000	2000	1.5	3000	50	15	30000	2000	1.1	2200	500	0.6	300	35500
Southwest	Centar Zupa	Zitineni	RAIL073	30	10	10	1.5	15	50	15	150	10	1.1	11	30	0.6	18	194
Southwest	Centar Zupa	Bajramovici	RAIL074	40	80	80	1.5	120	50	15	1200	80	1.1	88	40	0.6	24	1432
Southwest	Centar Zupa	Breshtanik	RAIL075	30	30	30	1.5	45	50	15	450	30	1.1	33	30	0.6	18	546
Southwest	Centar Zupa	Breshtanik	RAIL076	40	40	40	1.5	60	50	15	600	40	1.1	44	40	0.6	24	728
Southwest	Centar Zupa	Pralenik	RAIL077	30	30	30	1.5	45	50	15	450	30	1.1	33	30	0.6	18	546
Southwest	Centar Zupa	Kodzadzik	RAIL078	50	10	10	1.5	15	50	15	150	10	1.1	11	50	0.6	30	206
Southwest	Centar Zupa	Kodzadzik	RAIL079	30	30	30	1.5	45	50	15	450	30	1.1	33	30	0.6	18	546
Southwest	Centar Zupa	Novak	RAIL080	50	20	20	1.5	30	50	15	300	20	1.1	22	50	0.6	30	382
Southwest	Centar Zupa	Novak	RAIL081	15	5	5	1.5	7.5	50	15	75	5	1.1	5.5	15	0.6	9	97
Southwest	Centar Zupa	Novak	RAIL082	500	1500	1500	1.5	2250	50	15	22500	1500	1.1	1650	500	0.6	300	26700
Southwest	Centar Zupa	Novak	RAIL083	150	100	100	1.5	150	50	15	1500	100	1.1	110	150	0.6	90	1850
Southwest	Centar Zupa	Elevci	RAIL084	30	15	15	1.5	22.5	50	15	225	15	1.1	16.5	30	0.6	18	282
Southwest	Centar Zupa	Dolgash	RAIL085	100	100	100	1.5	150	50	15	1500	100	1.1	110	100	0.6	60	1820
TOTAL for Municipality Centar Zupa				**2840**	**8180**	**8180**		**12270**			**122700**	**8180**		**8998**	**2840**		**1704**	**145672**
GRAND TOTAL - Southwest Region																		**674786**

Using the same individual approach (site visits and risk screening data), Model B or landfill capping without gas collection system in medium term should be applied for following MSW landfills in the Southwest Region: Makedonski Brod (RALL001), Kichevo (RALL003), Ohrid (RALL005) and Debar (RALL007) and also medium term dumpsites RAIL045 and RAIL087.

Closure and remediation costs associated with landfills capping construction (Model B approach) in Southwest Region are given below.

Table 3-85: Closure and remediation indicative costs associated with landfill capping construction according to Model B

Region	Landfill No	Municipality	Settlement	Locality	Area [m^2]	Volume [m^3]	Unit price [€/m^2]	Sum [€]
Municipality landfills								
Southwest	RALL001	M. Brod	M. Brod	Barbaras	22500	22500	26.65	599625
Southwest	RALL003	Kichevo	Kichevo	Oslomej	3000	15000	26.65	79950
Southwest	RALL005	Ohrid	Ohrid	Majker	26400	26400	26.65	703560
Southwest	RALL007	Debar	Debar	Krivci	20000	100000	26.65	533000
Southwest	RAIL045	Kichevo	Kichevo		5000	10000	26.65	133250
Southwest	RALLC002	Struga	Struga	Closed	10980	43900	26,65	292617
		GRAND TOTAL– Southwest Region						**2342002**

Using the same individual approach (site visits and risk screening data), Model C or landfill capping with gas collection system in medium term should be applied for MSW Landfill in Struga, Strushko Lope (RALL006) that have hight risk ranking and Ohrid, Bukovo (RALL004) that have medium risk ranking, but because of significant waste volume disposed waste, should be treated according to Model C. Closure and remediation costs associated with landfills capping construction (Model C approach) in Southwest Region are given below.

Table 3-86: Closure and remediation indicative costs associated with landfill capping construction according to Model C

Region	Landfill No	Municipality	Settlement	Locality	Area, [m^2]	Volume [m^3]	Unit price [€/m^2]	Sum [€]
Southwest	RALL004	Ohrid	Ohrid	Bukovo	65000	1430000	32	2080000
Southwest	RALL006	Struga	Struga	Strushko Lope	35000	297500	32	1120000
		GRAND TOTAL Southwest Region						**3 200 000**

Monitoring programs (data provision and after care control) are envisaged for MSW landfills with the waste volume above 15000 m^3. Costs associated are summarized below:

Table 3-87: Monitoring for data provision

Landfill No	Region	Municipality	Settlement	Locality	Landfill volume [m^3]	Cost (€)
RALL 001	Southwest	M. Brod	M. Brod	Barbaras	22 500	12 000
RALL003	Southwest	Kichevo	Kichevo	Oslomej	15 000	12 000
RALL004	Southwest	Ohrid	Ohrid	Bukovo	1 430 000	28 000
RALL005	Southwest	Ohrid	Ohrid	Majker	26 400	12 000
RALL006	Southwest	Struga	Struga	Strushko Lope	297 500	18 000
RALLC002	Southwest	Struga	Struga	Closed site	43900	12000
RALL007	Southwest	Debar	Debar	Krivci	100 000	12 000
GRAND TOTAL Southwest Region						**94 000**

Table 3-88: After care monitoring

Landfill No	Region	Municipality	Settlement	Locality	Volume landfill [m^3]	Cost per year (€)	30 year (€)
RALL 001	Southwest	M. Brod	M. Brod	Barbaras	22 500	2 000	60 000
RALL003	Southwest	Kichevo	Kichevo	Oslomej	15 000	2 000	60 000
RALL004	Southwest	Ohrid	Ohrid	Bukovo	1 430 000	4 000	120 000
RALL005	Southwest	Ohrid	Ohrid	Majker	26 400	2 000	60 000
RALL006	Southwest	Struga	Struga	Strushko Lope	297 500	4 000	120 000
RALLC002	Southwest	Struga	Struga	Closed site	43900	2 000	60 000
RALL007	Southwest	Debar	Debar	Krivci	100 000	2 000	60 000

Model B			Model C		
Monitoring activity	indicative Cost(€)/year	Total (€) for 30 years	Monitoring activity	indicative Cost(€)/year	Total (€) for 30 years
Runoff Q/Q	500	15000	Runoff Q/Q	500	15000
Leachate Q/Q	/	/	Leachate Q/Q	1000	30000
Surface water Q/Q	500	15000	Surface water Q/Q	500	15000
Ground water Q/Q	500	15000	Ground water Q/Q	500	15000
Gas emissions	/	/	Gas emissions	1000	30000
Slope stability	500	15000	Slope stability	500	15000
TOTAL	2000	60000	TOTAL	4000	120000

3.7.13 Overview of Alternative Options

SWOT Analysis of Waste Management Options

A SWOT analysis is a strategic planning method that is aimed at identifying key Strengths, Weaknesses, Opportunities and Threats of the subject of interest. Strengths and opportunities can be considered attributes that are helpful in achieving the objective, whilst weaknesses and threats are likely to prevent objectives being achieved. Strengths and Weaknesses are attributes that can be found within the waste industry at present, whilst opportunities and threats are more attributes of the external environment. The SWOT has been completed for Green Points, Separate collection of packaging waste, Separate collection of biowaste, household composting, Green waste composting, conventional combustion and MBT/MBS/MRF Process.

Green Points

Strengths

- Separation is easier for residents as one place receives all their waste streams.
- Jobs creation
- Large recovery rate of materials
- The Recycling centers are versatile; they can have their own income and be financially sustainable by : a)charging the disposal of big quantities, b) selling sorted materials, etc
- Extends the lifetime of landfill
- Reduces landfill costs

Weaknesses

- An area in the city is required for the construction
- A small investment and operational cost is required
- Licensing is required
- Residents must transport the goods themselves.

Opportunities

- Reduction of waste for final disposal
- Costs reduction of final disposal
- Job creation

Threats

- Negative backlash from citizens that have to transport their goods.

In Green Points will be collected WEEE, C&D waste, hazardous household waste and some small amounts of recyclables.

Separate Collection and Recycling of WEEE

Strengths

- Relevant EU and National legislation and targets exist.
- National producer responsibility schemes are in place.
- There is extensive experience available at EU level.
- It can contribute to the valorization of a significant amount of municipal and household waste.
- There are diverse technologies, methods and equipment to choose from for application.
- Separate collection of these wastes has significant positive impact on environment and health.
- It extends landfill lifetime expectancy.
- There are economic gains while implementing these incentives.
- Creation of new jobs.
- It is a tried and proven method.
- Higher quality materials are collected for recycling
- It contributes to the reduction of greenhouse gases and resource recovery

Weaknesses

- Local Authorities are required to set up local collection points.
- Collection systems and points must be able to meet demand.
- It requires very good public awareness of residents.
- In the case of several producer responsibility schemes, in one area there is often competition amongst them to secure the WEEE.

Opportunities

- Contributes to local, regional and national authorities in meeting their respective legislative targets.
- New jobs are created in the community.
- Materials are available in the community for local industry and they do not have to import.
- Results in a decrease in waste production.
- Provides residents with the incentives to participate in waste prevention activities
- Reduces landfill costs.
- Local authority acquires environmentally positive profile.

Threats

- There are cases where geographic location of Local Authorities lead to a reluctance of the producer responsibility schemes to integrated them as it is more costly.
- Inefficient collection schemes may create negative backlash from residents.
- Existing waste management staff at times perceives initiating these programs as a threat to their positions.
- There are initial expenses related to these projects (e.g. public awareness)

Separate Collection and Environmental Management of Hazardous Household Waste

Strengths

- There is extensive experience available at EU level.
- Separate collection of these wastes has significant positive impact on environment and health.
- Job creation
- Significant support from residents.

Weaknesses

- Must have an efficient collection system that meets the demands of the local population.
- Requires good public awareness.

Opportunities

- Creation of new jobs
- Provides significant benefits to environment.
- Local authority acquires environmentally positive profile.

Threats

Separate Collection of Construction and Demolition Waste

Strengths

- National and EU legislation exists
- Environmental and health protection
- Results in new permanent jobs
- Raw materials recovery and contributes to GHG emissions reduction

Weaknesses

- Requires basic organization for collection system
- Participation of local authorities in the citizens' information campaign

Opportunities

- Creation of new jobs
- Provides significant benefits to environment.
- Local authority acquires environmentally positive profile.

Threats

Separate Collection of packaging waste

Strengths

- EU and National legislation exists
- National producer responsibility schemes are in place
- It can contribute to the valorization of a significant amount of municipal and household waste.
- It can extend landfill lifetime expectancy.
- There are economic gains while implementing these incentives.
- The residents have knowledge on how these systems work and they participate in them.
- There is general support from society as a whole
- Indirect incentives to residents for participation
- Creation of new jobs.
- It is a tried and proven method.
- There are diverse technologies, methods and equipment to choose from, for application.
- Higher quality materials are collected for recycling
- It contributes to the reduction of greenhouse gases.

Weaknesses

- The more separation of source streams are required, the higher effort is required by residents.
- The Municipality must develop highly efficient collection systems and increase services.
- Residents must be educated often to reach higher targets.
- Where there are more than one producer responsibility schemes in place, competition may evolve between them.

Opportunities

- Contributes to local, regional and national authorities in meeting their respective legislative targets.
- New jobs are created in the community.
- Materials are available in the community for local industry and they do not have to import.
- Results in a decrease of waste production.
- Opportunity to generate income from the sale of materials.
- Increases community solidarity-residents acknowledge they are doing something good for their local environment.
- Local authority acquires environmentally positive profile.
- Provides residents with the incentives to participate in waste prevention activities.

Threats

- There are cases where geographic location of Local Authorities lead to a reluctance of the producer responsibility schemes to integrated them as it is more costly.
- Inefficient collection schemes may create negative backlash from residents.
- There are initial expenses related to these projects (e.g.. public awareness)

Separate Collection of Biowaste

Strengths

- EU legislation exists
- Can combine different sources of organic waste, such as : agricultural activities, slaughter houses, olive processing plants, etc.
- Has the potential to manage 100% of MSW organic fraction
- Increases landfills' life span
- Lower costs for the technology involved, compared to other methods such as MBT and thermal treatment
- Results in new permanent jobs
- There is social consensus in this method
- A useful and valuable material is produced
- Contributes to GHG emissions reduction

Weaknesses

- Requires separate collection infrastructure (bins)
- Requires integrated planning and operation control
- Requires space for the composting facility
- Problems related to the establishment of the facility (area selection, permits, social reactions)
- High initial costs (bins, facilities)
- Constant information and sensitization campaigns for quality and quantity assurance
- Cooperation with and training of waste collection personnel of municipality

Opportunities

- Waste reduction
- Reduction of final disposal costs
- Results in new permanent jobs
- Active participation of citizens that can become more active in other waste management related issues
- Positive environmental profile of the municipality that can lead to privileged access to environmental funding, increased tourism etc
- Positive political profile with increased acceptance levels from citizens

Threats

- Can work only if it is accepted by the citizens
- Negative reactions from waste collection personnel of municipality
- Improper participation from citizens can lead to bad quality compost

Household composting

Strengths

- Supports European legislation
- Widespread applicability
- Can have significant impact source reduction
- Increases life-span of landfills
- No permits required
- Cost-benefit interest for the Municipality
- Benefit for citizens (citizens benefit from the use of compost)

Weaknesses

- When implemented at large-scale local level requires good planning to take all factors at household level into account.
- There is a cost (although small)
- Requires very good public awareness and support to citizens

Opportunities

- Garners strong support from citizens
- Creates the opportunity for green job creation (directly and indirectly)

Threats

- Low awareness of population (if not properly informed especially initially may have backlash)

Green Waste Composting

Strengths

- Greenwaste are valuable and always on demand from composting facilities
- EU legislation exists
- Simple and widely spread know-how on management methods
- Has the potential to manage 100% of MSW green waste fraction
- Increases landfills' life span
- Lower costs for the technology involved, compared to other methods such as MBT and thermal treatment
- Results in new permanent jobs
- There is social consensus in this method
- A useful and valuable material is produced
- Contributes to GHG emissions reduction

Weaknesses

- Requires integrated planning and operation control
- Requires space for the composting facility
- Small number of composting facilities in some countries
- A relatively small capital cost is required for the initiation
- Cooperation with and training of waste collection personnel of municipality

Opportunities

- Waste reduction
- Reduction of final disposal costs
- Results in new permanent jobs
- Active participation of citizens that can become more active in other waste management related issues
- Positive environmental profile of the municipality
- Positive political profile with increased acceptance levels from citizens

Threats

- Can work only if it is accepted by the citizens
- Negative reactions from waste collection personnel of municipality
- Low participation levels from citizens

Conventional Combustion

Strengths

- Established, mature and reliable technology.
- Significant experience and operational data on wide range of waste feedstocks.
- Can process multiple fuels, and is tolerant of fluctuations in fuel quality and composition.
- Fuel is generally not dependent on pre-treatment, with the exception of fluidised bed technology.
- Several designs available : moving grate, bubbling fluidised bed, circulating fluidised bed, and fixed bed designs.
- Can reduce the volume of the waste by up to 95%.

Weaknesses

- Combustion processes require sophisticated gas cleaning monitoring and control system that may require significant capital expenditure.
- Process produces small volumes of fly ash and APCr that must be handled as hazardous waste.
- Power generation from combustion is only possible by means of raising steam to drive a steam turbine delivering low electrical efficiency. Gross electrical efficiencies of such processes tend to be in the order of 15-30%.
- Potential net increase in greenhouse gas emissions.
- Low value by-product associated

Opportunities

- Diversion of biodegradable materials from landfill and associated reduction in greenhouse gas generation potential.
- Opportunities for electricity and heat generation.
- Incinerator bottom ash can be diverted from landfill due to potential uses as an aggregate substitute.

Threats

- Combustion suffers from poor public image, thereby presenting difficulties in gaining public and political support for the development of such processes.

MBT/MBS/MRF

Strengths

- Combines proven and well established technologies
- Further recovery of recyclable waste and diversion of biodegradable BMW from landfill
- Provides an alternative to landfill and incineration
- Can be tailored to meet local requirements
- Can have built in flexibility to respond to changing inputs

Weaknesses

- Quality of outputs may be low, i.e. recyclables may be low grade
- Potential lack of benchmarks and quality standards for some outputs
- May still result in a fraction that will need to be landfilled
- Is dependent on market demand for outputs
- High cost

Opportunities

- Offers a flexible and versatile solution
- May be perceived as a more publicly acceptable solution
- Can be designed at appropriate scales, and is not as influenced by economies of scale as incineration
- Can treat a wide range of waste streams, i.e. MSW, C&I
- Can preserve nutrients in Compost Like Output (N,P,K)

Threats

- Market volatility
- Product risk
- Discourages source segregation of waste streams
- Uncertainty of biodegradability of outputs

Overview of Alternative Technologies

The following Table provides an overview comparison of the whole discussed treatment technologies.

Table 3-89: Comparison of the technologies for the Treatment Waste

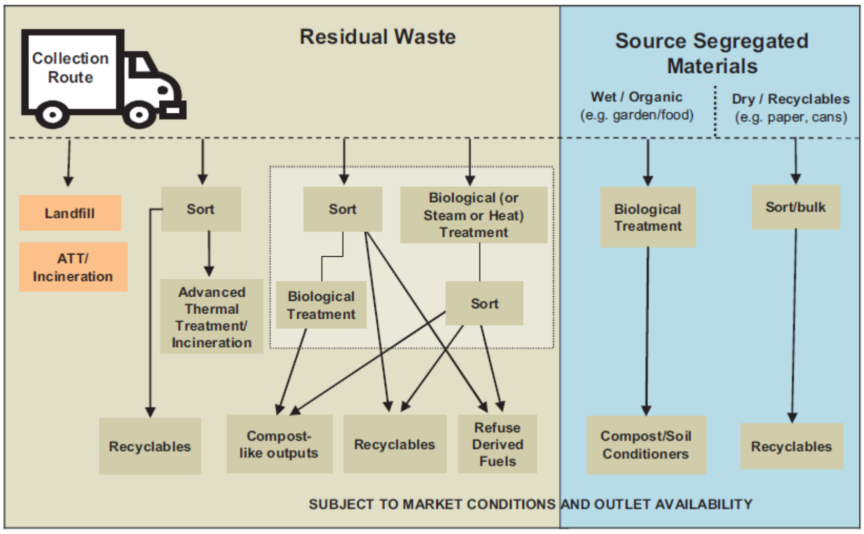
	Biological methods		**Thermal methods**		
	Composting	**Anaerobic digestion**	**Incineration**	**Pyrolysis**	**Gasification**
Economic					
Cost of treatment	Low to high, depending on technology. Based on a simple facility, 11-14 €/t. for a fully covered facility	Costs depend on scale of unit and fate of residuals. Costs of anaerobic digestion alone: capital 66 €/t O&M 46 €/t Annualised cost 58 €/t, after allowing for an offset of 8 €/t for gas. For a smaller unit (5-20000 t/year) the cost is likely to be 25-34 €/t.	High, in the order of 144 €/t, to which must be added collection costs.	Medium to high. No reliable figures available.	High to very high. No reliable figures available.
Technology					
Basic principle	Degradation by Aerobic microorganisms	Degradation by Anaerobic microorganisms	Combustion	Anaerobic Thermochemical conversion	Thermochemical conversion
Proven technology, track record	Yes; Very common	Yes; common	Yes; very common	Partly; few	Partly; few
Suitability	Good	Good	Good	Medium	Depending on Technology
Waste acceptance	Source separated waste only since matter and nutrients is to be recovered as pure as possible	Source separated wet waste only since matter and nutrients are to be recovered as pure as possible	All waste since air cleaning technology is good and residual solids are minimised by volume reduction	In particular suitable for contaminated, well defined dry waste fractions	Source separated dry waste only unless combined with better cleaning technology
Acceptance of	Yes	Yes	Yes	Possible but	Possible but
wet household waste				normally no	normally no
Acceptance of dry household waste	Yes	Yes	Yes	Yes	Possible
Acceptance of garden and park waste	Yes	Yes	Yes	Yes	Possible

	Biological methods		Thermal methods		
	Composting	**Anaerobic digestion**	**Incineration**	**Pyrolysis**	**Gasification**
Economic					
Acceptance of waste from hotels and restaurants	Yes	Yes	Yes	Yes	Possible but normally no
Acceptance of paper and board	Small amounts of paper possible	No	Yes	Yes	Possible
Excluded waste Fractions	metal, plastic, glass, plants without high sanitary treatment, no waste of animal origin	Metal, plastic glass, garden waste(plants without high sanitary treatment: no waste of animal origin)	None	Wet household Waste	Wet household Waste
Environment					
Solid residues	High	Medium - high	Medium - high	Medium	Medium
Air impact	Low	Medium	Medium -high	Medium	Medium - high
Water impact	Medium - high	High	High	Medium - high	Medium - high
Control of odour	Bad - good	Bad - good	good	Medium - good	good
Working environment	Bad - good	Medium - good	good	good	good
Energy recovery	No	Yes; 3200 MJ/ ton waste	Yes; 2700 MJ/ tons waste	Yes; ≈ 70 % of incineration + energy contained in the char	Yes; comparable to incineration
Carbon cycle (% of weight)	50 % in compost 50 % to air	75 % in fibres/liquids 25 % as biogas	1 % in solids 99 % to air	20–30 % in solids 70–80 % to air	2 % in solids 98 % to air
Nutrient recovery (kg nutrient/ton waste input)	Yes; 2,5–10 kg N 0,5–1 kg P; 1–2 kg K	Yes; 4,0–4,5 kg N 0,5–1 kg P; 2,5–3 kg K	No	No	No
Products for recycling or recovery, (weight- % of waste input) 40-50 % compost 30 % fibres, 50–65 % fluids, 3 % metal 15–25 % bottom ash (incl. Clinker grit, glass), 3 % metal 30–50 % char (incl. bottom ash, clinker, grit, glass) 15–25 % vitrified bottom ash (incl. clinker grit, glass), 3 % metal					
Residuals for other waste treatment or for land filling (Weight- % of waste input)	2–20 % overflows sieving (plastic, metal, glass, stones)	2–20 % overflows sieving (plastic, metal, glass, stones)	3 % fly ash (incl. flue gas residues)	2–3 % flue gas residues	2 % gas cleaning residues
Compliance related					

	Biological methods		Thermal methods		
	Composting	Anaerobic digestion	Incineration	Pyrolysis	Gasification
Economic					
no particular issues					
Implementation risks					
			Sitting of an incinerator can be difficult – negative popular perception		

A flow diagram with the combinations and possible applications of all these technologies in an Integrated Waste Management system, it is shown in the follow in figure.

Figure 3-73: Options for Recovery & Treatment of Municipal Solid Waste (DEFRA 2007)



3.7.14 Selection of possible sites for establishing Waste Management Facilities

Introduction

The selection of a site for Waste Management treatment facility is critical to minimising the impact of the facility on the environment. Careful site selection will assist in reducing the impact of the plant on the community and surrounding environment, and can also lead to reduce operational and rehabilitation costs. At this point we should mention that the Waste Management facility site refers to the regional landfill site and/or the site of other proposed facilities.

The evaluation procedure for selection of a suitable location for the waste management facilities in the region was carried out in the following stages:

- **Data collection:** data collection carried out in a general survey (including desk survey) in order to study and analyze some critical factors, such as topography, morphology, geology, hydro-geology, seismic conditions, climatic and meteorological conditions, land-use, protection areas, nearest settlements etc. The collected data will be used in order to identify suitable areas for the sitting of the waste management facilities in accordance with international practice and requirements of national legislation.
- **Development of exclusion – selection criteria**: Based on the above mentioned data, and the requirements of national legislation exclusion and selection criteria will be developed, in order to

identify suitable areas for the sitting of the waste management facilities. The suitable areas will be shown in a map.

- **Site visit – Application of exclusion – selection criteria for the site under investigation – Identification of alternative sites:** The target of that stage is to find alternative sites, with the use of the exclusive areas map, and also check in situ the characteristics (geological, hydro-geological, geo-technical etc) of all the sites.
- **Development of evaluation criteria - Multi-Criteria Decision Analysis for the comparative evaluation of the sites – Selection of the most appropriate site:** The sites that will not respect the exclusion criteria will be excluded from further evaluation. The sites that will go forward following the exclusion phase will be comparatively assessed on a basis of evaluation criteria. Several multi-criteria decision-making (MCDM) methods based on weighted averages, priority setting, outranking, fuzzy principles and their combinations have been employed in waste management planning decisions. MCDM applications include areas such as integrated manufacturing systems, technology investment evaluations, solid waste and wastewater management, agricultural management and energy planning. More specific, MCD Methods comprise of:
  - AHP (Analytic Hierarchy Process) in all variations,
  - MAUT (Multi-Attribute Utility Theory),
  - TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution),
  - Outranking methods like PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) and ELECTRE (Elimination and Choice Expressing Reality).

In next stage of the current project, the appropriate method for the purposes of site selection regarding the future construction of Waste Management Facility will be selected.

Exclusion criteria for the examination of alternative potential sites

The exclusion criteria reflect minimum acceptable sitting practice and are intended to be applied as minimum standards that must be met by all solid waste management facilities. By excluding from consideration land areas that are determined to be unsuited for waste management activities and by requiring the screening of non-excluded land areas for preferred attributes, the criteria provide a rational basis for identifying locations that are potentially suitable for such facilities and therefore worthy of further investigation. The main goal in adopting these criteria is to direct site screening activities to the investigation and selection of land areas that appear to be suitable and appropriate for these facilities.

In this respect, exclusion criteria for the sitting of waste management infrastructure (treatment & disposal) are mainly related to the distances from settlements, roads, cultural monuments, areas of high ecological interest, etc.

Exclusion criteria proposed in accordance with guidelines of the World Health Organization (Petts & Eduljee, 1994) are as follows:

1. Unstable or weak soils (organic, swelling, delicate sands etc.)
2. Areas where there are or have potential of subsidence.
3. Saturated soils (e.g., wetlands, coastal zones)
4. Groundwater recharge area. Where a protective waterproof layer requires special investigation.
5. Areas that flood. Return period of at least 100 years must be ensured.
6. Areas of upstream concentration of surface waters, e.g. reservoirs, points for potable or irrigation water or anywhere can decline due to rapid surface water contaminant transport.
7. Atmospheric conditions are not conducive to safe dispersion of pollutants from escaping after an extraordinary event.
8. Major natural hazards: landslides, increased seismic movements.
9. Natural ecosystems: Habitat endangered species, parks, forests, nature protection areas.

10. Areas of economic or cultural significance.
11. Historical and archaeological sites and buildings or areas associated with local traditions. In such positions, the destruction or contamination and avert visual, aural and functional disturbance, must be avoided.
12. Sensitive locations, such as airports, warehouses of flammable or explosive materials etc.
13. Locations of special population concentrations e.g. hospitals, prisons.
14. Occupying space that leads to inequality between population groups due to the destruction of cultural traditions or relationships with the area.

Moreover it is prohibited to install WM treatment facilities within the following areas:

- Areas of archaeological cultural interest, i.e. officially proclaimed and statutory archaeological sites.
- Traditional Settlements
- Protected areas and individual elements of nature and landscape
- Residential areas (areas within settlement boundaries)
- Areas of special or general prohibitory provision, and National Defense and Security.

Exclusion areas

In order to identify suitable areas for sitting waste treatment and disposal works of solid waste throughout the area of interest, conditions and limitations of suitability will be laid down in accordance with international practice and the requirements of national legislation.

The basic terms and restrictions placed are:

- **Geologic constraints:** Firstly, there must be effort to avoid areas dominated by geological Permeability. In case of difficulty finding areas which are geologically constructed of impermeable formations, selecting areas with impermeable bedrock cannot be a criterion for exclusion.
- **Hydrological constraints:** Principle areas which are watersheds where dams exist should be avoided, but this is not an exclusion criterion.
- **Nature Protected areas:** Strict Nature Reserve areas, Natural Monuments with important characteristics and Emeralds areas any other protected area under national legislation are excluded.
- **Archaeological sites:** areas declared as archaeological sites are excluded.
- **Settlements:** areas within settlement boundaries are excluded.

Criteria for alternative site selection

The first important factor for the location of waste treatment and disposal is the selection of suitable site, which will definitely affect the progress of implementation of projects and operations and especially landfill and will be the basis for future reintegration of the area.

The disposal of waste with the sanitary landfilling method faces reactions of the surrounding communities, and that is because it often proceeds without design, planning and proper organization of the project. Correct planning starts by analyzing the current situation and possible environmental, technical and economic criteria, in order to guarantee as much as possible, environmental protection.

The selection process begins with the identification of suitable sites using maps at appropriate scale and content (geological, hydrogeological, topographical etc.) and determining the form of terrain (flat, valley, slopes), geology sites, distance from settlements, the region's road network, as well as the water resources of the region. After the initial assessment and data obtaining from charts, studies (eg hydrogeological, regulators) or reports (eg archeological, forest inspections, etc.), site visits offer a more systematic approach in the identification and evaluation of locations.

A number of criteria that should be taken under consideration for the identification of suitable locations are as follows:

- Capacity: It is important to ensure that the selected areas provide the necessary capacity for the landfill.
- Distance from settlements and visual concealment: This criterion takes into account the distance and concealment of a settlement from each site
- Topography and covering material: The morphology of the terrain significantly affects the type of construction and operating procedures. In addition, the possibility of finding cover material in situ contributes in minimizing the operating cost.
- Geology – Hydrogeology: Better groundwater protection is ensured by compact rock, clay and soil material with clay. As acceptable option, fine soil materials and sandy soils because, could be considered, which, although permeable, they can filter and purify the leachate.
- The hydrological and climate conditions: The local hydrological conditions are important for calculation and design of drainage works. The meteorological conditions also affect works operation.
- Ownership: This criterion examines the cost effectiveness for the acquisition of land, when it is not state property, or the alternative cost of a possible different exploitation. At the same time it is considered the possibility, the procedure and the time required for the acquisition of the land, if necessary expropriation proceedings. In general, public ownership of land is preferable.
- Construction -operating-restoration of the site and transport costs: This criterion involves all the relevant costs of the projects in relation to each particular alternative location.

Setting of alternative potential facility sites

In this stage the number of alternative potential sites will be determined in the project area. These sites will be selected for evaluation from the multi-criteria analysis procedure.

Setting of comparative evaluation criteria

The criteria for comparative evaluation, each including a number of individual criterions, are given below.

Group of criteria A: *Geological criteria*.

The group A will comprise the following criteria:

(1) Permeability of the underground layer
(2) Tectonic structure of the area
(3) Existence of hydrant points
(4) Existence and use of underground water
(5) Ground Erosion – Stability of slope
(6) Seismicity and seismic risk of the area
(7) Surface water recipient (distance of the facility from water resources, ability of self-attenuation of groundwater)
(8) Protecting of underground water
(9) Geomorphology of the area (type and extent of catchment area)
(10) Borrow pits for clay sealing materials

Group of criteria B: *Environmental criteria*.

The group B will comprise the following criteria:

(1) Land cover, ecological characteristics, landscape
(2) Optical isolation (level of impact to the aesthetics of the environment during the operation of the waste management facility site)
(3) Nuisance by odour and air pollution
(4) Nuisance from the circulation of the transported vehicles in inhabited areas

Group of criteria C: *Land planning criteria*.

The group C will comprise the following criteria:

(1) Distance of settlements
(2) Distance from agricultural activities
(3) Distance from stock-raising activities
(4) Distance from Industrial activities/areas
(5) Proximity to incompatible uses (protected area and high forests, landscape protection area, tourist zone, archaeological sites, etc)
(6) Final access road

Group of criteria D: *Operational criteria*.
The group D will comprise the following criteria:

(1) Impacts on operation in Waste treatment facilities from the climatic conditions in the area
(2) Adequacy of the available area - Expansion Capabilities
(3) Adequacy of covering layer

Group of criteria E: *Financial criteria*.
The group E will comprise the following criteria:

(1) Demands for infrastructure works
(2) Land Value
(3) Availability of public utilities
(4) Cost of the transport of the waste to the site

All the above individual criteria will be calibrated on a scale of 1-10.

Estimation of the criteria weight factors

A significant step for the entire procedure is the quantification of the significance of each category of criteria (Groups A-E) as well as per criterion in each category. The determination of these weights will be based on the opinion of the people involved in municipal solid waste and the experience of our team in the development of multi-criteria analysis applications. An example of the determination of these weights is presented in the following table.

Table 3-90: Indicative final weight factors for criteria

	Criteria	**Criteria description**	**Criterion weight (%)**
A	**Geological**	A1: Permeability of the underground layer	20
		A2: Tectonic structure of the area	18
		A3: Existence of hydrant points	10
		A4: *Existence and* use of underground water	10
		A5: Ground Erosion – Stability of slope	5
		A6: *Seismicity and seismic risk of the area*	5
		A7: Surface water recipient *(distance of the facility from water resources, ability of self-attenuation of groundwater)*	7
		A8: *Protection* of underground water	10
		A9: Geomorphology of the area, *Type and extent of catchment area*	10
		A10: Borrow pits for clay sealing materials	5
		Total	**100**
B	**Environmental**	B1: Land cover, ecological characteristics, landscape	25
		B2: Optical isolation (level of impact to the aesthetics of the environment during the operation of the waste management facility site)	30

	Criteria	Criteria description	Criterion weight (%)
		B3: Nuisance by odour and air pollution	25
		B4: Nuisance from the circulation of the transported vehicles in inhabited areas	20
		Total	**100**
C	Land Planning	C1: Distance of settlements	30
		C2: Distance from agricultural activities	15
		C3: Distance from stock-raising activities	5
		C4: Distance from Industrial activities/areas	10
		C5: Proximity to incompatible uses (protected area and high forests, landscape protection area, tourist zone, archaeological sites, etc)	20
		C6: Final access road	20
		Total	100
D	Operational	D1: Impacts on operation in Waste treatment facilities from the climatic conditions in the area	10
		D2: Adequacy of the available area - Expansion Capabilities	60
		D3: Adequacy of covering layer	30
		Subtotal	100
E	Financial	E1: Demands for infrastructure works	35
		E2: Land Value	20
		E3: Availability of public utilities	15
		E4: Cost of the transport of the waste to the site	30
		Total	100

Grading of alternative potential facility sites

The next essential step of the procedure will be the collection and recording of the data for each individual criterion for the different potential facility sites. In particular, all data which referred to the exclusive criteria and to the criteria for the comparative evaluation of the different potential facility sites will be collected using:

(1) Files and records kept by the municipalities of each region and regional and national authorities
(2) Available technical reports and site studies
(3) Available specific studies e.g. geological studies
(4) Bibliographic references

After processing, the primary data will be presented in a document.

The following table presents a template regarding the results for the different potential facility sites obtained for the criteria of all Groups. The same will be done for the individual criteria for each the other four groups.

Table 3-91: Template of Extraction of multi-criteria matrix and w,p,q thresholds

Site	Site 1	Site 2	Site 3	Site 4	......
A1	1	1	1	1	
A2	10	10	10	10	
A3	5	5	5	5	
A4	10	3	10	5	
A5	4	4	4	4	
A6	7	7	7	7	
A7	3	5	3	5	
A8	10	10	10	10	
A9	6	6	6	6	
B1	5	7	9	7	
B2	6	7	7	6	

Site	Site 1	Site 2	Site 3	Site 4	......
B3	5	5	5	5	
B4	2	2	2	2	
C1	7,5	7,5	6	7,5	
C2	10	10	10	10	
C3	6	6	6	6	
C4	5	7	9	7	
C5	6	7	7	6	
C6	5	5	5	5	
D1	6	6	6	6	
D2	5	7	9	7	
D3	6	7	7	6	
E1	6	6	6	6	
E2	5	7	9	7	
E3	6	7	7	6	
E4	5	5	5	5	

Use of the appropriate MCDM method

After the development of a multi-criteria matrix as well as the determination of the w, p and q thresholds, the outcome will be entered to the appropriate software which will be based on the appropriate method for the ranking of the alternative facility sites. This will be selected in next stages during the elaboration of the feasibility study.

Ranking of alternative potential facility sites

After running the appropriate software tool, the alternative potential facility sites will be ranked according to their performance. The following figures present an example of the partial ranking results.

3.8 PROPOSED SCENARIOS FOR REGIONAL WASTE MANAGEMENT

3.8.1 Introduction

In order to support decisions regarding future solutions for the Waste Management Plan in Southwest Region, reliable strategies and concepts are needed. For this purpose, four waste management scenarios (including sub-scenarios) have been defined. The scenarios are based on objectives and recent national legislation for waste management and take into account regional waste production and composition as well as existing waste system infrastructure. For each scenario, the following material flows were quantified:
(1) wastes that would be sent to collection systems, such as green waste, biodegradable waste, electric and electronic waste (WEEE), hazardous material, Construction and Demolition waste, recyclable waste (paper/cardboard, glass, plastic, Fe, Al);
(2) wastes that would be sent to different processes, such as those of mechanical-biological treatment with aerobic composting or anaerobic digestion, mechanical-recycling facility, mechanical-biological stabilization, incineration;
(3) residues to be diverted to landfills;
(4) materials recovered by recycling processes (mechanical separation)
(5) energy obtained by waste-to-energy plants.

Also for each scenario are quantified carbon dioxide emissions (CO_2) from waste management activities. CO_2 is one of the major GHG emissions generated by MSW management and of significant interest under the Kyoto Protocol (IPCC 1997, 2006). For the quantification of GHG emissions used the SWM-GHG calculator that follows the Life Cycle Assessment (LCA) method. Different waste management strategies can be compared by calculating the GHG emissions of the different recycled (glass, paper/cardboard, plastics, metals, organic waste) and disposed of waste fractions over their whole life cycle. The tool sumps up the emissions of all residual waste of recycling streams respectively and calculates the total GHG emissions of all process stages in CO_2 equivalents. The emissions calculated also include all future emissions caused by a given quantity of treated waste. This means that when waste is sent to landfill, for example, the calculated GHG emissions, given in tone CO_2 equivalents per ton waste, include the cumulated emissions this waste amount will generate during its degradation. This method corresponds to the 'Tier 1' approach described in IPCC.

The waste management sector contributes to the greenhouse effect primarily through emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). But in the greenhouse gas (GHG) inventories based on IPCC (Intergovernmental Panel on Climate Change) methodology, positive impacts of reducing, re-using or recycling of waste as well as waste-to-energy strategies on climate protection are either attributed to other source categories-in particular to the energy sector and to industrial processes-or they are not accounted for at all.

Developing countries and emerging economies could not only considerably reduce their GHG emissions at comparably low costs but also significantly contribute to improve public health conditions and environmental protection if they were to put in place sustainable waste management systems. GHG produced by the waste management sector in developing countries and emerging economies are highly relevant, in particular because of the high percentage of biodegradable components contained in the waste streams. Stepping up recycling could further reduce emissions by energy savings.

Climate change is considered one of the greatest global challenges of the 21st century. A general consensus exists among the vast majority of climate experts that global warming is the result of rising concentrations of greenhouse gases in the Earth's atmosphere. Since industrialization began, human activities have intensified the natural greenhouse effect, which is caused largely by carbon dioxide, methane and ozone in the atmosphere, through anthropogenic emissions of greenhouse gases, resulting in global warming.

Several strategies can be used for the reduction of GHG emissions in waste management:

- Methane reduction: Collection and flaring of landfill gas can already cut the emissions in half because it leads to CO_2 emissions instead of methane emissions. Even more, waste incineration or composting have significantly less global warming potential than landfilling.
- Recycling: The use of secondary raw materials instead of primary raw materials reduces the energy consumed in industrial processes. In glass production, 35% of energy can be saved, in paper production 50% and in aluminium production, the use of secondary raw materials can even save 90% of energy use compared to the use of primary raw materials. In addition to the savings in energy, recycling also avoids the emissions and environmental impact resulting from the exploitation of primary raw materials. Composting of organic waste generates alternative fertilizer which leads to less energy consumption for producing chemical fertilizer.
- Energetic use: Waste can be used energetically in many ways. Waste fractions with a high calorific value can be used as alternative fuel resources, and organic waste can be digested to produce biogas. When waste is used to substitute primary fossil fuels in these processes, this leads to reductions of emissions.

The emission savings resulting from recycling processes vary significantly according to the material recycled. When for example waste paper is recycled and not disposed on a landfill, this results not only in reducing the emissions that would have occurred by the material degradation on the landfill, but also in reducing the emissions caused by cutting trees as well as the energy and emissions from processing wood for paper production and part of the energy used for processing cellulose.

As it is mentioned before, the calculation method used in the SWM-GHG Calculator follows the Life Cycle Assessment (LCA) method. The SWM-GHG calculator comprises different sheets where the users enter basic information and can define the status quo waste management practices as well as scenarios for future waste management options.

- *Waste characteristics*. In a start sheet, users specify the waste amount, waste composition, and the country-specific electricity grid
- *Definition of waste recycling options*. In the recycling sheet, users define the percentage of different waste fractions (organic and non-organic) that are currently recycled or valorized. For organic waste, there are the options of composting and digestion.
- *Definition of disposal options*. For the residual waste remaining after recovery, specifications have to be introduced regarding different treatment and disposal options in the disposal sheet. Different treatment types and technologies exist. Some should be avoided as they cause health hazards to the population and damage the environment, some are very simple but at least less hazardous and finally there are advanced treatment technologies. The treatment technologies represented in the SWM-GHG calculator are divided in three groups. The first group includes common practices that should be avoided. They affect waste which is not regularly collected but usually scattered or delivered to a wild dump site. Additionally, scattered waste is sometimes burned in the open air, producing huge amounts of toxic substances (in particular dioxins, furans, aromatic hydrocarbons etc.). The second group is that of simple treatment and disposal technologies. Apart from disposal to controlled landfills (with or without landfill gas collection) this includes simple biological stabilization before disposal whereby methane emissions are reduced. The third group includes advanced technologies. Apart from waste incineration this include treatment options with the purpose of separating recyclable fractions before stabilizing the remaining waste biologically prior to sending to landfill or to produce a refuse derived fuel that may be incinerated e.g. in cement kilns

In this study different scenarios have been defined for solid waste management. For quantification of GHG emissions from the treatment of MSW in each of the scenarios, SWM-GHG calculator was adopted.

3.8.2 Overview of proposed scenarios

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

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

The following table presents a summary of the scenarios analyzed in the current chapter.

Table 3-92: Scenarios overview

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

3.8.3 Scenario 1: One Bin collection system (Mixed Waste Bin)

3.8.3.1 Key Features

Scenario 1 is based in one bin collection system (mixed waste) and includes three sub-scenarios depending on the treatment technology selected to treat residual waste: sub-scenario 1a, which includes MBT Plant, sub-scenario 1b which includes MBT Plant with Anaerobic Digestion and aerobic composting of digestate sub-scenario 1b which includes Incinerator. The key features of scenario 1 are:

Collection

- *One Bin Collection system for mixed waste*. According to calculations, the total number of waste bins (capacity 1,1 m^3) needed for scenario 1a, 1b and 1c is 3697. However because there are already existing bins in Southwest Region, the necessary bins that need to be purchased in scenario 1a, 1b and 1c are 3014. The amount of waste estimated to be collected in this system will be 51229 t/y (81,37% of total generated waste) for scenario 1a, 1b and 1c.
- *Separate Collection of Hazardous material/WEEE/C&D material/Recycling Materials/Wood/Other Special Waste Streams*. The following assumptions were made: (i) Collection of 50% of electric and electronic waste fraction i.e. 0,36% of total generated waste (225 t/y), (ii) Collection of 100% of municipal hazardous waste fraction i.e. 0,69% of total generated waste (436 t/y), (iii) Collection of 50% of construction and demolition waste fraction, i.e. 0,59% of total generated waste (373 t/y), (iv) collection of 15% of wood fraction i.e. 0,12% of total generated waste (77 t/y), (v) collection of 50% of other special waste streams i.e. 0,17% of total generated waste (105 t/y) and (vi) Collection of 3% of recyclable materials in Green Points, i.e. 0,97% of total generated recyclable waste (610 t/y). All these assumptions are the same for scenario 1a, 1b and 1c.
- *Separate collection of Green Waste.* The assumption made is that the 40% of green waste fraction collected, i.e. 5,70% of total generated waste (3591 t/y). This assumption is common for scenario 1a, 1b and 1c.
- *Sorting at Source for packaging waste (Collective Schemes)*. The minimum requirements that need to be achieved in year 2021 are: glass packaging 47,20%, plastic packaging 10,20%, paper packaging 38,60%, Fe packaging 33,60% and Al packaging 33,60% (all of these percentages are of generated packaging waste fraction). The total percentage of collected packaging waste in 2021 for scenario 1a, 1b and 1c after calculations, is 27,09% of total generated packaging waste and 6,85% of total generated waste (4313 t/y).

Treatment of Mixed Waste Bin

- Collected Mixed Waste from the mixed Bin processed either to a Mechanical Biological Treatment Plant with aerobic composting process (scenario 1a) or to a Mechanical Biological Treatment Plant with anaerobic digestion and aerobic composting of digestate (scenario 1b) or to an incineration plant (scenario 1b).

Treatment of Biodegradables sorted at source (Home Composting)

- *Home Composting*. For the estimation of quantities that will be directed to home composting process is assumed that the 20% of rural population will be served, ie 20%*35.2%=7%, and the fractions that can be used in this process are green waste and biodegradable waste. According to calculations, the total number of waste bins (capacity 0,2 m^3) that needed for scenario 1a, 1b and 1c for home composting process is 3520. Home composting process takes place in scenario 1a, 1b and 1c.

Treatment of Green Waste

- Collected Green Waste will be directed to windrow composting process for the production of high quality compost (Scenario 1a, 1b) or to the incinerator plant (Scenario 1c).

Table 3-93: Assumptions and calculations for scenarios 1a, 1b and 1c

		Scenario 1a % Collection (Average 2021-2046)	Scenario 1b % Collection (Average 2021-2046)	Scenario 1c % Collection (Average 2021-2046)
Green Points	A* A A C	3% of recyclable materials fraction 15% of wood packaging fraction 3,37% of packaging waste Total collection: 0,97% of generated waste	3% of recyclable materials fraction 15% of wood packaging fraction 3,37% of packaging waste Total collection: 0,97% of generated waste	3% of recyclable materials fraction 15% of wood packaging fraction 3,37% of packaging waste Total collection: 0,97% of generated waste
Sorting at source of packaging waste (Collective Schemes)	A C	26,24% of packaging waste 6,85% of generated waste	26,24% of packaging waste 6,85% of generated waste	26,24% of packaging waste 6,85% of generated waste
Green Waste	A C	40% of green waste fraction 5,70% of generated waste	40% of green waste fraction 5,70% of generated waste	40% of green waste fraction 5,70% of generated waste
Home Composting	A C	Served the 20% of rural population, 7% of total population 7% of Green waste +Biodegredable waste 3,18% of generated waste	Served the 20% of rural population, 7% of total population 7% of Green waste +Biodegredable waste 3,18% of generated waste	Served the 20% of rural population, 7% of total population 7% of Green waste +Biodegredable waste 3,18% of generated waste
Separate Collection of other waste fractions	A A A C	50% of WEEE fraction 50% of C&D material fraction 50% of other special waste streams fraction 1,12% of generated waste	50% of WEEE fraction 50% of C&D material fraction 50% of other special waste streams fraction 1,12% of generated waste	50% of WEEE fraction 50% of C&D material fraction 50% of other special waste streams fraction 1,12% of generated waste
Hazardous materials	A C	100% of Hazardous material fraction 0,69% of generated waste	100% of Hazardous material fraction 0,69% of generated waste	100% of Hazardous material fraction 0,69% of generated waste
Packaging waste Mechanical Treatment/Incineration	A C	26,48% of packaging waste 6,91% of generated waste	26,48% of packaging waste 6,91% of generated waste	-

A: Assumption, C: Calculation

In order to determine the recyclable quantities and packaging materials collected from mechanical separation of MBT Plant (Scenario 1a and 1b) the following assumptions were made:

Recyclables	Incoming quantities of recyclables in Mechanical treatment % (of generated waste)	Final Recovery %	Recovery of packaging fraction*
Paper	10,23%	3,27%	1,63%
Plastic	11,66%	4,66%	3,80%
Glass	3,23%	0,65%	0,35%
Fe	1,15%	0,98%	0,59%
Al	0,63%	0,54%	0,54%
Total	**26,90%**	**10,10%**	**6,91%**

**Paper packaging=100%Cardboard+25%Paper=49,69% of total paper fraction*
**Plastic packaging=Plastic packaging waste+Plastic bags+PET Bottles= 81,55% of total plastic fraction*
**Glass packaging=70%Glass=54,50% of total glass fraction*
**Fe metal packaging=70% Fe metal=60,40% of total Fe metal fraction*
**Al metal packaging=100% Al metal=1% of generated waste of 100% of total Al fraction*

In order to determine the Fe metals and electric energy production from the incineration plant (scenario 1c) the following figures were used:

Parameter	Origin
60% recovery only of Fe metals (from Fe metals that insert the incineration plant)	A*
Calorific value of incoming waste in incineration plant 10180KJ/kg	C*
Net electricity production = (incoming waste in WtE)*22%*10180/3600 (MWh/y)	C
Annual operational hours 7488	A
Net electric power = Net electricity production/7488 (MW)	C

**A: Assumption, C: Calculation*

3.8.3.2 Achievement on national targets for Recylcing and Biodegradables

In the following tables the achievement of national targets for recycling and biodegradable waste for landfilling is presented.

Packaging waste

Recycling of packaging waste % (2021)	**Scenario 1a / Scenario 1b**	**Achievement on recycling targets**	**Scenario 1c**	**Achievement on recycling targets**
Total % of recycling of packaging waste	56,10%	Yes	29,62%	No
% glass packaging	60,16%	Yes	50,20%	No
% plastic packaging	47,92%	Yes	13,20%	No
% paper packaging	60,29%	Yes	41,60%	No
% Fe packaging	90,49%	Yes	36,60%	No
% Al packaging	90,49%	Yes	36,60%	No
% wood packaging	15%	Yes	15%	Yes

Biodegradable waste

Reduction of BMW	**Scenario 1a**	**Achievement on targets of BDW**	**Scenario 1b**	**Achievement on targets of BDW**	**Scenario 1c**	**Achievement on targets of BDW**
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2021)*	81.90%	Yes	96.04%	Yes	100%	Yes
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2027)	81.40%	Yes	95.93%	Yes	100%	Yes

**Biodegradable municipal waste in territory 1995=300005 t (Rulebook LoWM Article 87)*
Total population of country 2022547 (statistical office 2002)
Southwest Region Population 221546 (10,95% of territory)
*Biodegradable municipal waste in Southwest Region 1995, 10,95%*305000 t =33409 t*

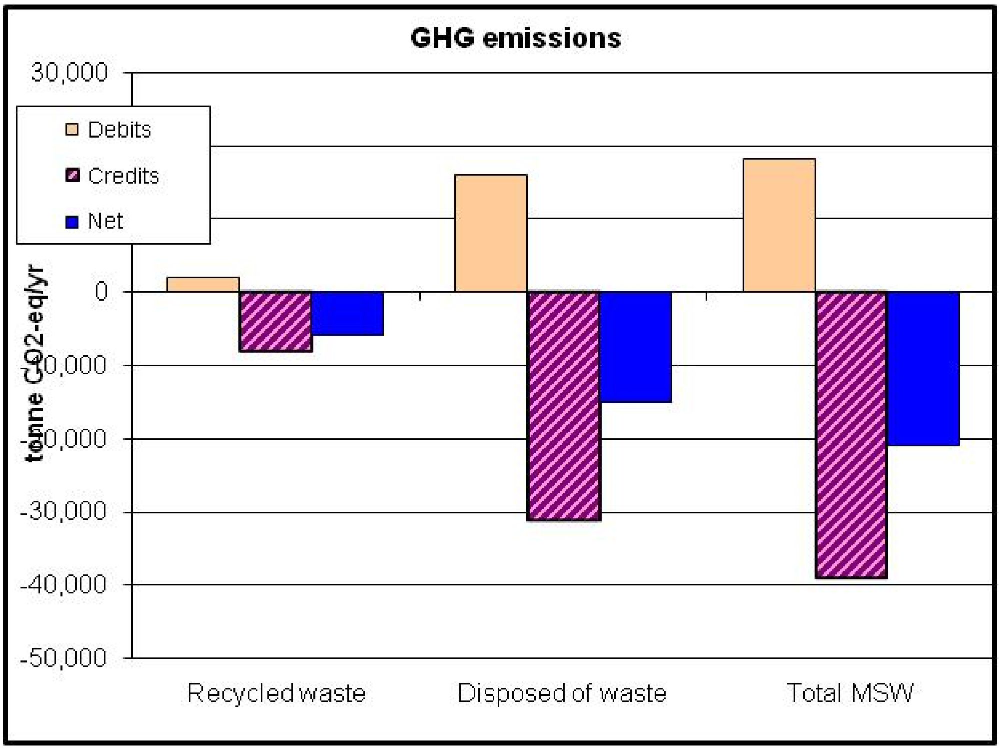
3.8.3.3 Greenhouse gas emissions

For the calculation of greenhouse gas emission impact, SWM-GHG Calculator was applied, a tool for calculating greenhouse gases in solid waste management.

Debits: Represents the GHG emissions caused by recycling/disposed of waste
Credits: Represents the GHG emissions savings by recycling/disposed of waste
Net: Net effect, i.e. difference between debits and credits

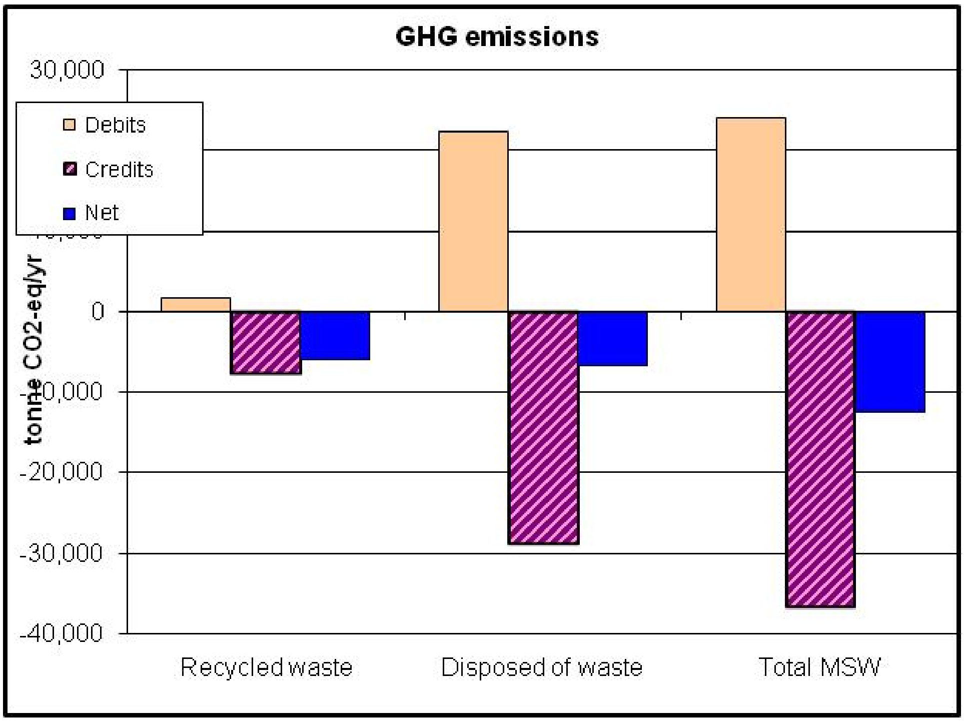
Scenario 1a/1b

t CO_2-eq/yr	Recycled waste	Disposed waste	Total MSW
Debits	2054	16099	18153
Credits	-7999	-31079	-39078
Net	-5945	-14980	**-20925**

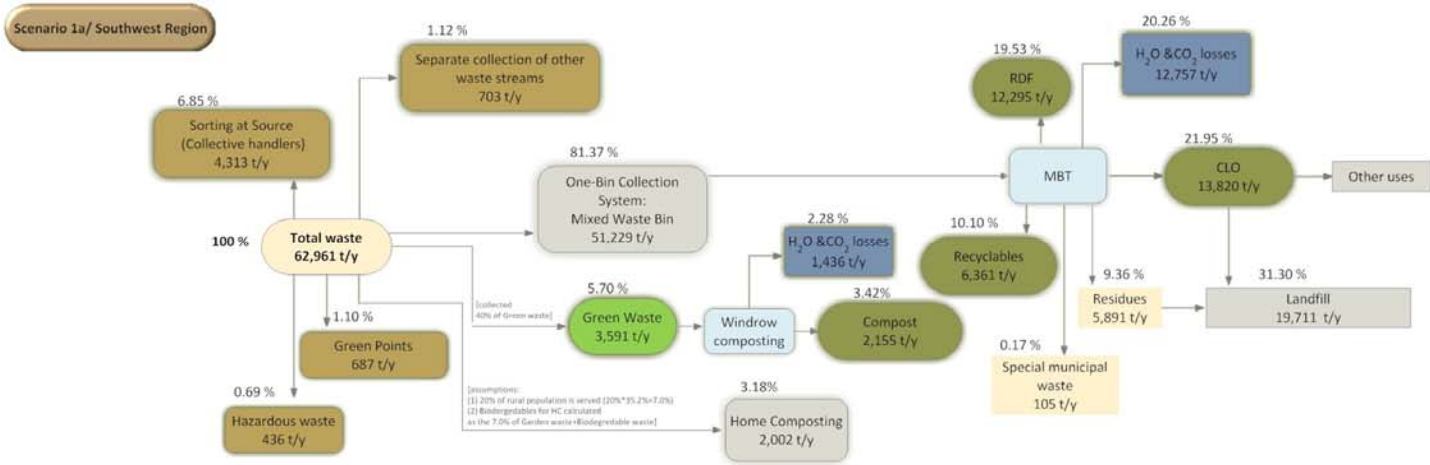


Scenario 1c

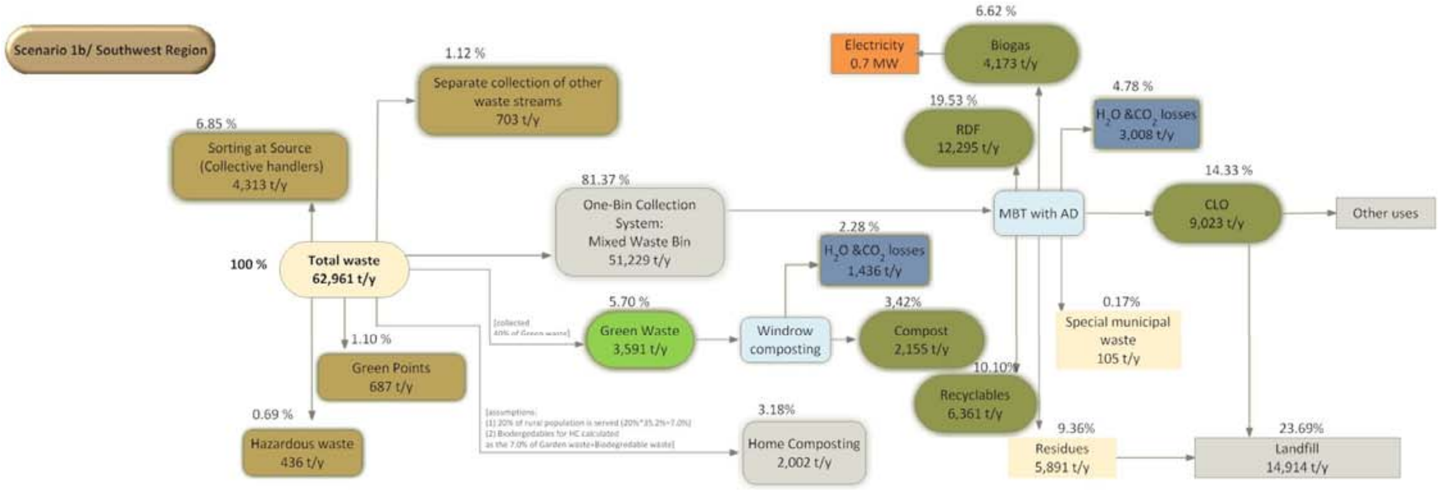
t CO_2-eq/yr	Recycled waste	Disposed waste	Total MSW
Debits	1744	22328	24072
Credits	-7661	-2895	-36620
Net	-5917	-6631	**-12548**


GHG emissions
30,000
0
-10,000
-20,000
-30,000
-40,000
tonne CO2-eq/yr
Debits
Credits
Net
Recycled waste
Disposed of waste
Total MSW

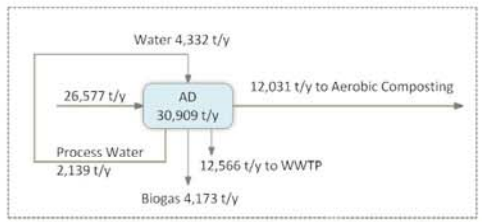
3.8.3.4 Detailed flow diagrams



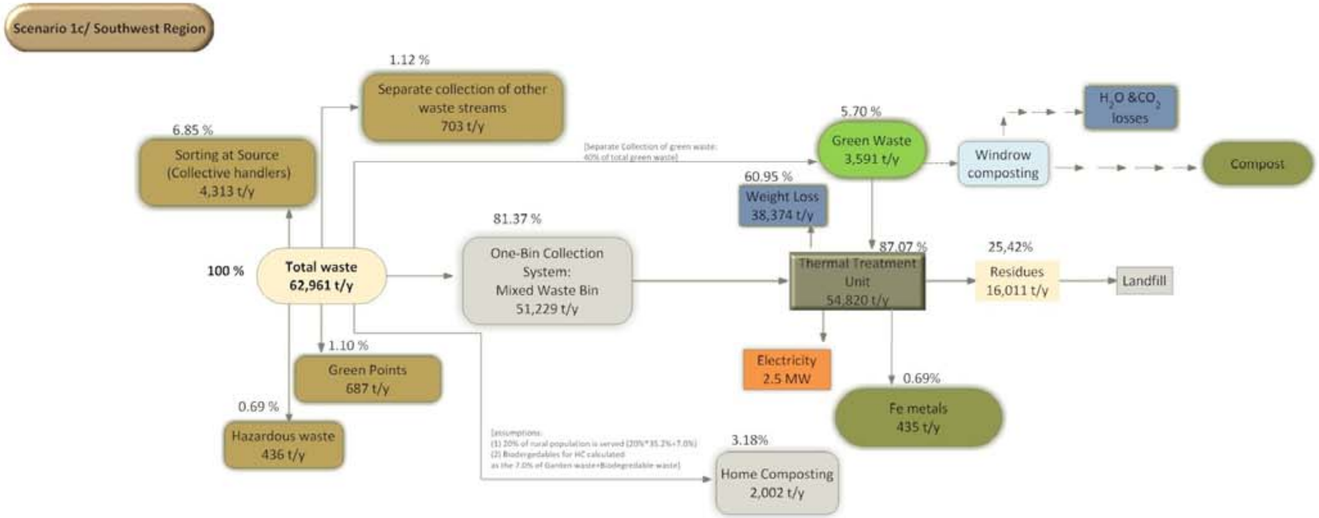
Scenario 1a	
Collection	One Bin Collection System
	Green Points
	Separate Collection of Green waste
Treatment of Mixed Bin	Aerobic Composting
Treatment of Green Waste	Aerobic Composting
Treatment at the source	Home Composting
Products	Compost
	CLO
	Recyclables
	RDF
Landfill	Residues from treatment



Anaerobic Digestion



Scenario 1b	
Collection	One Bin Collection System Green Points Separate Collection of Green waste
Treatment of Mixed Bin	Anaerobic Digestion and Aerobic composting of digestate
Treatment of Green Waste	Aerobic Composting
Treatment at the source	Home Composting
Products	Compost CLO Recyclables RDF Biogas
Landfill	Residues from treatment



Scenario 1c	
Collection	One Bin Collection System Green Points Separate Collection of Green waste
Treatment of Mixed Bin	Thermal Treatment
Treatment of Green Waste	Incineration
Products	Eel Fe metals
Landfill	Residues from Incineration

3.8.4 Scenario 2: Two bin collection system (Mixed Waste & Biowaste)

3.8.4.1 Key Features

Scenario 2 is based in two bin collection system (mixed waste and biodegradable waste) and does not include sub-scenarios. The key features of scenario 2 are:

Collection

- *Two Bin Collection system*. One *organic waste bin* for separate collection of biowaste at source and one *Mixed Bin* for residual waste. According to calculations, the total number of mixed waste bins (capacity 1,1 m^3) that needed for Scenario 2 is 2632 and the total number of organic waste bins (capacity 0,66 m^3) is 2364. However because there are already existing bins in Southwest Region, the necessary mixed waste bins that needed to be purchased in Scenario 2 are 1975. The amount of waste estimated to be collected in mixed waste bin will be 36467 t/y (57.92% of total generated waste) and the amount of waste collected in organic waste bin is 16764 t/y (26.63% of total generated waste).
- *Separate Collection of Hazardous material/WEEE/C&D material/Recycling Materials/Wood/Other Special Waste Streams*. The following assumptions were made: (i) Collection of 50% of electric and electronic waste fraction i.e. 0,36% of total generated waste (225 t/y), (ii) Collection of 100% of municipal hazardous waste fraction i.e. 0,69% of total generated waste (436 t/y), (iii) Collection of 50% of construction and demolition waste fraction, i.e. 0,59% of total generated waste (373 t/y), (iv) collection of 15% of wood fraction i.e. 0,12% of total generated waste (77 t/y), (v) collection of 50% of other special waste streams i.e. 0,17% of total generated waste (105 t/y) and (vi) Collection of 3% of recyclable materials in Green Points, i.e. 0,97% of total generated recyclable waste (610 t/y).
- *Separate collection of Green Waste.* The assumption made is that the 40% of green waste fraction collected, i.e. 5,70% of total generated waste (3591 t/y).
- *Sorting at Source for packaging waste (Collective Schemes)*. The minimum requirements that need to be achieved in year 2021 are: glass packaging 47,20%, plastic packaging 10,20%, paper packaging 38,60%, Fe packaging 33,60% and Al packaging 33,60% (all of these percentages are of generated packaging waste fraction). The total percentage of collected packaging waste in 2021 for scenario 1a, 1b and 1c after calculations, is 27,09% of total generated packaging waste and 6,85% of total generated waste (4313 t/y).
- *Sorting at Source for biodegradable waste (Organic waste bin*). The minimum requirements that needed to be achieved in year 2021 and 2027 are: 20% and 74% respectively for biodegradable waste and 20% and 85% respectively for garden waste.

Treatment of Mixed Waste Bin

- Collected Mixed Waste from the mixed waste Bin processed to a Material Recovery Facility (MRF). Recovered materials such as Fe, Al, plastic, paper and glass can be sold. Residues from MRF disposed in landfill. Mechanical Recovery Facility produces also RDF.

Treatment of Biodegradables sorted at source (Organic Waste Bin)

- Biological treatment (aerobic composting). The produced compost can be sold as good quality compost.

Treatment of Green Waste

- Collected Green Waste will be directed to Biological Treatment Process together with the waste from the Organic Waste Bin.

Table 3-94: Assumptions and calculations for scenario 2

		Scenario 2 **% Collection (Average 2021-2046)**
Green Points	A* A A C	3% of recyclable materials fraction 15% of wood packaging fraction 3,38% of packaging waste Total collection: 1,09% of generated waste
Sorting at source of packaging waste (Collective Schemes)	A C	26,24% of packaging waste 6,85% of generated waste
Green Waste	A C	40% of green waste fraction 5,70% of generated waste
Separate Collection of other waste fractions	A A A C	50% of WEEE fraction 50% of C&D material fraction 50% of other special waste streams fraction 1,12% of generated waste
Hazardous materials	A C	100% of Hazardous material fraction 0,69% of generated waste
Organic waste bin (Sorting at Source of biodegradable waste)	A C	65.54% of biodegradable waste fraction and 44.79% of green waste fraction 26.63% of total generated waste
Packaging waste from MRF	A C	35,86% of packaging waste 9,36% of generated waste

A: Assumption, C: Calculation

In order to determine the recyclable quantities and packaging materials collected from the mechanical separation of MRF (scenario 2) the following assumptions were made:

Recyclables	**Incoming quantities of recyclables in Mechanical treatment % (of generated waste)**	**Final Recovery %**	**Recovery of packaging fraction***
Paper	10,23%	5,94%	2,95%
Plastic	11,66%	5,75%	4,69%
Glass	3,23%	1,92%	1,04%
Fe	1,15%	0,59%	0,36%
Al	0,63%	0,32%	0,32%
Total	**26,90%**	**14,51%**	**9,36%**

**Paper packaging= 49,69% of total paper fraction*
**Plastic packaging= 81,35% of total plastic fraction*
**Glass packaging= 54,50% of total glass fraction*
**Fe metal packaging=60,40% of total Fe metal fraction*
**Al metal packaging=100% Al metal=1% of generated waste of 100% of total Al fraction*

3.8.4.2 Achievement on national targets for Recycling and Biodegradables

In the following tables the achievement of national targets for recycling and biodegradable waste for landfilling. Is presented

Packaging waste

Recycling of packaging waste % (2021)	Scenario 2	Achievement on recycling targets
Total % of recycling of packaging waste	65,48%	Yes
% glass packaging	79,83%	Yes
% plastic packaging	55,99%	Yes
% paper packaging	75,47%	Yes
% Fe packaging	68,93%	Yes
% Al packaging	68,93%	Yes
% wood packaging	15%	Yes

Biodegradable waste

Reduction of BMW	Scenario 2	Achievement on targets of BDW
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2021)*	64.28%	Yes
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2027)	74.00%	Yes

**Biodegradable municipal waste in territory 1995=305000 t (Rulebook LoWM Article 87)*
Total population of country 2022547 (statistical office 2002)
Southwest Region Population 221546 (10,95% of territory)
*Biodegradable municipal waste in Southwest Region 1995, 10,95%*305000 t =33409 t*

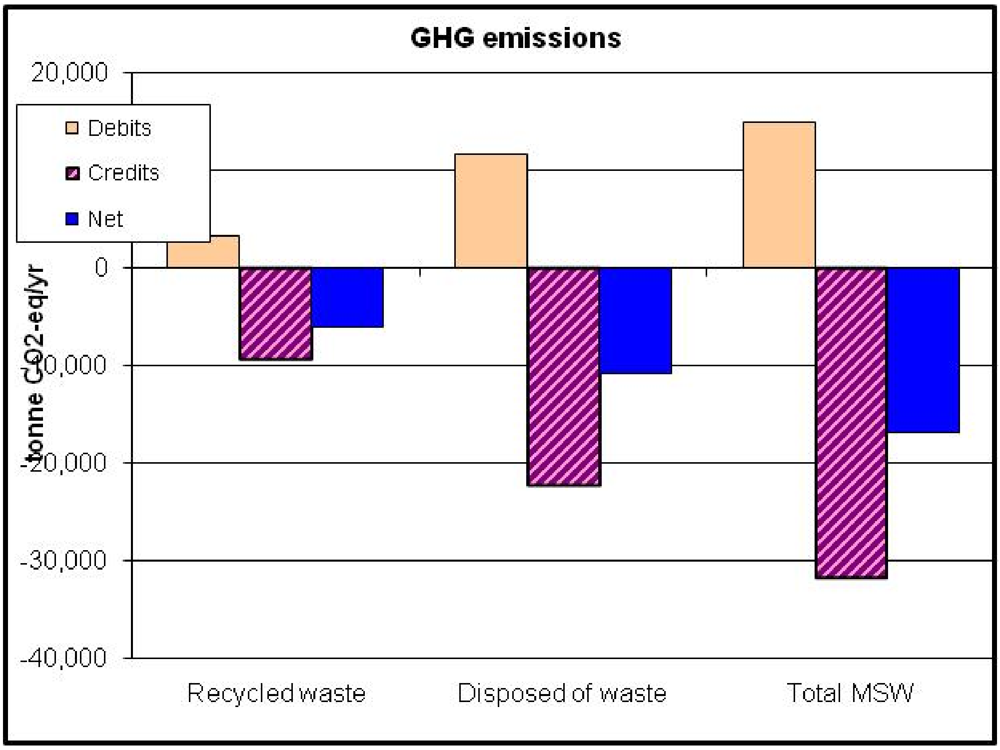
3.8.4.3 Greenhouse gas emissions

For the calculation of greenhouse gas emission impact, SWM-GHG Calculator was applied, a tool for calculating greenhouse gases in solid waste management.

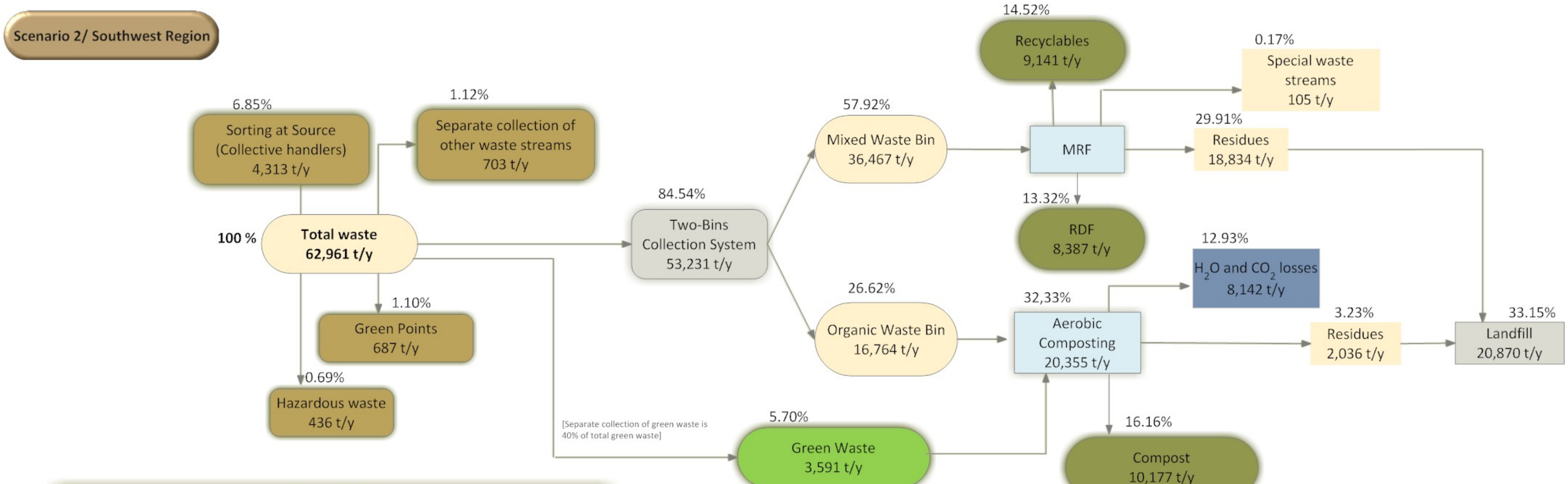
Debits: Represents the GHG emissions caused by recycling/disposed of waste
Credits: Represents the GHG emissions savings by recycling/disposed of waste
Net: Net effect, i.e. difference between debits and credits

Scenario 2

t CO_2-eq/yr	Recycled waste	Disposed waste	Total MSW
Debits	3326	11572	14898
Credits	-9388	-22339	-31727
Net	-6062	-10767	**-16829**



3.8.4.4 Detailed Flow Diagrammes



Scenario 2	
Collection	Two Bins Collection System (Mixed Waste Bin and Organic Waste Bin) Green Points Separate Collection of Green waste
Treatment of Mixed Bin	MRF
Treatment of Organic Waste Bin	Aerobic Composting
Treatment of Green Waste	Aerobic Composting
Products	Compost Recyclables RDF
Landfill	Residues from MRF and aerobic composting

3.8.5 Scenario 3: Two bin collection system (Mixed Waste & Recyclable Waste)

3.8.5.1 Key Features

Scenario 3 is based in two bin collection system (mixed or residual waste and recyclable waste) and includes three sub-scenarios depending on the treatment technology selected to treat residual waste. Sub-scenario 3a, which includes MRF Plant and MBT plant with Aerobic Composting, sub-scenario 3b which includes MRF Plant and MBT with AD and aerobic composting of digestate and sub-scenario 3c which includes MRF and MBS Plant. The key features of scenario 3 are:

<u>Collection</u>

- <u>*Two Bin Collection system*</u>. One *Recyclable waste bin* for separate collection of recyclables at source and one *Residual Waste Bin* for residual waste. According to calculations, the total number of residual waste bins (capacity 1,1 m^3) required for scenario 3a,3b and 3c is 3006. Also the total number of recyclable waste bins (capacity 1,1 m^3) is 2016 for scenario 3a, 3b and 3c. However, because there are already existing residual waste bins in Southwest Region, the necessary mixed waste bins that need to be purchased in scenario 3a, 3b and 3c are 2341. Regarding scenario 3a,3b and 3c, the amount of waste estimated to be collected in residual waste bin will be 41668 t/y (66.18% of total generated waste) and the amount of waste estimated to be collected in recyclable waste bin will be 13874 t/y (22.03% of total generated waste).
- <u>*Separate Collection of Hazardous material/WEEE/C&D material/Recycling Materials/Wood/Other Special Waste Streams*</u>. The following assumptions were made: (i) Collection of 50% of electric and electronic waste fraction i.e. 0,36% of total generated waste (225 t/y), (ii) Collection of 100% of municipal hazardous waste fraction i.e. 0,69% of total generated waste (436 t/y), (iii) Collection of 50% of construction and demolition waste fraction, i.e. 0,59% of total generated waste (373 t/y), (iv) collection of 15% of wood fraction i.e. 0,12% of total generated waste (77 t/y), (v) collection of 50% of other special waste streams i.e. 0,17% of total generated waste (105 t/y) and (vi) Collection of 3% of recyclable materials in Green Points, i.e. 0,97% of total generated recyclable waste (610 t/y). All these assumptions are the same for scenario 3a, 3b and 3c.
- <u>*Separate collection of Green Waste.*</u> The assumption made is that the 40% of green waste fraction collected, i.e. 5,70% of total generated waste (3591 t/y). This assumption is common for scenario 3a, 3b and 3c.
- <u>*Sorting at Source for recyclable waste*</u>. The recyclables which will be inserted in recyclable bin should be: glass 4.89%, plastic 12.78%, paper 13.60%, Fe 1.52% and Al 0.97% (all of these percentages are of total generated waste). The above assumptions are common for all sub-scenarios (3a, 3b and 3c).

<u>Treatment of Residual Waste Bin and</u>

- Collected Residual Waste from residual waste Bin can be treated with different processes: MBT with aerobic composting (3a), MBT with anaerobic digestion (3b) Mechanical Biological Stabilization (3c).

<u>Treatment of Recyclable Waste Bin</u>

- Collected Recyclable Waste from the Recyclable waste bin and aerobic composting will be diverted in Material Recovery Facility (MRF). Recovered materials will be sold. Residues will be disposed in landfill

<u>Treatment of Biodegradables sorted at source (Home Composting)</u>

- <u>*Home Composting*</u>. For the estimation of quantities that will be directed to home composting process is assumed that the 20% of rural population will be served, ie 20%*35.2%=7%, and the fractions that can be used in this process are green waste and biodegradable waste. According to calculations, the total number of waste bins (capacity 0,2 m^3) that needed for all sub-scenarios for home composting process is 3520. Home composting process takes place in scenario 3a, 3b and 3c.

Treatment of Green Waste

- Collected Green Waste will be diverted to aerobic composting process for the production of high quality compost.

Table 3-95: Assumptions and calculations for scenarios 3a, 3b and 3c

		Scenario 3a **% Collection (Average 2021-2046)**	**Scenario 3b** **% Collection (Average 2021-2046)**	**Scenario 3c** **% Collection (Average 2021-2046)**
Green Points	A* A A C	3% of recyclable materials fraction 15% of wood packaging fraction 3,37% of packaging waste <u>Total collection: 0,97% of generated waste</u>	3% of recyclable materials fraction 15% of wood packaging fraction 3,37% of packaging waste <u>Total collection: 0,97% of generated waste</u>	3% of recyclable materials fraction 15% of wood packaging fraction 3,37% of packaging waste <u>Total collection: 0,97% of generated waste</u>
Green Waste	A C	40% of green waste fraction <u>5,70% of generated waste</u>	40% of green waste fraction <u>5,70% of generated waste</u>	40% of green waste fraction <u>5,70% of generated waste</u>
Home Composting	A C	Served the 20% of rural population, 7% of total population 7% of Green waste +Biodegredable waste <u>3,18% of generated waste</u>	Served the 20% of rural population, 7% of total population 7% of Green waste +Biodegredable waste <u>3,18% of generated waste</u>	Served the 20% of rural population, 7% of total population 7% of Green waste +Biodegredable waste <u>3,18% of generated waste</u>
Separate Collection of other waste fractions	A A A C	50% of WEEE fraction 50% of C&D material fraction 50% of other special waste streams fraction <u>1,12% of generated waste</u>	50% of WEEE fraction 50% of C&D material fraction 50% of other special waste streams fraction <u>1,12% of generated waste</u>	50% of WEEE fraction 50% of C&D material fraction 50% of other special waste streams fraction <u>1,12% of generated waste</u>
Hazardous materials	A C	100% of Hazardous material fraction <u>0,69% of generated waste</u>	100% of Hazardous material fraction <u>0,69% of generated waste</u>	100% of Hazardous material fraction <u>0,69% of generated waste</u>
Packaging waste from Mechanical Treatment of MBT/MRF/MBS	A C	65,85% of packaging waste <u>17,19% of generated waste</u>	65,85% of packaging waste <u>17,19% of generated waste</u>	54,32% of packaging waste <u>14,18% of generated waste</u>

A: Assumption, C: Calculation

For the determination of recyclable quantities and packaging materials collected from mechanical separation of MRF (Scenario 3a, 3b and 3c) the following assumptions were made:

Recyclables	Incoming quantities of recyclables in Mechanical treatment % (of generated waste)	Final Recovery %	Recovery of packaging fraction*
Paper	13.60%	8.21%	5.10%
Plastic	12.78%	6,30%	5.24%
Glass	4.89%	2.95%	2.04%
Fe	1.52%	0.78%	0.55%
Al	0.97%	0.49%	0.49%
Total	**33.76%**	**18.73%**	**13.42%**

**Paper packaging=62,10% of total paper fraction*
**Plastic packaging=83,16% of total plastic fraction*
**Glass packaging= 70% of total glass fraction*
**Fe metal packaging= 70% of total Fe metal fraction*
**Al metal packaging= 100% of total Al fraction*

For the determination of recyclable quantities and packaging materials collected from mechanical separation of MBT (scenario 3a and 3b) the following assumptions were made:

Recyclables	Incoming quantities of recyclables in Mechanical treatment % (of generated waste)	Final Recovery %	Recovery of packaging fraction*
Paper	4.73%	1.32%	0.82%
Plastic	5.85%	2.34%	1.95%
Glass	1.70%	0.34%	0.24%
Fe	0.67%	0.57%	0.40%
Al	0.43%	0.36%	0.36%
Total	**13.38 %**	**4.94%**	**3.77%**

**Paper packaging=62,06% of total paper fraction*
**Plastic packaging=83,16% of total plastic fraction*
**Glass packaging= 70% of total glass fraction*
**Fe metal packaging= 70% of total Fe metal fraction*
**Al metal packaging= 100% of total Al fraction*

Especially for scenario 3c also collected Fe metals and Al for Mechanical Biological Stabilization plant (MBS). For the determination of these recyclable quantities and packaging materials the following assumptions were made:

Recyclables	Incoming quantities of recyclables in Mechanical treatment of MBS % (of generated waste)	Final Recovery %	Recovery of packaging fraction*
Fe	0,67%	0,57%	0,40%
Al	0,43%	0,36%	0,36 %
Total	**1,10%**	**0,93%**	**0,76%**

**Fe metal packaging=70% Fe metal=1,11% of generated waste or 70% of total Fe metal fraction*
**Al metal packaging=100% Al metal=1% of generated waste of 100% of total Al fraction*

3.8.5.2 Achievement on national targets for Recycling and Biodegradables

In the following tables the achievement of national targets for recycling and biodegradable waste for landfilling is presented.

Packaging waste

Recycling of packaging waste % (2021)	Scenario 3a / Scenario 3b	Achievement on recycling targets	Scenario 3c	Achievement on recycling targets
Total % of recycling of packaging waste	69.77%	Yes	58.25%	Yes
% glass packaging	68.28%	Yes	61.54%	Yes
% plastic packaging (2018)	68.59%	Yes	50.82%	Yes
% paper packaging	70.98%	Yes	61.54%	Yes
% Fe packaging	88.83%	Yes	88.83%	Yes
% Al packaging	88.83%	Yes	88.83%	Yes
% wood packaging	15%	Yes	15%	Yes

Biodegradable waste

Reduction of BMW	Scenario 3a	Achievement on targets of BDW	Scenario 3b	Achievement on targets of BDW	Scenario 3c	Achievement on targets of BDW
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2021)*	78,83%	Yes	91,52%	Yes	82.08%	Yes
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2027)	78,25 %	Yes	91,29%	Yes	81.59%	Yes

Biodegradable municipal waste in territory 1995=305000 t (Rulebook LoWM Article 87)
Total population of country 2022547 (statistical office 2002)
Southwest Region Population 221546 (10,95% of territory)
*Biodegradable municipal waste in Southwest Region 1995, 10,95%*305000 t =33409 t*

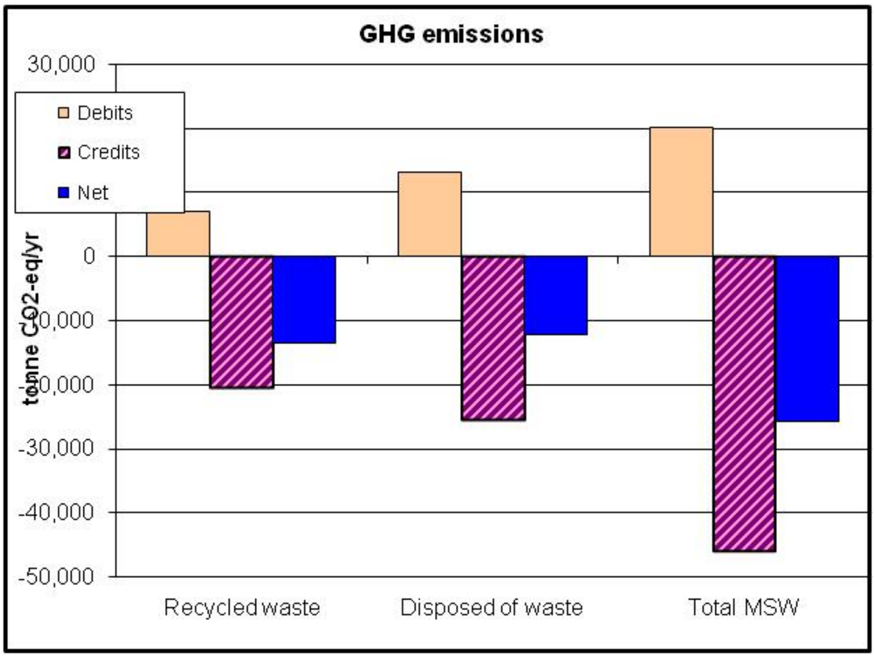
3.8.5.3 Greenhouse gas emissions

For the calculation of greenhouse gas emission impact, SWM-GHG Calculator was applied, a tool for calculating greenhouse gases in solid waste management.

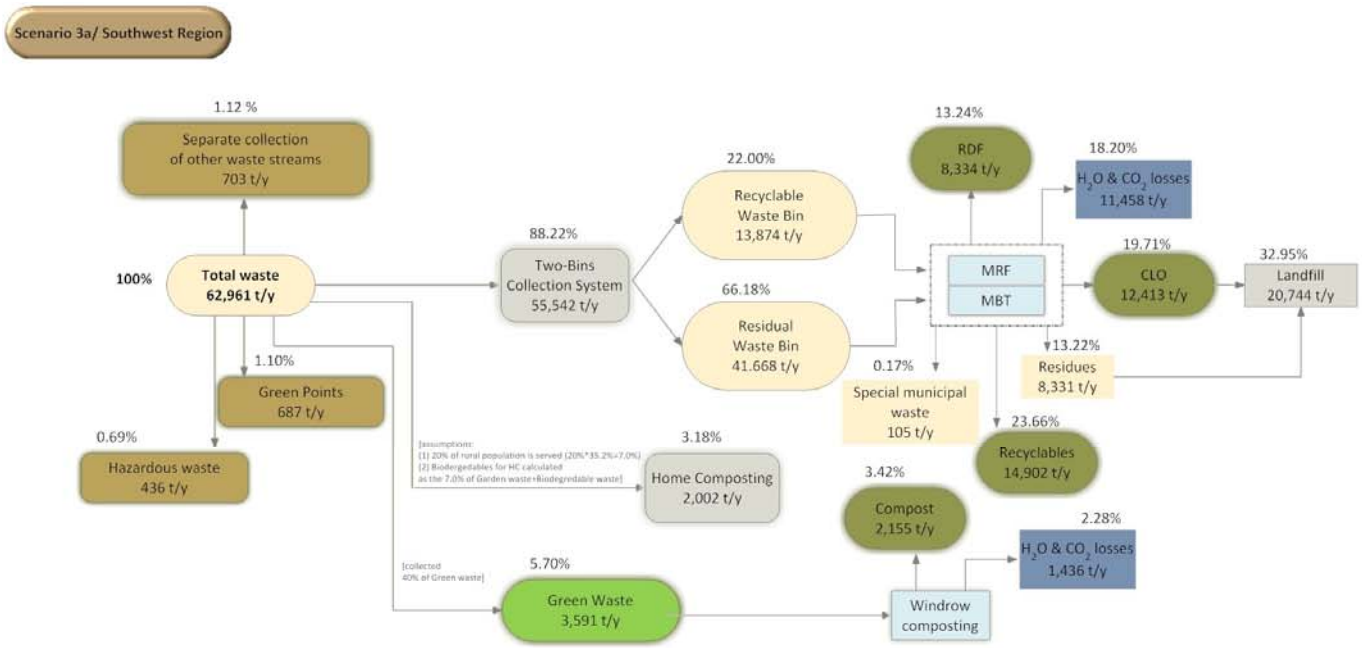
Debits: Represents the GHG emissions caused by recycling/disposed of waste
Credits: Represents the GHG emissions savings by recycling/disposed of waste
Net: Net effect, i.e difference between debits and credits

Scenario 3a/3b/3c

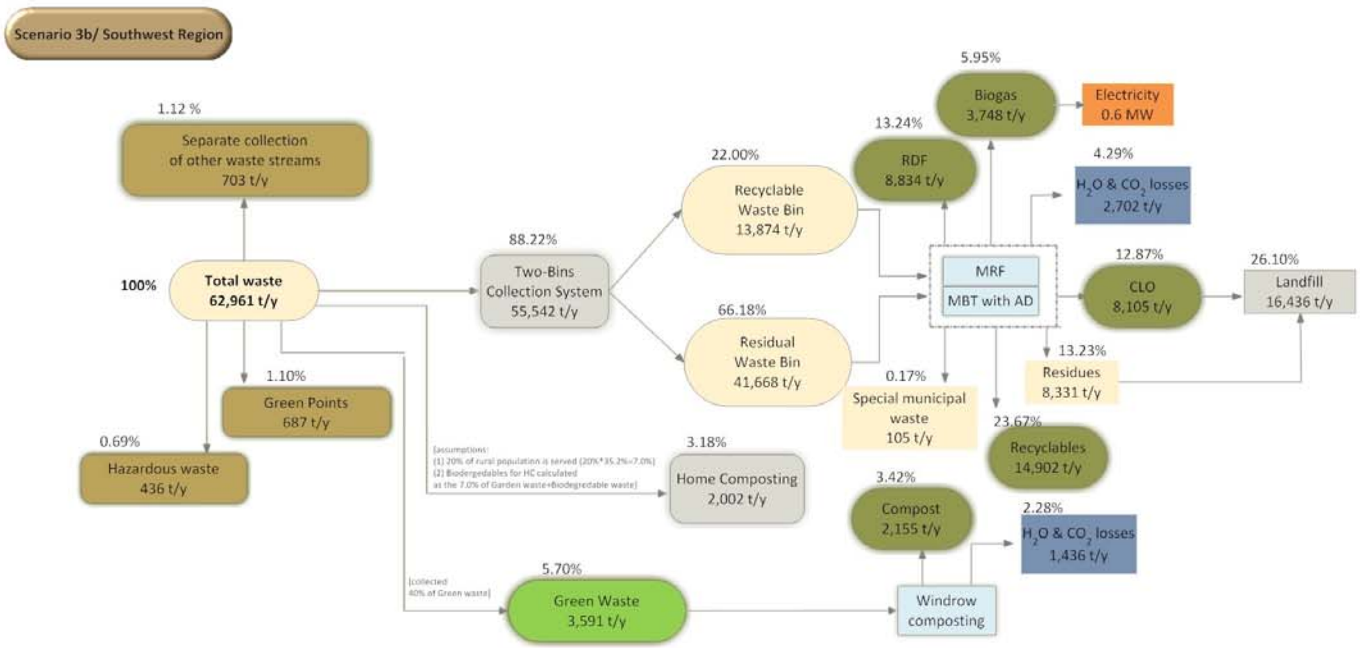
t CO_2-eq/yr	Recycled waste	Disposed waste	Total MSW
Debits	6966	13204	20170
Credits	-20516	-25490	-46006
Net	-13549	-12286	**-25836**



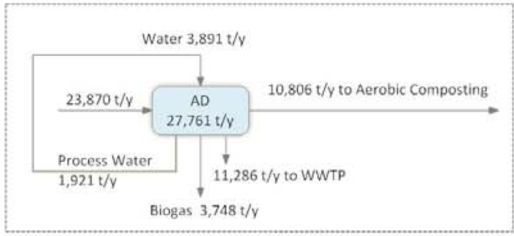
3.8.5.4 Detailed flow diagrams



Scenario 3a	
Collection	Two Bins Collection System (Recyclable Waste Bin and Residual Waste Bin) Green Points Separate Collection of Green waste
Treatment of Recyclable Waste Bin	MRF
Treatment of Residual Waste Bin	MBT with aerobic composting
Treatment of Green Waste	Aerobic composting
Treatment at the Source	Home Composting
Products	Compost Recyclables
Landfill	Residues from MRF Facility and MBT

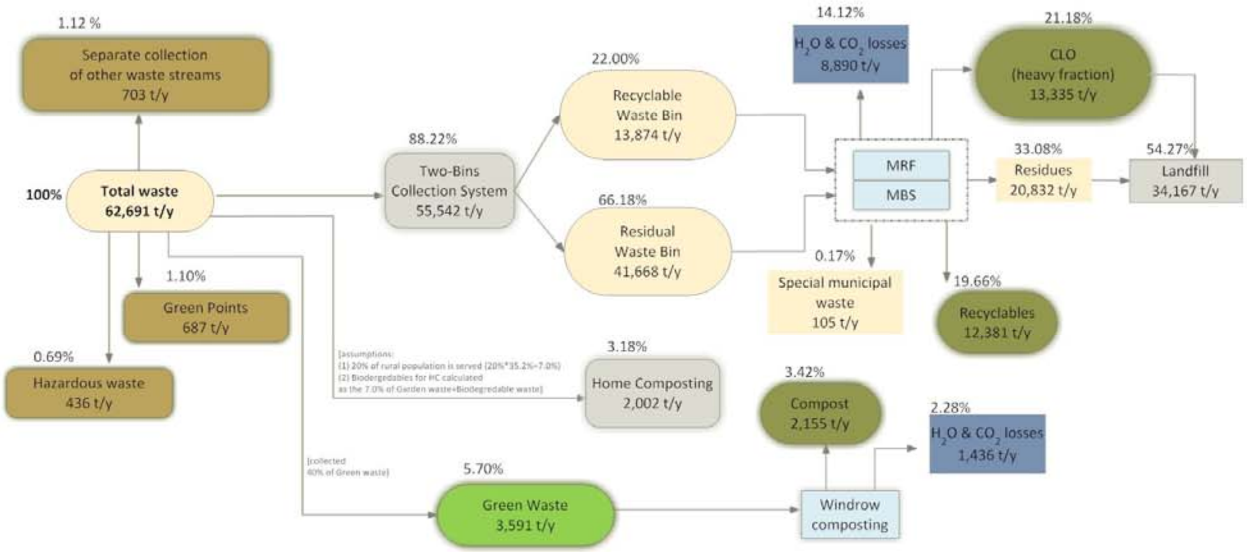


Anaerobic Digestion



Scenario 3b	
Collection	Two Bins Collection System (Recyclable Waste Bin and Residual Waste Bin) Green Points Separate Collection of Green waste
Treatment of Recyclable Waste Bin	MRF
Treatment of Residual Waste Bin	MBT with Anaerobic Digestion and aerobic composting of digestate
Treatment of Green Waste	Aerobic composting
Treatment at the Source	Home Composting
Products	Compost Recyclables Biogas
Landfill	Residues from MRF Facility and MBT

Scenario 3c/ Southwest Region



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

3.8.6 Scenario 4: Three bin collection system (Mixed Waste, Recyclable Waste & Biodegradable waste)

3.8.6.1 Key Features

Scenario 4 is based in three bin collection system (mixed waste, biodegradable waste and recyclable waste) and does not include sub-scenarios. The key features of scenario 4 are:

Collection

- *Three Bin Collection system*. One *organic waste bin* for separate collection of biowaste at source, one *Recyclable waste Bin* for separate collection of recyclables at source and one *Mixed Bin* for residual waste. According to calculations, the total number of residual waste bins (capacity 1,1 m^3) needed for Scenario 4 is 1942, the total number of organic waste bins (capacity 0,66 m^3) is 2364 and the total number of recyclable waste bins, (capacity 1,1 m^3) is 2016. However because there are already existing residual waste bins in Southwest Region, the necessary residual/mixed waste bins that needed to be purchased in Scenario 4 are 1301. The amount of waste estimated to be collected in residual waste bin is 26906 t/y (42.73% of total generated waste), the amount of waste estimated to be collected in organic waste bin is 16764 t/y (26.63% of total generated waste) and the amount of waste estimated to be collected in recyclable waste bin is 13874 t/y (22.03% of total generated waste).
- *Separate Collection of Hazardous material/WEEE/C&D material/Recycling Materials/Wood/Other Special Waste Streams*. The following assumptions were made: (i) Collection of 50% of electric and electronic waste fraction i.e. 0,36% of total generated waste (225 t/y), (ii) Collection of 100% of municipal hazardous waste fraction i.e. 0,69% of total generated waste (436 t/y), (iii) Collection of 50% of construction and demolition waste fraction, i.e. 0,59% of total generated waste (373 t/y), (iv) collection of 15% of wood fraction i.e. 0,12% of total generated waste (77 t/y), (v) collection of 50% of other special waste streams i.e. 0,17% of total generated waste (105 t/y) and (vi) Collection of 3% of recyclable materials in Green Points, i.e. 0,97% of total generated recyclable waste (610 t/y).
- *Separate collection of Green Waste.* The assumption made is that the 40% of green waste fraction collected, i.e. 5,70% of total generated waste (3591 t/y).
- *Sorting at Source for recyclable waste*. The recyclables which will be inserted in recyclable bin should be: glass 4.89%, plastic 12.78%, paper 13.60%, Fe 1.52% and Al 0.97% (all of these percentages are of total generated waste).
- *Sorting at Source for biodegradable waste (Organic waste bin*). The minimum requirements that needed to be achieved in year 2021 and 2027 are: 20% and 74% respectively for biodegradable waste and 20% and 85% respectively for garden waste.

Treatment of Residual Waste Bin

- Collected Residual Waste from the residual waste Bin disposed directly to landfill.

Treatment of Biodegradables sorted at source (Organic Waste Bin)

- Biological treatment (aerobic composting). The produced compost can be sold as good quality compost.

Treatment of Recyclable Waste Bin

- Collected Recyclable Waste from the Recyclable waste bin treated to a Material Recovery Facility (MRF). Recovered materials will be sold. Resides will be disposed in landfill.

Treatment of Green Waste

- Collected Green Waste will be diverted to aerobic composting process for the production of high quality compost together with the waste from the Organic Bin.

Table 3-96: Assumptions and calculations for scenario 4

		Scenario 4 **% Collection (Average 2021-2046)**
Green Points	A* A A C*	3% of recyclable materials fraction 15% of wood packaging fraction 3,37% of packaging waste Total collection: 0,97% of generated waste
Green Waste	A C	40% of green waste fraction 5,70% of generated waste
Separate Collection of other waste fractions	A A A C	50% of WEEE fraction 50% of C&D material fraction 50% of other special waste streams fraction 1,12% of generated waste
Hazardous materials	A C	100% of Hazardous material fraction 0,69% of generated waste
Organic waste bin (Sorting at Source of biodegradable waste)	A C	65.54% of biodegradable waste fraction and 44.79% of green waste fraction 26.63% of total generated waste
Packaging waste from MRF	A C	51.49% of packaging waste 13.44% of generated waste

**A: Assumption, C: Calculation*

For determine of recyclable quantities and packaging materials that collected from mechanical separation of MRF (scenario 4) the following assumptions were made:

Recyclables	**Incoming quantities of recyclables in Mechanical treatment % (of generated waste)**	**Final Recovery %**	**Recovery of packaging fraction***
Paper	13.60%	8.21%	5.10%
Plastic	12.78%	6,30%	5.24%
Glass	4.89%	2.95%	2.04%
Fe	1.52%	0.78%	0.55%
Al	0.97%	0.49%	0.49%
Total	**33.76%**	**18.73%**	**13.42%**

**Paper packaging=62,10% of total paper fraction*
**Plastic packaging=83,16% of total plastic fraction*
**Glass packaging= 70% of total glass fraction*
**Fe metal packaging= 70% of total Fe metal fraction*
**Al metal packaging= 100% of total Al fraction*

3.8.6.2 Achievement on national legislation

In the following tables the achievement of national targets for recycling and biodegradable waste for landfilling is presented.

Packaging waste

Recycling of packaging waste % (2021)	Scenario 4	Achievement on recycling targets
Total % of recycling of packaging waste	55.33%	Yes
% glass packaging	61.54%	Yes
% plastic packaging	50.82%	Yes
% paper packaging	61.54%	Yes
% Fe packaging	52.47%	Yes
% Al packaging	52.47%	Yes
% wood packaging	15.00%	Yes

Biodegradable waste

Reduction of BMW	Scenario 4	Achievement on targets of BDW
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2021)*	31.64%	No
Reduction of quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2027)	72.10%	Yes

Biodegradable municipal waste in territory 1995=305000 t (Rulebook LoWM Article 87)
Total population of country 2022547 (statistical office 2002)
Southwest Region Population 221546 (10,95% of territory)
*Biodegradable municipal waste in Southwest Region 1995, 10,95%*305000 t =33409 t*

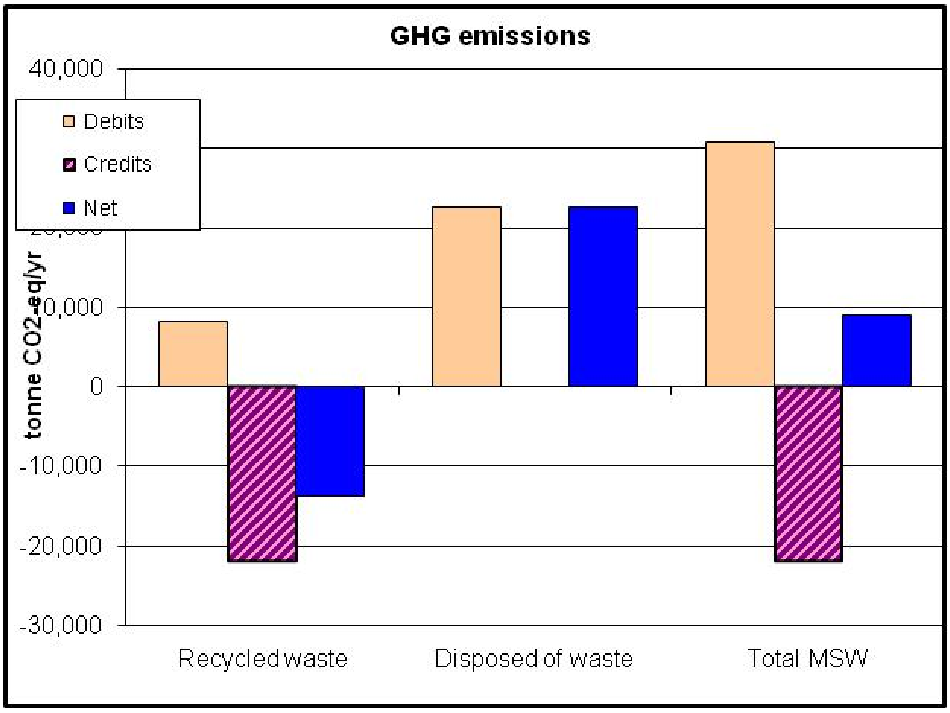
3.8.6.3 Achievement on targets for Recycling and Biodegradables

For the calculation of greenhouse gas emission impact, SWM-GHG Calculator was applied, a tool for calculating greenhouse gases in solid waste management.

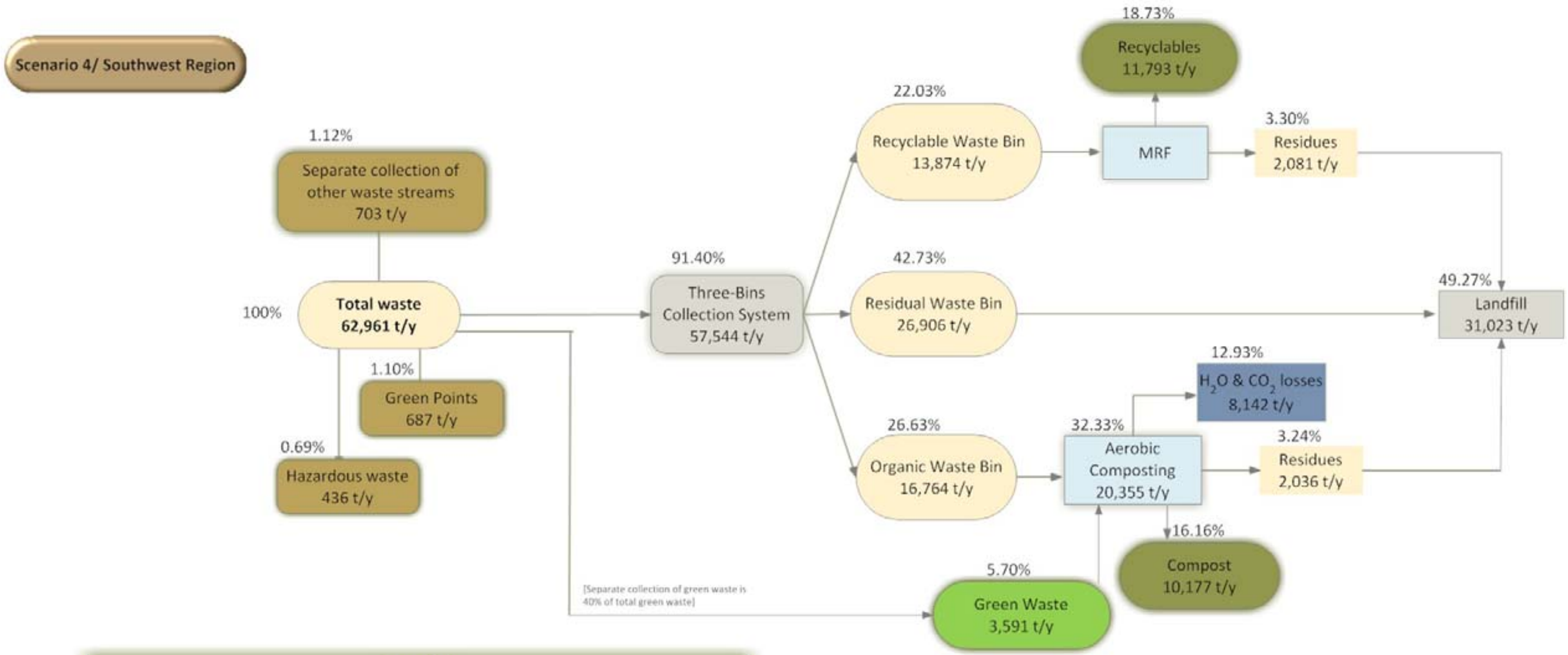
Debits: Represents the GHG emissions caused by recycling/disposed of waste
Credits: Represents the GHG emissions savings by recycling/dispo
Net: Net effect, i.e. difference between debits and credits

Scenario 4

t CO_2-eq/yr	Recycled waste	Disposed waste	Total MSW
Debits	8239	22591	30830
Credits	-21905	0	-21905
Net	-13666	22591	**8925**



3.8.6.4 Detailed flow diagrams



Scenario 4	
Collection	Three Bins Collection System (Recyclable Waste Bin and Residual Waste Bin and Organic Waste Bin) Green Points Separate Collection of Green waste
Treatment of Recyclable Waste Bin	MRF
Treatment of Residual Waste Bin	Directly to the Landfill
Treatment of Organic Waste Bin	Aerobic Composting
Treatment of Green Waste	Aerobic Composting
Products	Compost Recyclables
Landfill	Residues from MRF Facility and Aerobic Composting

3.8.7 Overview of Scenarios and Scenarios Performance

The table below presents a summary of the scenarios analyzed in the current chapter.

Table 3-97: Scenarios overview

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

Table 3-98: Capacities of treatment facilities (t/y)

	1a	1b	1c	2	3a	3b	3c	4
MRF				36,467	13,874	13,874	13,874	13,874
Aerobic Composting Organic waste bin				16,764				16,764
MBT Plant mixed waste bin	51,229	51,229			41,668	41,668		
MBS Plant Residual waste bin							41,668	
Incineration			54,820					
Biological treatment green waste	3,591	3,591		3,591	3,591	3,591	3,591	3,591
Home Composting	2,002	2,002	2,002		2,002	2,002	2,002	
Landfill	19,711	14,914	16,011	20,870	20,744	16,436	34,167	31,023

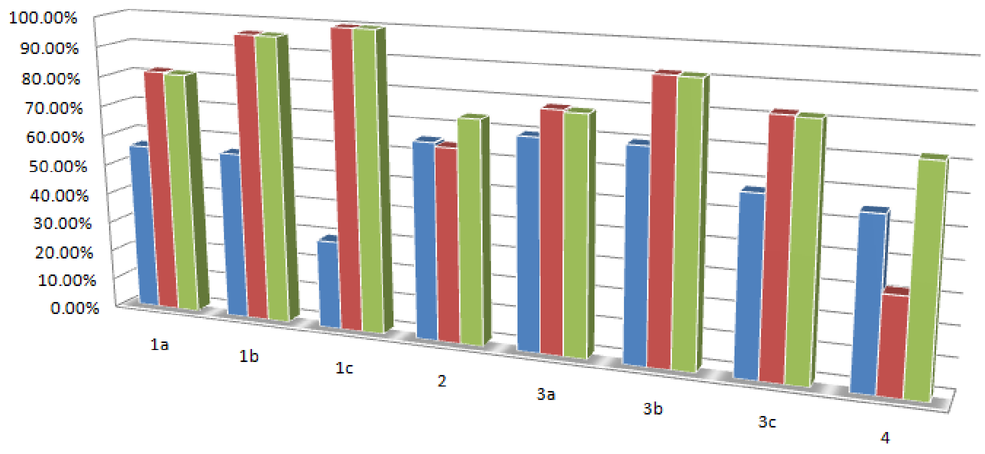
As it is aforementioned the discussed scenarios must achieve the minimum requirements based on national legislation according to the Law on management of packaging and packaging waste and to the Law in relation to reduction of the quantity of Biodegradable municipal waste landfilled. The table below presents the quantification of targets for all scenarios in Southwest Region.

Table 3-99: Quantification of targets for all scenarios in Southwest Region

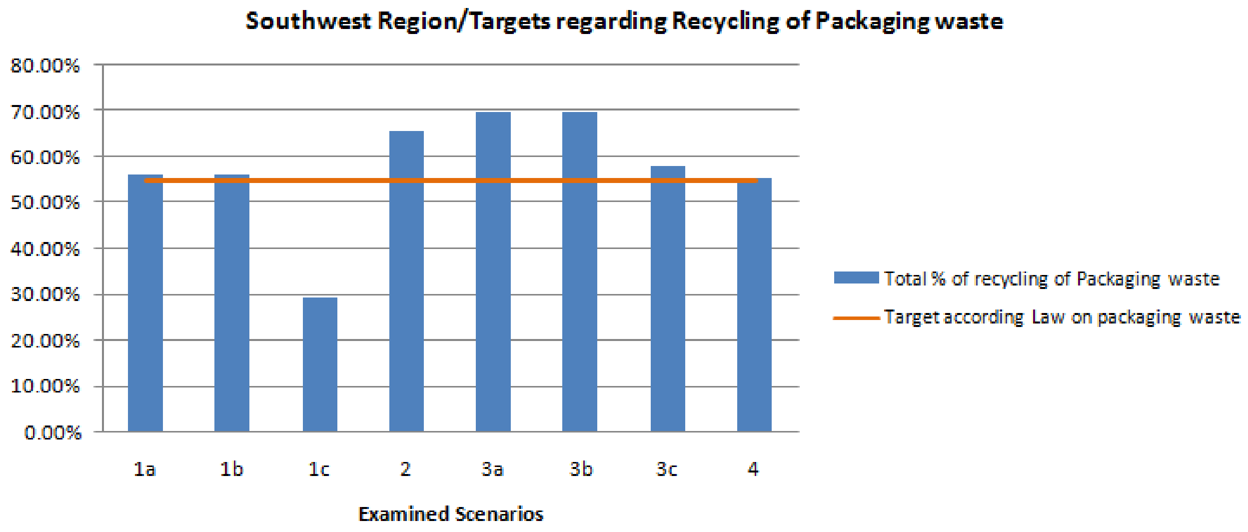
Scenarios	Total percentage of recycling of packaging waste (2021)		Reduction of the quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995	
			2021	2027
1a	56,10 %	Glass 60,16%	81,90 %	81,40%
		Plastic 47,92%		
		Paper 60,29%		
		Fe 90,49%		
		Al 90,49%		
		Wood 15,00%		
1b	56,10 %	Glass 60,16%	96,04%	95,93%
		Plastic 47,92%		
		Paper 60,29%		
		Fe 90,49%		
		Al 90,49%		
		Wood 15,00%		
1c	29,62 %	Glass 50,20%	100,00%	100,00%
		Plastic 13,20%		
		Paper 41,60%		
		Fe 36,60%		
		Al 36,60%		
		Wood 15,00%		
2	65,48%	Glass 79,83%	64,28%	74,00%
		Plastic 55.99%		
		Paper 75,47%		
		Fe 68,93%		
		Al 68,93%		
		Wood 15,00%		
3a	69.77%	Glass 68.28%	78,83%	78,25 %
		Plastic 68.59%		
		Paper 70.98%		
		Fe 88.83%		
		Al 88,83%		

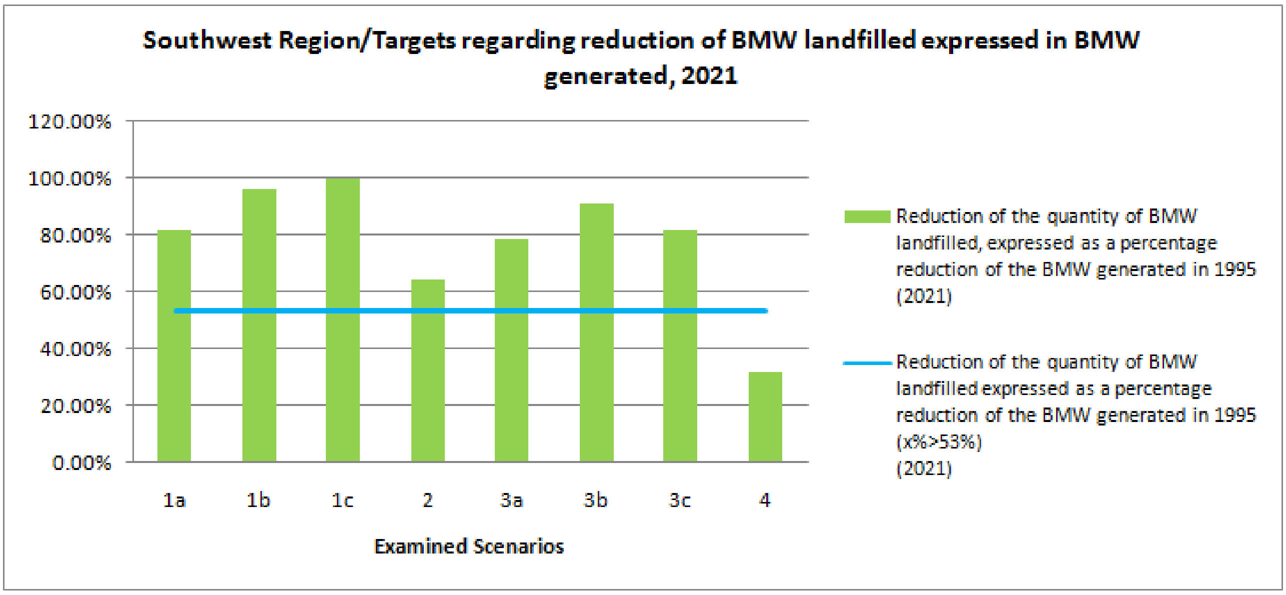
Scenarios	**Total percentage of recycling of packaging waste (2021)**		**Reduction of the quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995**	
			2021	**2027**
		Wood 15,00 %		
3b	69,77%	Glass 68.28%	91,52%	91,29%
		Plastic 68.59%		
		Paper 70.98%		
		Fe 88.83%		
		Al 88,83%		
		Wood 15,00 %		
3c	58.25%	Glass 61.54%	82.08%	81.59%
		Plastic 50,82%		
		Paper 61.54%		
		Fe 88,83%		
		Al 88,83%		
		Wood 15,00 %		
4	55.33%	Glass 61.54%	31,64%	72,10%
		Plastic 50.82%		
		Paper 61.54%		
		Fe 52,47%		
		Al 52,47%		
		Wood 15,00 %		

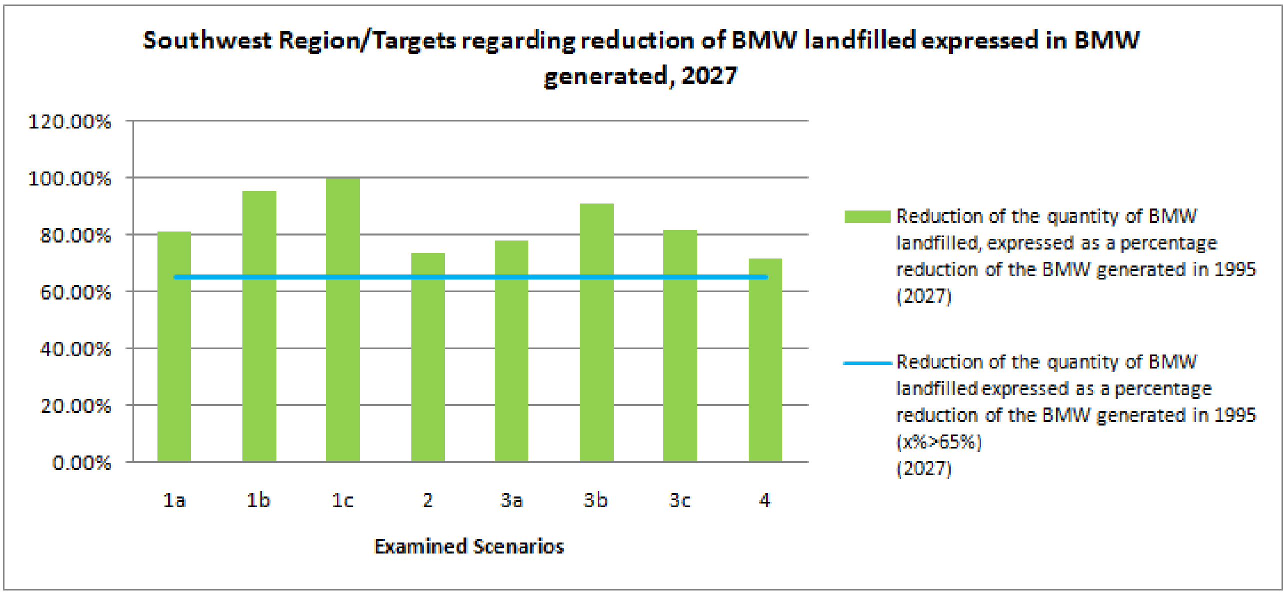
To summarize, the scenarios 1c and 4 do not achieve the targets for Biodegradable Municipal waste landfilled in 2021. All the other scenarios achieve the targets.



	1a	1b	1c	2	3a	3b	3c	4
Total % of recycling of Packaging waste	56.10%	56.10%	29.62%	65.48%	69.77%	69.77%	58.25%	55.33%
Reduction of the quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2021)	81.90%	96.04%	100.00%	64.28%	78.83%	91.52%	82.08%	31.64%
Reduction of the quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995 (2027)	81.40%	95.93%	100.00%	74.00%	78.25%	91.29%	81.59%	72.10%







Regarding Greenhouse gases, the following table summarizes the results for GHG emissions recycling and disposal in t CO_2-eq/yr for each proposed scenario for Southwest Region.

Scenario's	t CO_2-eq/yr Net emissions		
	Recycled Waste	Disposed Waste	Total MSW
1a /1b	-5945	-14980	-20925
1c	-5917	-6631	-12548
2	-6062	-10767	-16829
3a/3b/3c	-13549	-12286	-25836

4	-13666	-22591	8925

The term of 'Recycling' of waste considers the recycling rates of different waste fractions and additionally for the type of treatment in the case of organic waste.

- recycling rates for dry materials,
- recycling rates for organic waste (food waste, garden and park waste),
- share of composting and/or digestion of recycled organic waste

The term of 'Disposal' of waste is referred to different types of waste treatment and disposal in remaining waste amount after recycling. These include:

- Unburned scattered waste
- Open burning of scattered waste
- Wild dumps/unmanaged disposal site
- Controlled dump/landfill without gas collection
- Sanitary landfill with gas collection
- Biological stabilization and landfill
- Mechanical Biological Treatment and landfill
- Mechanical Biological Stabilization and/or mechanical physical stabilization and co-processing cement kiln
- Incineration

3.9 FINANCIAL AND ECONOMIC ANALYSIS OF PROPOSED SCENARIOS

3.9.1 Investment Cost

The estimation of investment cost of each development scenario is one of the main evaluation criteria, which is affected by a number of parameters:

- the capacity of the unit
- the type and complexity of the technology
- the degree of automation of production processes
- the required infrastructure

It is obvious that a detailed investment cost will incur only after the preliminary design where the technical parameters and the location of the facilities have been selected and determined. Therefore, it is decided at this stage of decision-making to make an approximation by using unit cost. The investment unit costs can be estimated a) from relevant EU studies, such as:

- «Costs for Municipal Waste Management in the EU, Eunomia Research and Consultants»
- «Economic Analysis of Options for Managing Biodegradable Municipal Waste Eunomia Research and Consultants»
- «Assessment of the options to improve the management of biowaste in the European Union, Annex E: Approach to estimating costs, EC DG Environment, Arcadisnv»

and b) from the experience of the Consultant from similar project adjusted to Macedonian conditions.

It is noticed, that the objective is not to determine an absolute cost but rather make estimates of cost of alternative scenarios for benchmarking purposes. Indeed, variations in technology offered by different suppliers can have significant effect on the costs.
The estimated investments during the implementation phase (2016-2020) presented in the following table, the analytical data is presented in relevant Annex.

Table 3-100: Investment Cost of each Scenario in EURO, contingencies and VAT not included (price level 2016)

	Cost of Treatment & Disposal	Cost of Collection Transportation (purchase bins & truck)	Cost of Intangible components	Cost of Acquisition of land	Grand Total
	(€)	(€)	(€)	(€)	(€)
Scenario 1a	16,067,710	3,251,950	1,350,000	343,736	21,013,396
Scenario 1b	20,111,268	3,251,950	1,350,000	339,027	25,052,245
Scenario 1c	49,752,000	3,251,950	1,850,000	214,320	55,068,270
Scenario 2	13,658,599	4,179,765	1,350,000	345,460	19,533,823
Scenario 3a	16,140,373	4,586,975	1,350,000	373,363	22,450,711
Scenario 3b	19,772,135	4,586,975	1,350,000	353,206	26,062,316
Scenario 3c	17,163,219	4,586,975	1,350,000	518,483	23,618,676
Scenario 4	13,455,393	5,184,615	1,350,000	489,174	20,479,182

	Cost of Treatment	Cost of Collection Transportation (purchase bins & truck)	Cost of Intangible components	Cost of Acquisition of land	Grand Total
	(MKD)	(MKD)	(MKD)	(MKD)	(MKD)
Scenario 1a	990,026,413	200,371,826	83,181,465	21,179,603	1,294,759,307
Scenario 1b	1,239,173,850	200,371,826	83,181,465	20,889,461	1,543,616,602
Scenario 1c	3,065,514,257	200,371,826	113,989,415	13,205,520	3,393,081,017
Scenario 2	841,586,842	257,539,982	83,181,465	21,285,825	1,203,594,114
Scenario 3a	994,503,624	282,630,593	83,181,465	23,005,113	1,383,320,795
Scenario 3b	1,218,277,912	282,630,593	83,181,465	21,763,106	1,605,853,076
Scenario 3c	1,057,527,177	282,630,593	83,181,465	31,946,773	1,455,286,008
Scenario 4	829,066,140	319,454,719	83,181,465	30,140,879	1,261,843,203

During the operating phase collection equipment (bins and trucks) is assumed to be replaced every 8^{th} years and a part of machines and equipment in treatment and disposal plant is assumed to be replaced in 2034. The estimated reinvestment cost for each scenario, during the operational period, is presented in relevant Annex.

3.9.2 Operating Cost

3.9.2.1 Operating Cost for Collection & Transportation

In order to proceed with the calculation of the operating cost for collection and transportation the following assumptions are adopted:

- Waste generation, projections and existing collection - transportation means are according to the previous chapters.
- The assumed density of municipal waste and biowaste is about 450 kg/m^3
- The assumed density of recyclable waste is about 300 kg/m^3.
- Collection is done with press-pack rear loading RCV, capacity of 14 m^3 and payload of approx. 4,2 - 6,3 t/RCV regarding the transferred material. The new trucks will serve the whole region, in order to optimise costs.
- Collection of green waste will be done in open trucks
- Transport trucks which were purchased in 2008 or before are considered to be too old and have reached their useful life and therefore have to be replaced
- A indicative distance of 40km to the Waste Management Center was adopted

The existing trucks were taken from the waste questionnaires. The operating cost for collection and transportation of each scenario are presented in the following table:

Table 3-101: Operating cost for Collection and transportation, average 2021-2046 (constant price 2016)

	O&M for Collection &Transportation (€)	O&M for Collection &Transportation (MKD)
Scenario 1a	1,291,100	79,552,278
Scenario 1b	1,291,100	79,552,278
Scenario 1c	1,291,100	79,552,278
Scenario 2	1,708,649	105,279,917
Scenario 3a	1,799,113	110,853,957
Scenario 3b	1,799,113	110,853,957
Scenario 3c	1,799,113	110,853,957
Scenario 4	2,091,361	128,861,098

3.9.2.2 Operating Cost for Treatment

The operating cost of each scenario is projected by waste component: i.e. waste transfer and transportation, waste sorting, waste biological treatment, waste thermal treatment and disposal.
For the calculation of the operating costs of various waste management facilities considered the following cost categories.

Maintenance cost: The annual maintenance costs for all facilities are calculated based on a certain percentage of the investment cost, which is assumed:

- 4% for mechanical sorting and biological treatment.
- 2,5% for thermal treatment
- 1.5% for landfills and
- 1% for infrastructure

Labour Costs: The labor cost is calculated based on typical salaries for different categories of staff, including the various insurances, taxes, employer contributions, etc.

Table 3-102: Assumption for labour cost

	WORKER UNSKILLED (@4590€/y)	WORKER SKILLED (@6120€/y)	ENGINEERS/ CHEMISTS/ SUPERVISORS (@8160€/y)	Total No of workers
Scenario 1a	18	8	2	28
Scenario 1b	19	10	2	31
Scenario 1c	18	15	4	37
Scenario 2	14	6	2	22
Scenario 3a	29	12	3	44
Scenario 3b	30	14	3	47
Scenario 3c	14	10	2	26
Scenario 4	13	8	2	23

Administrative costs: Administrative costs are calculated as a percentage of labor costs, ie to 20% of labor costs.

Energy – Fuel: : Electricity and fuel is needed for the operation of the mechanical separation, biological treatment, the landfills, as well as for the infrastructure facilities. The unit consumption factors have been adopted by the Consultant's experience from supervision of similar facilities and projects. In scenario (1c), it is assumed that a part of the produced energy is used for own consumption. The consumption values per t of incoming waste are presented in the following table:

Table 3-103: Energy and fuel consumption per t of incoming waste

	Energy	Fuel
	(KWh/t) @ (0,08 EUR/KWh)	(l/t) @ (0,804 EUR/l)
Mechanical Sorting	30	3
Biological Plant (Aerobic Composting)	10	3
Biological Treatment (Anaerobic Digestion)	50	0,1
Windrow Composting	5	2
Landfill	5	5
Infrastructure	80.000 kWh/year	5.000 l/year

The cost of kWh was taken equal to 0.08 €/KWh and the cost of diesel fuel was taken equal to 0.804 € per litre.

Monitoring: For the necessary environmental monitoring (noise, dust, odors, etc.) at work / perimeter of the site and ensuring product quality are adopted following annual costs:

Table 3-104: Cost for Monitoring

	EUR/y	MKD/y
Mechanical Sorting	25000	1540398
Biological Plant	15000	924239
Windrow Composting	5000	308080
Landfill	20000	1232318
Thermal Treatment	90000	5545431

Aftercare/Insurance: The aftercare/insurance cost has been calculated as a given percentage of the investment cost, i.e. 0.70% of investment cost.

Transportation cost for RDF: The respective transportation cost for RDF at a suitable cement industry has been calculated, where a typical distance of 170km was adopted. The cost of transport has been analyzed in fuel costs, maintenance costs and insurance of transport vehicles, and personnel costs (drivers). Calculations for all scenarios are given in the relevant annex. The total transportation cost for each scenario are presented in the following table:

Table 3-105: Transportation cost for RDF, average 2021-2046 (constant price 2016)

Scenario	Transportation cost for RDF	
	(€/year)	(MKD/t)
Scenario 1a/1b	230,132	14,179,761
Scenario 2	133,289	8,212,729
Scenario 3a/3b	133,276	8,211,915

Within each element the cost is split into fixed and variable to allow for better projection and differentiation of growth rates.

- Fixed Cost: The fixed cost comprises labour (worker skilled/unskilled, engineers/chemists/supervisors), maintenance, administrative cost, insurance, control and monitoring. All elements of the total fixed cost are projected flat.
- Variable cost: The variable cost evolves mainly with each tone of waste, e.g. fuel cost and energy. Variable cost is assumed to remain flat.

The forecast of the full O&M costs are presented in the relevant Annex. The average operating cost per scenario from operation during the period 2021-2046, is presented in the following table:

Table 3-106: Operating Cost of each Scenario, average 2021-2046 (constant price 2016)

Scenario	O&M for the operation of Waste Management facilities	
	(EUR/year)	(MKD/year)
Scenario 1a	2,928,775	180,459,097
Scenario 1b	1,509,814	93,028,552
Scenario 1c	7,249,762	446,700,600
Scenario 2	3,009,719	185,446,546
Scenario 3a	3,474,007	214,054,058
Scenario 3b	3,708,312	228,490,951
Scenario 3c	3,121,683	192,345,314
Scenario 4	3,091,401	190,479,453

Revenues from recyclables

Potential revenues from the operation of WMC include i) sale of recyclables & products and ii) sale of electricity. The unit revenues were taken from current market prices. Moreover it has been taken into consideration the cross contaminations of recyclables resulting in lower quality since there are recovered from mixed municipal waste. Thus, the market values of recyclables that they have been used are shown in the following table:

Table 3-107: Values of recyclables in €/t, constant price 2016

Process Outputs	Unit	Values for recyclables from MBT	Values for recyclables from MRF
Glass	€/tonne	2	5
Paper & cardboard	€/tonne	15	30
Al	€/tonne	600	600
Fe	€/tonne	140	140
Plastics	€/tonne	28	56
RDF / SRF	€/tonne		
Compost from green waste (and / of presorted organic waste)	€/tonne	5	
CLO	€/tonne	0	
Revenues from collective shcemes	€/tonne	15	30

Revenues from energy

The thermal-treatment plant (scenario 1c) produces electricity. The price of electricity for the thermal treatment of biomass is 0,150 €/kWh (source: Energy Regulatory Commission, Republic of Macedonia). For the thermal treatment unit, based on the biomass quantities, the selling price to the national grid will be 0,76 €/kWh.

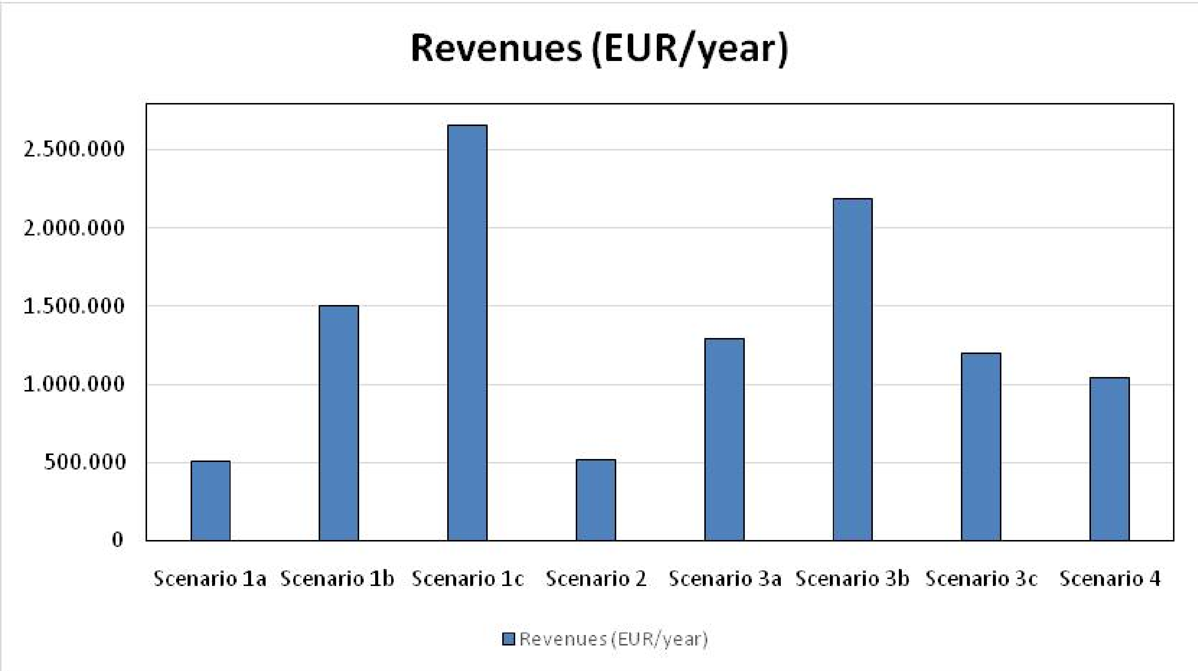
The anaerobic digestion produce energy from the utilization of the biogas. The price of electricity for the anaerobic digestion is 0,180 €/kWh (source: Energy Regulatory Commission, Republic of Macedonia).

The forecast of the revenues are presented in the relevant Annex. The average revenues per scenario from operation during the period 2021-2046 is presented in the following table:

Table 3-108: Revenues of each Scenario (average 2021-2046), constant price 2016

Scenario	Revenues (EUR/year)	Revenues (MKD/year)
Scenario 1a	510,003	31,424,308
Scenario 1b	1,509,814	93,028,552
Scenario 1c	2,658,309	163,794,079
Scenario 2	521,739	32,147,441
Scenario 3a	1,294,572	79,766,197
Scenario 3b	2,192,572	135,097,310
Scenario 3c	1,202,807	74,112,049
Scenario 4	1,046,307	64,469,122

Figure 3-74: Revenues of each scenario



3.9.3 Levelised Unit Cost (LUC) and Affordability

3.9.3.1 Levelised Unit Cost (LUC) calculations

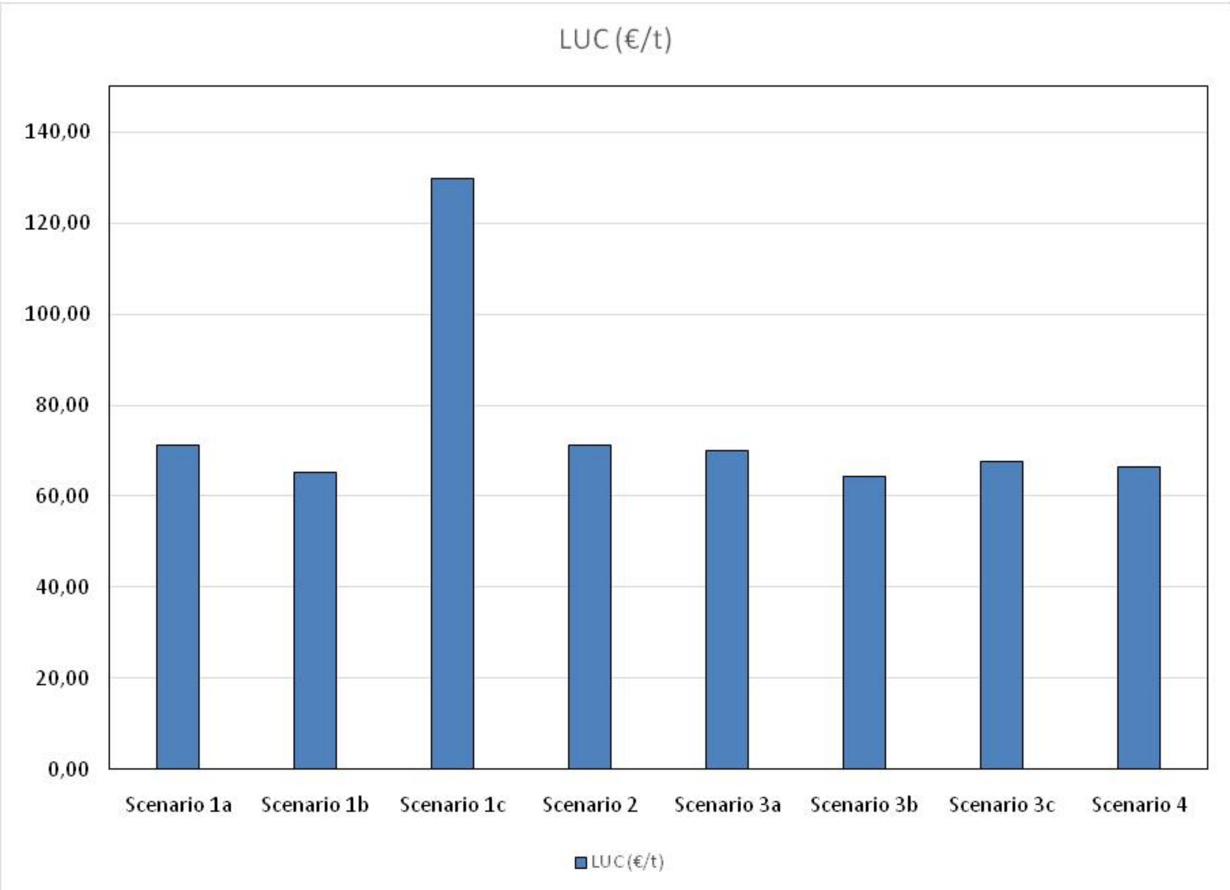
The index of Levelised Unit Cost is an index of cost-effectiveness and it is widely used in environmental projects. It is expressed in €/t and is calculated by dividing the net present value of the facility's net cost flows over the reference period (including the investment and OM&A cost, net of revenues from sale of by-products such as heat, electricity and scrap metals) by the discounted quantity of waste treated in the same period, using a financial discount rate of 4 %. This index is presented in the *Guide to Cost - Benefit Analysis of Investment Project* by the European Commission, December 2014.

Taking into account the categories of operating costs and revenues (described in previous paragraphs) and the generated waste quantities for the period 2021-2046, then it is determined the Levelised Unit Cost (LUC) for each scenario. An overview of LUC results are presented in the following table.

Table 3-109: Levelised Unit Cost

Scenarios	LUC	
	(€/t)	(MKD/t)
Scenario 1a	71.00	4375
Scenario 1b	65.16	4015
Scenario 1c	129.75	7995
Scenario 2	71.14	4384
Scenario 3a	69.83	4303
Scenario 3b	64.24	3958
Scenario 3c	67.55	4162
Scenario 4	66.21	4080

Figure 3-75: Levelised Unit Cost of each scenario



3.9.3.2 Affordability calculations

The Polluter Pays Principle (PPP) is one of the principles of Community environmental policy and applies throughout the European Union. According to Art. 14§1 of Directive 2008/98/EC on waste, the costs of waste management shall be borne by the original waste producer or by the current or previous waste holders.

The simplest way to implement PPP is to introduce a full cost recovery waste tariff, which means a tariff high enough to recover the full costs of services provided, including capital and operating costs as well as management and administrative costs of the system.

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

The estimation of affordability will take place in the next stage of the project.

3.10 EVALUATION OF ALTERNATIVE SCENARIOS BY USING THE METHOD OF MULTICRITERIA ANALYSIS – FINAL PROPOSED REGIONAL WASTE MANAGEMENT SYSTEM

3.10.1 Introduction

Finding the best way to address a management problem is a very complex process, because of the need to evaluate different options / scenarios, which, in many cases, are apparently equivalent.
In order to achieve an evaluation of all the different suggested solutions, it is not sufficient to compare only one critical parameter, but it is needed the analysis and rating of a number of different criteria. These criteria are common to all suggested scenarios and their importance for solving the problem is characterized by a weighting factor.
The selection of appropriate criteria is particularly important for the export of the optimal conclusions. The kind of criteria depends:
(A) directly from the type of problem to be solved and its particular characteristics
(B) indirectly as the problem is affected or affects the attitude of various stakeholder groups
The simultaneous analysis of the characteristics of various alternative scenarios through the evaluation and rating of all the different criteria, for the extraction of the optimal solution, is the Multi – Criteria Analysis.

3.10.2 Setting up of criteria and evaluation of alternative scenarios

The multi-criteria analysis method was specifically designed in order to evaluate the 8 waste management schemes (scenarios). This analysis involves three main phases (a) the setting of criteria, (b) the weighting of criteria according to their significance and (c) the ranking of the alternative schemes (scenarios). A brief description of the analysis performed in the RWMP is presented below.
The criteria that have been selected are classified into four major groups incorporating Financial, Technical, Environmental and Social-Institutional parameters. The following table presents the groups of criteria and their individual criteria (sub-criteria) that were examined. The groups of criteria and the sub-criteria were set specifically for the purposes of the project, since they focus on the examination and evaluation of alternative systems for the effective management of MSW.

Table 3-110: Groups of criteria and individual criteria that was examined

Financial	Technical	Environmental	Social-Institutional
(F1) Investment Cost	(T1) Flexibility regarding waste quantity	(E1) Air pollution	(S1) Application of priority of legislation
(F2) Net operational Cost	(T2) Flexibility regarding waste quality	(E2) Generation of waste water	(S2) Possibility of creation of new jobs
(F3) Dynamic Prime Cost	(T3) Simplicity	(E3) Generation of solid waste residues	(S3) Degree of fulfillment of targets
	(T4) Energetic exploitation	(E4) Toxicity of residues	(S4) Public acceptance
	(T5) Recovery of materials		(S5) Transition to future conditions

Weighting of Criteria

The most important step in Multi-criteria evaluation methods is the assignment of weights, since weights reflect to the relative importance of the various impacts considered. PROMETHEE method does not provide specific guidelines for determining these weights, but assumes that the Decision Maker is able to weigh the criteria appropriately. In this research, firstly weights are defined for each group of criteria and secondly weights are defined for every criterion in the group. After the multiplication of every criterion weight with the group weight that is belongs then it is possible to calculate the final weights. Analytical calculations are presented in the relevant Annex.

3.10.3 Rating of Alternative Waste Management Scenarios

Performance of alternative management scenarios

In this section the performance of alternative scenarios is presented. Each criterion was quantified according to its performance for each alternative scenario. All the criteria are benefit criteria, that is, the higher the score the better the performance is. The following table presents the performance of alternative scenarios.

Table 3-111: Performances of each alternative scenario in legislative, environmental, technical and financial criteria

	Financial			Technical					Environmental				Social-Institutional				
	F1	F2	F3	T1	T2	T3	T4	T5	E1	E2	E3	E4	S1	S2	S3	S4	S5
S1a	8,5	6,5	7	9	9	9	6	6	8	7	7	8	9	6	7,5	7	9
S1b	8	8	8	8	8	7	8	6	8	6	8	8	9	6	7,5	7	9
S1c	5	5	6	7	6	5	9	5	6	9	8	5	9	6	5	7	9
S2	9	7	8	9	9	6	6	7	6,5	8	7	8	9	5	8	7	6
S3a	8,5	7,5	8	9	9	8,5	6	9	8,5	7	7	8	9	9	9	7	9
S3b	8	9,5	9,5	8	8	7	8	9	8,5	6	8	8	9	9	9	7	9
S3c	8,5	8	9	9	9	9	5	8	8,5	8	8	8	9	7	8	7	9
S4	9	8	9,5	9	9	7	5	8	5	8	5	8	9	7	9	7	5

Indifference and Preference Thresholds

Indifference threshold [qi] is a difference beneath which the decision maker in indifferent between two management alternatives for the criterion i. Alternative b is weakly preferred to alternative a in terms of criterion i if

$$g_i(b) \succ g_i(a) + q(g_i(a))$$

Preference threshold [pi] is a difference above which the decision maker strongly prefers a management alternative over all for the criterion i. Alternative b is strictly preferred to alternative a in terms of criterion i if

$$g_i(b) \succ g_i(a) + p(g_i(a))$$

For the determination of Indifference and Preference Thresholds Linear function have been used.

3.10.4 Results of Evaluation-Recommended Scenario

All the potential alternative waste management scenarios presented above were examined and ranked according to their efficiency and performance through the use of PROMETHEE multi-criteria method. The next figure presents the final rankings as they exported from PROMETHEE multi-criteria method for three different cases of weights of criteria and sub-criteria.

Taking into consideration the results of Multi Criteria Analysis Method (PROMETHEE) after the examination of three different evaluation scenarios ((i) equal value to all criteria, (ii) focus on financial criteria, (iii) focus on environmental criteria), the recommended scenario for Southwest Region is Scenario 3b. The next preferable scenarios are the Scenarios 3c and 3a.

Figure 3-76: Results of PROMETHEE Ranking Method

PROMETHEE Flow Table

Rank	action	Phi	Phi+	Phi-
1	S3b	0,2348	0,2955	0,0607
2	S3c	0,1875	0,2179	0,0304
3	S3a	0,1464	0,2000	0,0536
4	S1b	0,0232	0,1482	0,1250
5	S1a	-0,0125	0,1321	0,1446
6	S4	-0,0205	0,1688	0,1893
7	S2	-0,0536	0,1107	0,1643
8	S1c	-0,5054	0,0875	0,5929

Evaluation Scenario A:

Equal value of all the groups of criteria

PROMETHEE Flow Table

Rank	action	Phi	Phi+	Phi-
1	S3b	0,2645	0,3287	0,0643
2	S3c	0,2068	0,2389	0,0321
3	S3a	0,1275	0,1950	0,0675
4	S1b	0,0343	0,1611	0,1268
5	S4	0,0163	0,1916	0,1754
6	S1a	-0,0311	0,1364	0,1675
7	S2	-0,0336	0,1232	0,1568
8	S1c	-0,5846	0,0864	0,6711

Evaluation Scenario B:

Focus on the financial criteria

PROMETHEE Flow Table

Rank	action	Phi	Phi+	Phi-
1	S3b	0,2304	0,3082	0,0779
2	S3c	0,2136	0,2411	0,0275
3	S3a	0,1304	0,1936	0,0632
4	S1b	0,0282	0,1604	0,1321
5	S1a	-0,0107	0,1389	0,1496
6	S4	-0,0307	0,1800	0,2107
7	S2	-0,0311	0,1279	0,1589
8	S1c	-0,5300	0,1011	0,6311

Evaluation Scenario C:

Focus on environmental criteria

3.11 POSSIBLE SITES FOR INTEGRATED WASTE MANAGEMENT FACILITIES

Having in mind the current status of active MSW landfills in the region, there is no site with favourable conditions for further extension and upgrade. Bukovo site near Ohrid is limited in space and cannot be significantly extended, while landfill near Struga is close to the lake shore and located in permeable base. Barabros in Makedonski Brod is located in very porous carbonate rocks and any construction over such could be very expensive. Debar landfill is located in relatively good geological setting but is far from the other sites.

After an initial survey that has taken place, the new MSW landfill in Kichevo, located in former lignite mine, is considered to be one possibly useful location. However, a further elaboration on this choice will be provided at a later stage of the project. We strongly believe that there are locations within the mining area that can be used for construction of a regional landfill. The area is already under heavy anthropogenic influence and could be acceptable for local population. The necessary infrastructure is already established, there is enough material for capping and no sensitive receptor within the area.

Figure 3-77: Kichevo landfill and Oslomej lignite mine (closed)

Figure 3-78: Kichevo landfill and Oslomej lignite mine (closed)

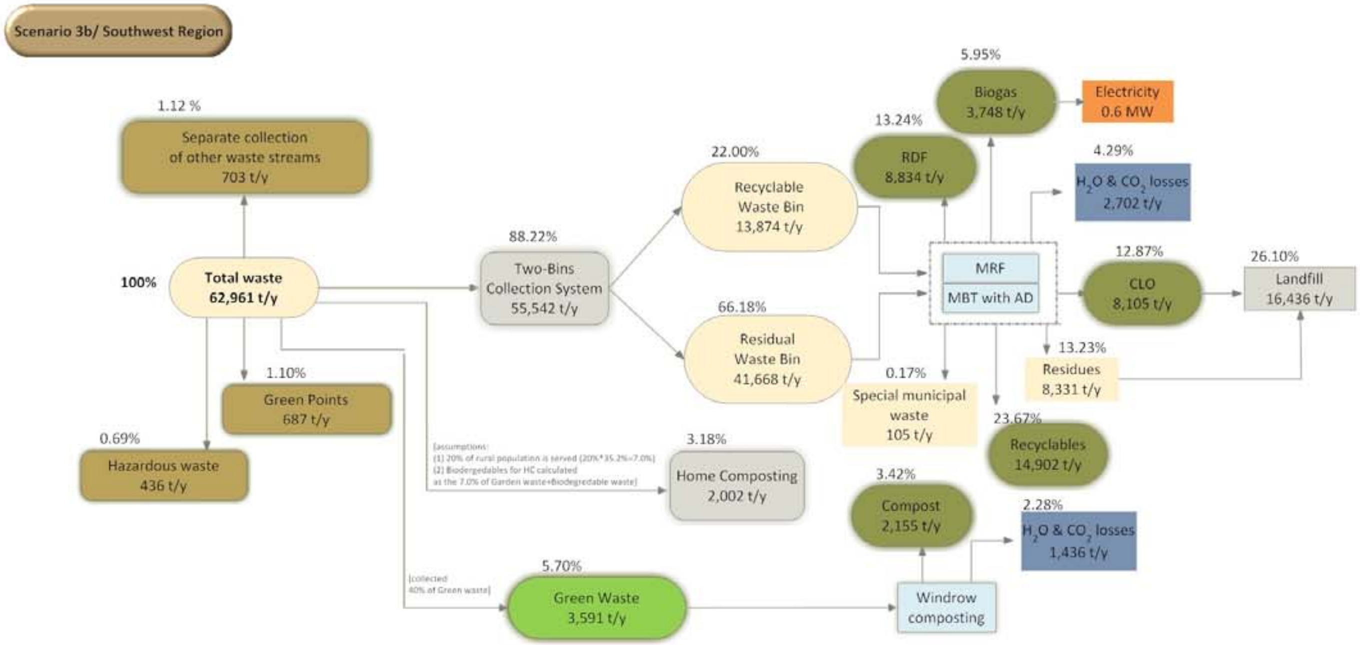
3.12 PROPOSED SCENARIO AND ACTION PLAN

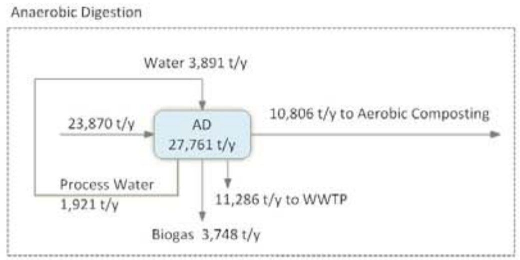
3.12.1 Synopsis of proposed scenario

The proposed scenario for the Waste Management System in Southwest Region is Scenario 3b. According to this scenario, the waste management system includes:

- Separate collection of recyclable materials and wood packaging fraction in green points,
- Separate collection of hazardous materials in municipal waste,
- Separate collection of other waste fraction, i.e. other special waste streams (elastic-tyres), WEEE and construction and demolition waste.
- Home composting actions,
- Separate collection of green waste which will be diverted to windrow composting process for the production of high quality compost.
- Recyclable waste bin which will be diverted to a Material Recovery Facility (MRF) for the recovery of recyclables (glass, paper, plastic, metals)
- Residual waste bin which will be diverted to a Mechanical Biological treatment plant (MBT) with anaerobic digestion (Biogas/Electricity production) and aerobic composting of digestate. Recyclables and RDF will be recovered from mechanical treatment of residual waste bin.
- Landfill which will accept residues from MRF/MBT and CLO.

The next figure illustrates the total waste management system that can be applied:

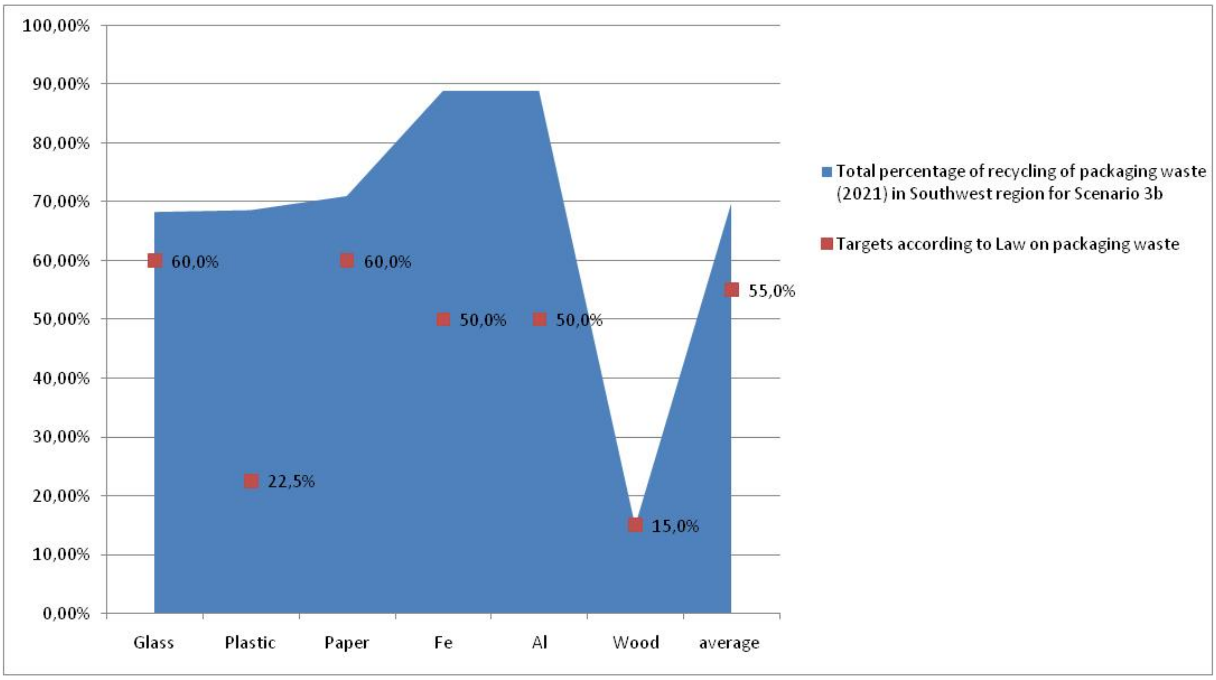


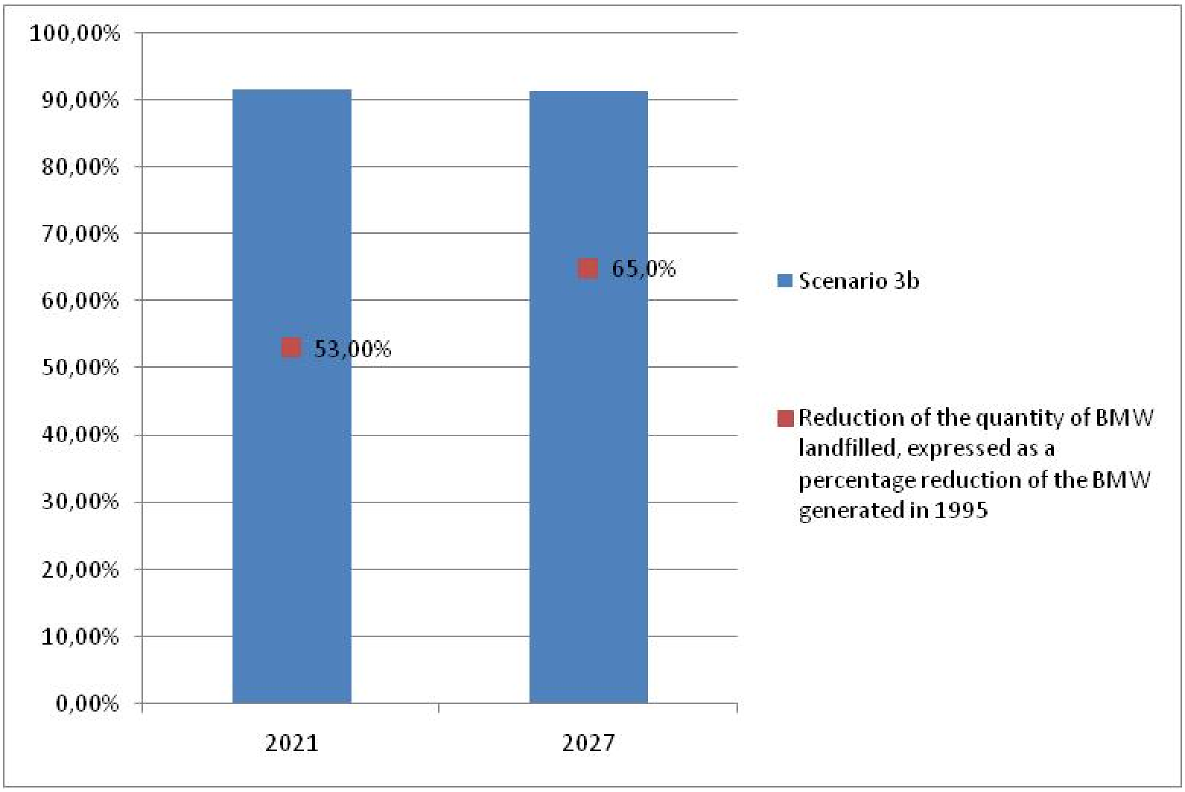


Scenario 3b	
Collection	Two Bins Collection System (Recyclable Waste Bin and Residual Waste Bin) Green Points Separate Collection of Green waste
Treatment of Recyclable Waste Bin	MRF
Treatment of Residual Waste Bin	MBT with Anaerobic Digestion and aerobic composting of digestate
Treatment of Green Waste	Aerobic composting
Treatment at the Source	Home Composting
Products	Compost Recyclables Biogas
Landfill	Residues from MRF Facility and MBT

The following table presents the quantification of the targets for the selected scenario (scenario 3b), concerning recycling of Packaging and reduction of Biodegradable Municipal Waste Landfilled:

Total percentage of recycling of packaging waste (2021) in Southwest Region for Scenario 3b		Reduction of the quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995	
		2021	2027
3b	Glass 68.28%	91.52%	91.29%
	Plastic 68.59%		
	Paper 70.98%		
	Fe 88.83%		
	Al 88.83%		
	Wood 15.00%		




100,00%
90,00%
80,00%
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
53,00%
65,0%
2021
2027
Scenario 3b
Reduction of the quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995

3.12.2 Possible sources of funding

The identification of the different sources of financing that cover the investment costs will be incur in the next stage, during the Financial and Economic analysis (or Cost Benefit Analysis).
In particular, within the framework of EU co-financed projects, the main sources can be:

- Union assistance (the EU grant);
- national public contribution (including, always, the counterpart funding from the Operational Plan plus additional grants or capital subsidies at central, regional or local government level, if any);
- project promoter's contribution (loans or equity), if any;
- private contribution under a PPP, (equity and loans) if any.

Calculation of EU contribution:

The amount of EU contribution will be defined during the Financial Analysis. The analyses will be carried out based on the Discounted Cash-flow (DCF) method, that allocates costs and benefits on a time series in the year in which they occur and then discounts them to express their present value. In the following, the methodological steps to establish the funding gap rate and the EU Grant are described.

Step 1: Calculation of the funding gap rate (R):

R = Max EE/DIC

where Max EE is the maximum eligible expenditure (DIC – DNR), DIC is the discounted investment cost (excluding contingencies) and DNR is the discounted net revenue (= discounted revenues – discounted operating costs + discounted residual value). Other investment cost such as the replacement cost and variations of working capital attributed to the project will also be included in the DNR calculation, in accordance with the EU CBA guide.

Step 2: Calculation of the decision amount (DA), i.e. "the amount to which the co-financing rate for the priority axis applies":

DA = EC*R

where EC is the eligible cost.

Step 3: Calculation of the (maximum) EU Grant:

EU Grant = DA*Max CRpa

where Max CRpa is the maximum co-financing rate fixed for the priority axis in the Commission's decision adopting the operational programme (OP).

3.12.3 Proposed Action Plan

3.12.3.1 Brief Overview

As mentioned in previous chapters, Article 4 of the revised EU Waste Framework Directive sets out 5 steps for dealing with waste, ranked according to environmental impact - the 'waste hierarchy'. Driving waste management up the waste hierarchy is central to the development of sustainable waste management and the ambition of a Zero Waste society. The waste hierarchy gives top priority to preventing waste in the first place. When waste is created, it gives priority to preparing it for re-use, then recycling, then recovery, and last of all disposal.

The following measures and waste management options deliver the best overall environmental outcome. The proposed scenario is based on national objectives and targets and recent national waste management legislation. The minimum requirements set by the national waste management legislation for packaging and packaging waste are covered. Also, the set of targets for biodegradable municipal waste (BMW) that should be diverted from landfills are achieved.

Table 3-112: Inter-relation in waste management hierarchy and actions-measures / waste management options connected/linked with the Scenario 3b

Stages	Actions-Measures taken
Prevention:	**Definition:** using less material in design and manufacture, keeping products for longer, re-use, using less hazardous materials **Proposed actions:** ✓ Waste prevention awareness activities (targeted to households, as well as specific target groups, i.e. businesses, municipalities, hospitals, etc). ✓ Funding and implementation of re-use based projects and services in the municipalities of the Region. ✓ Support and enable community and voluntary sector, i.e. food banks, feed the poor initiatives, etc. ✓ Preparation and elaboration of various waste prevention guidelines ✓ Research and development ✓ Food waste prevention, reduction of paper use, reduction of glass containers
Preparing for re-use:	**Definition:** checking, cleaning, repairing, refurbishing, whole items or spare parts **Proposed actions**: ✓ Promote remanufacture and repair (public awareness campaigns, etc.). ✓ Presentation of good practice (benefits) and training of the targeted groups. ✓ Promotion and establishment of remanufacture/repair/reuse centers.
Recycling:	**Definition**: turning waste into a new substance or product, includes composting if it meets quality protocols (The products of the measure are compost and recyclables) **Proposed actions:** ✓ Implementation of two- bin collection system (recyclable waste bin and residual waste bin) and subsequent treatment of the contents of the recyclable waste bin in a Material Recovery Facility (MRF). • Anaerobic Digestion of residual waste bin followed by aerobic composting of digestate (MBT) • Separate Collection of green waste and windrow composting of the of separately collected green waste ✓ Home composting (20% of rural population) Strengthening of the public and private waste management sector in the Region to introduce and practice two-bin collection system (training, preparation of guides, technical equipment-hardware and software etc). ✓ Public awareness (focused to the main target groups) for practicing of two-bin collection system. ✓ Public awareness campaigns, transfer of knowledge, presentation of good practice and preparation of practical guides. ✓ Construction and operation of Green points
Other recovery:	**Definition:** includes incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste, some backfilling **Proposed actions:** Waste management options that fall under the category of „Other recovery", as specified in the Waste Framework Directive, were not proposed.
Disposal:	**Definition:** landfill and incineration without energy recovery **Proposed actions:** ✓ Landfilling of residues from MRF and Mechanical Biological Stabilisation of residual

Stages	Actions-Measures taken
	waste bins (MBS). ✓ Identification of the location for the Regional landfill. ✓ Providing technical documentation and consent for building.

The proposed measures for each stage of the waste hierarchy are presented analytically in the following paragraphs.
The following table presents an overview of the relevant targets and the timeframe for their achievement.

Table 3-113: Assumptions and calculations for scenario 3b

		Scenario 3b **% Collection (Average 2021-2046)**
Green Points	A* A A C	3% of recyclable materials fraction 15% of wood packaging fraction 3,37% of packaging waste Total collection: 0,97% of generated waste
Green Waste	A C	40% of green waste fraction 5,70% of generated waste
Home Composting	A C	Served the 20% of rural population, 7% of total population 7% of Green waste +Biodegredable waste 3,18% of generated waste
Separate Collection of other waste fractions	A A A C	50% of WEEE fraction 50% of C&D material fraction 50% of other special waste streams fraction 1,12% of generated waste
Hazardous materials	A C	100% of Hazardous material fraction 0,69% of generated waste
Packaging waste from Mechanical Treatment of MBT/MRF/MBS	A C	65,85% of packaging waste 17,19% of generated waste

A: Assumption, C: Calculation

3.12.3.2 Stage 1 – Waste Prevention

In order to progress towards a zero waste economy, actions and measures have been set to:

- making it easier for people and businesses to find out how to reduce their waste, to use products for longer and enable reuse of items by others,
- help businesses recognise and act upon potential savings through better resource efficiency and preventing waste, to realise opportunities for growth; and
- support action by local government, businesses and civil society
- decouple waste generation from economic growth.

When establishing measures and actions in the Regional Waste Management Plan, it is important to take into consideration the capabilities of the local authorities and understand that there are limitations. This is very important, taking into account the absence of a National Waste Prevention Program, which would direct, enhance, support and fund these measures and actions.

There are inherent difficulties at taking measures in the market and the production of consumer goods only at a regional level. Furthermore, the action would have an impact on free competition and would distort the market.

Moreover, there are a number of areas where there is lack of experience or where initiatives have not been implemented even in more central areas, like the city of Skopje. As a consequence, tools and working methods are not developed yet.

The goals are unquantified. The extent to which waste reduction is actually attributable to waste prevention efforts must also be considered. A decrease in waste production may be linked to numerous structural or economic factors. For example, fluctuations in the economy have a significant impact on construction waste volumes. Similar considerations also apply to other statistical time series in the waste management sector. By defining unquantified waste prevention goals, we can retain a high degree of flexibility with our choice of waste prevention tools. The aim must always be to develop and implement those waste prevention measures which promise the greatest success, based on an ex ante view of the reduction of environmental impacts.

Horizontal Measures

Horizontal measure 1. Waste prevention awareness activities in the Region

Drawing public attention to waste prevention is a fundamental first step in stimulating behavioural change. Recycling has been readily adopted as a daily habit, and is accompanied by a feel-good factor associated with doing something green. Waste preventing actions are in fact much more environmentally beneficial, but often not as obvious[36]. There are a number of barriers to waste prevention for household waste, which impact on both the householders' values, as well as time and convenience. Additionally, waste prevention is a very personal behaviour, as it is driven by deeply held beliefs and attitudes rather than social norms[37]. These barriers should be taken into consideration when considering actions needed to engage the public in waste prevention initiatives

An example of waste prevention awareness activity targeted mainly at households can be the organization of eco-week by the municipalities, where various waste prevention related events can be organized, in collaboration with non-governmental organisations. Also, award schemes and competitions can be organized, where areas within a municipality or business groups can compete based on a range of environmental aspects. A waste prevention web platform can be established, where households, businesses and other target groups can acquire or exchange information.

The promotion of waste prevention awareness campaigns in schools can be proved effective, together with the adaptation of awards schemes.

Horizontal measure 2. Funding and implementation of re-use based projects and services in the Region

Bulky items and WEEE selectively collected could be fit to be reused directly or following preparation for re-use. Due to their high prevention potential, it is necessary to facilitate the reutilization of those items through web-platforms for exchange and donate items. Also, the items could be donated via the municipal social services and NGOs.

Example of an online reuse service which was initiated at a regional level (Dublin Region in Ireland) is FreeTrade.ie, which was funded by the Authorities and delivered real results with over 8300 items reused in 2009. Due to the success of the service it has been expanded to a national platform in July 2010[38], through http://www.freetradeireland.ie/, with Local Authorities across the country now promoting the Free Trade Ireland Service. The online initiative encourages the reuse of unwanted items by facilitating the free

[36] http://ec.europa.eu/environment/waste/prevention/guidelines.htm
[37] WRAP (2009). Introduction to behavioural change
[38] http://www.sdcc.ie/sites/default/files/editor/dublin-waste-plan-annual-progress-report-2010.pdf

advertising of items for members. The on-line platform was funded by "Be-green", the EPA's National Waste Prevention Program.
The following picture presents a snapshot of the website.

Horizontal measure 3. Support and enable community and voluntary sector, i.e. food banks, feed the poor initiatives.

Principally, foodbanks provide instantaneous support to people in crisis, helping people meet immediate need. A wide range of organisations, statutory and voluntary, can refer people to foodbanks, and they are located on a very local basis, within community locations and settings, such as community centres and places of worship, helping to make access as easy as possible. Indicative example of existing food bank in the Republic of Macedonia is "Food for all"[39] , founded in 2011 in Skopje, associate member of the European Federation of Food Banks. Examples of food banks and NGOs in Greece, is the non-profit organization "BOROUME- WE CAN – SAVING FOOD – SAVING LIVES"[40], which aims to coordinate the collection of food from catering companies, corporations, hotels, bakeries, grocery stores, bakeries etc. and distribute it to a network of 450 institutes throughout Greece. Also, "Food Bank – Institute for fighting against hunger"[41], supports 215 institutes and 27000 people. It was founded in 1995. The idea of the Food Bank was developed by John Van Hengel in 1967 in Phoenix, Arizona (USA). The idea spread to America as well as Europe. The Greek "Food Bank" is a charitable, non-profit institution (private legal entity) and is dedicated to the fight against hunger and reducing wastage.

The measure can be expanded to other products, such as medicines, clothes, etc.

Horizontal measure 4. Elaboration of various waste prevention guidelines.

Sector specific guidelines can be produced for various waste streams (i.e. guides to improve environmental performance in businesses, for running green meetings and events, for saving food waste at home or catering businesses, for waste prevention in farming, etc.). Examples of guides and toolkits for various occasions, elaborated by local authorities can be found on the website of the Local Authority Prevention Network (LAPN). It is a cooperative programme between the Environmental Protection Agency's National

[39] http://www.bankazahrana.org
[40] http://www.boroume.gr/
[41] http://www.traptrof.gr/

Waste Prevention Programme and local authorities in Ireland. LAPN aims to build capacity in local authorities for promoting waste prevention at a local level for the benefit of their regions[42].

Horizontal measure 5. Research and development
After the construction and one-year operation of the proposed waste management system, the consumption and waste generation pattern in each municipality will be clear. Research and development studies on specific aspects of waste prevention at municipal and regional level can be elaborated.

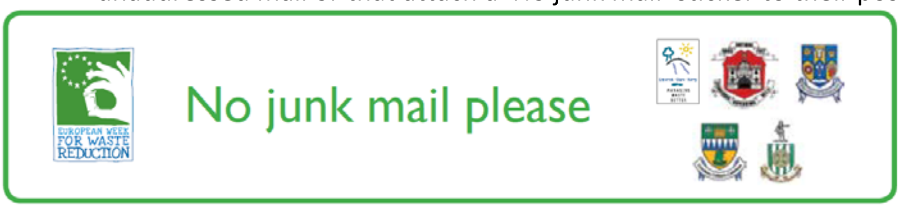
Specific measures
Food waste prevention
A significant part of food waste could be avoided by simply using good practices when shopping, preparing and storing food, making households a major source of prevention of organic matter. At domestic level, the prevention of food waste can be addressed first of all by raising public awareness of the quantities of usable food discarded, the financial losses this represents, and the environmental impact of collecting and treating this waste. Constructive information on waste prevention techniques can help households better plan their food purchases, keep food supplies fresher for longer periods, make better use of leftovers and can make a noticeable difference to household expenses. The Love Food Hate Waste Campaign (www.lovefoodhatewaste.com) in UK, selected as a best practice in the prevention of biodegradable waste, can be taken as a model here of the range of guidance that can be provided. Effective awareness campaigns on the prevention of food waste will integrate waste preventing habits into individual behaviour so that actions at home, in the workplace and at leisure are consistent. Good practices are often linked to specific situations and are often abandoned when they become less convenient[43].
Actions which can be taken:

- Promote responsible food purchasing and consumption
- Set-up or improve existing circuits to take advantage of surplus foodstuffs.

These actions can be coordinated with the respective horizontal measures.

Reduction of paper use
It is proposed to reduce the amount of paper fraction generated by reducing consumption, in particular in offices and, in the Municipalities and various facilities. At the same time, the reuse of textbooks and other books will be promoted together with the prevention of waste from general advertising as these also cause a visible impact with regard to the amounts generated and its municipal management and cleaning.
Actions which can be taken:

- Promotion of reduction in paper consumption and dematerialization of the information using ICT (Information and Communication Technologies), through waste prevention awareness activities targeted at the Local Authorities, businesses, offices, households, etc. An example is the No Junk Mail sign produced by Limerick Kerry Clare Regional Waste Management Office in Ireland for households and offices. Objectives may be the number of households that opt not to receive unaddressed mail or that attach a 'No junk mail' sticker to their post box,



- Promotion of re-use of books. Book exchange points can be set up
- Prevent unnecessary advertising.

Reduction of glass containers

[42] http://localprevention.ie/
[43] http://ec.europa.eu/environment/waste/prevention/guidelines.htm

- Promotion of re-usable glass containers in hospitality, restaurants and catering sector,
- Promotion of re-utilisation of cava bottles

3.12.3.3 Stage 2 – Preparing for re-use

Measures can be taken to promote remanufacture and repair activities, such as:

- **Public awareness campaigns to promote repair activities, together with**
- **Promotion of repair/re-use centres establishment.**

The quantity of bulky items, WEEE and textiles in municipal waste can be reduced and the reutilization and prolongation of their useful life can be promoted by means of preparing them for reutilisation, the creation of municipal repair facilities for citizens and the promotion of economic activities related with the restoration of such items.

Representatives from repair/reuse centre could also be present in the green points or the repair centres could be established within the green points. Citizens may bring items, especially WEEE but also furniture and textiles, normally because they are not functioning or torn, but also because they do not want it anymore or they have replaced it with a newer one. The condition of these items is afterwards checked, being fully reusable, needing slight or significant repair, or needing disposal. In the latter case, some spare parts may be in working condition. The citizens may collect the electrical appliance after repair. If there is unwanted furniture/ textiles, the reuse centres can function as second-hand shops.

The idea is to develop and offer repair, reuse and recycling initiatives of materials in one central hub. Reuse and repair centres already exist in more than 10 EU Member States, as independent facilities or in regional or national networks. They provide a crucial service by extending the life of a wide range of consumer products and have significant potential in diverting consumer waste from landfill. Often they are operated by social integration enterprises working with disadvantaged groups such as the long-term unemployed, who are trained in technical repair skills, thus also serving a social function. Organised networks of repair and reuse centres can play an integral role in local waste management systems run by public authorities, whether they are operated on a local, regional or national level.

Effective promotion of reuse and repair is strengthened by the provision of early access to the waste streams for reuse centres, as well as appropriate handling and storage conditions. This is part of 'preparing for reuse' in the waste hierarchy and supports the overall aims of waste prevention.

Networks of reuse centres exist at national level in France (3 national networks), the Netherlands (1 national network), Spain (1 national network), Austria (1 national network), Ireland (Ballymun Regeneration Ltd (BRL) was set up by Dublin City Council in 1997) and the UK (7 national or regional networks), at regional level in Belgium (2 regional networks), Finland, Germany and British Columbia, with strong examples at local level in Strasbourg, Vienna, Frankfurt, Bilbao, Bristol, Dublin, Brussels and Rome[44]. Indicative factsheets can be found at the following links:
http://ec.europa.eu/environment/waste/prevention/pdf/Kringloop%20Reuse%20Centres_Factsheet.pdf ,
http://www.prewaste.eu/index.php?option=com_k2&view=item&id=272&Itemid=101

An example of a social enterprise is presented in the following box.

[44] http://ec.europa.eu/environment/waste/prevention/guidelines.htm

Box: Oxfordshire County Council – Bicester Green reuse centre
Working in partnership with Sobell House Hospice Charity, Cherwell District Council, Oxfordshire Waste Partnership, Resource Futures, Sanctuary Housing and Grassroots Bicester (a local community group) Oxfordshire County Council set up a new social enterprise, Bicester Green. Bicester Green is a centre for 'skills, sustainability and second-hand stuff'. Opening in 2013, Bicester Green aimed to divert waste from landfill. The centre also brings together volunteers from across the community to provide them with practical work experience and the opportunity to learn new skills as well as functioning as a sustainability hub for the area, hosting events and meetings. During its first six months of operation, 1.3 tons of furniture, nearly a ton of bikes and more than 300kg of electrical items were prevented from becoming waste.[45]

3.12.3.4 Stage 3 – Recyling

The Regional Waste Management Plan sets out a number of measures in order to boost recycling.
Source separation is a critical precondition for generating high-quality secondary raw material from waste and to facilitate re-use of material. The separation of specific fractions of municipal waste at the source provides for best results in recycling certain materials.
A change in waste collection has been proposed in order to move waste further up the waste hierarchy, through a two- bin collection system (recyclable waste bin and residual waste bin).
Furthermore, the proposed Material Recovery Facility (MRF), which sorts waste into different material streams which are then sent to reprocessors, will provide high quality recyclates, as the contens of the recyclable waste bin will be treated.
The windrow composting of green waste is a viable option, due to the significant share of the organics within municipal waste.
Finally, the Green points will receive separated waste streams, which are suitable for recycling or for further suitable management. Apart from recyclables, a range of waste can be delivered such as batteries, electrical goods, bulky waste, C&D waste etc. General the following fractions will be collected separately: 50% of WEEE fraction, 100% of Hazardous material fraction, 50% of C&D material fraction, 50% of wood fraction, 50% of other special waste streams-elastic tires and 3% of recyclable materials fraction.

3.12.3.5 Stage 4 – Other Recovery

Waste management options that fall under the category of „Other recovery", as specified in the Waste Framework Directive, were not proposed.

3.12.3.6 Stage 5 – Disposal

Whilst landfill is the least preferred management option, the waste management technologies leave residual waste which needs to be landfilled.
This stage should be examined in combination with the next paragraph, which presents the measures for the diversion of biodegradable waste from landfill. The mechanical bilogical treatment extents the life of the landfill. Also, the landfill taxes are key drivers to divert waste from landfill.

3.12.3.7 Measures for Diversion of Biodegradable Waste from Landfill

The promotion of home composting, the separate collection of green waste and the Mechanical Biological treatment (MBT) of the residual waste bin are the proposed measures for diversion of biodegradable waste from landfills.
Home composting actions will be applied to 20% of rural population.
Seperate collection of green waste will be implemented, taking into consideration that 40% of green waste fraction will be collected. Collected green waste will be diverted to windrow composting.

45 http://www.local.gov.uk/documents/10180/5854661/LGA+Routes+to+Reuse+FINAL+FINAL.PDF/5edd19ba-7c13-47c5-b019-97a352846863

3.12.3.8 Measures for Increase of Packaging Waste Collection and Treatment Rate

As mentioned in Stage 3 – Recycling, the increase of packaging waste collection rate will be achieved through a two- bin collection system (recyclable waste bin and residual waste bin).
Furthermore, the proposed Material Recycling Facilities (MRFs), which sort waste into different material streams which are then sent to reprocessors will provide high quality recyclates, as the contens of the recyclable waste bin will be treated.

3.12.3.9 Proposed Action Plan

Action plan for project implementation

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

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

The content of short-term measures addresses the most pressing weaknesses in the existing waste management system, and the need to build a foundation for the future waste management system in the region.
The Action Plan includes sufficient data on whose grounds the level of required investment and reinvestment during different periods, together with estimates of the necessary operating costs can be determined.
The Action Plan may be divided into the following periods:

1. Priority measures for a period of up to three years (2018-2020)

- **1st period 2018 – 2019:** Search of possible funding sources.
- **2nd period 2019 – 2020:** Supply of the main collection equipment i.e. collection vehicles and bins. Construction of priority infrastructures (landfill for residues-cell A, Material Recovery Facility, Green Points, Transfer stations, MBT plant), continuation of raising of public awareness through campaigns.

2. Short-term measures for a period of up to five years (-2022)

Completion of construction of priority infrastructures (landfill for residues-cell A, Material Recovery Facility, Green Points, Transfer station, MBT plant) and commence of operation phase. Monitoring of the Regional Waste Management Plan, implementation of any required additional investments, which may be pending or determined in the revised RWMP, closure and rehabilitation of the non compliant landfills and dumpsites. The remediation procedure will be applied according to the remediation plan. Public awareness campaigns on waste management and waste prevention. Implementation of bundle of measures for waste prevention.

3. Medium-term measures for a period of six to ten years (-2027)

Monitoring and updating of the Regional Waste Management Plan.

4. Long-term measures for a period longer than ten years (-2046).

Substitution of old waste collection, transportation and treatment equipment, implementation of any required additional investments. Construction of second landfill cell for residues.
The Action Plan clearly defines the actions, duration and responsibility for implementation, along with the costs of the measures to be implemented. It includes clear and measurable stages for each of task and measure set, presented in tabular form. The following table summarises the necessary actions, which should be taken.

Table 3-114: Action plan for the period 2018 – 2046 – Southwest Region

Key Tasks	Actions	Timescale				Responsible authority
		Priority (2018-2020)	Short-term (-2022)	Mid-term (-2027)	Long-term (-2046)	
A. Improvement of collection and Transportation	A1. Supply of collection equipment for recyclables, mixed waste, green waste, home composting	✓		✓	✓	IWMB and Municipalities
	A2. Construction of TS, Green Points	✓			✓	IWMB and Municipalities
B. Promotion of waste minimization	B1. Construction of integrated waste management infrastructure (Material Recovery Facility for recyclables, treatment plant for residues, landfill cell A for residues)	✓			✓	IWMB and Municipalities
	B2. Promotion of home composting activities	✓		✓	✓	IWMB and Municipalities
	B3. Promotion of 3Rs practices	✓	✓	✓	✓	MoEPP, IWMB and Municipalities
C. Improvement of final disposal system	C1. Operation of landfill site		✓	✓	✓	IWMB
	C2. Remediation of existing non compliant municipal landfills and dumpsites	✓	✓			MoEPP, IWMB
D. Promotion of public participation and behavior change	D1. Raising of public awareness campaigns on waste management and common campaigns on waste prevention and waste management	✓	✓			MoEPP, IWMB
	D2. Promotion of establishment of repair / reuse centres and public awareness activities to promote repair/remanufacture		✓			MoEPP, IWMB
	D3.Implementation of public awareness education activities (Regular mechanism for awareness material, journal		✓	✓		MoEPP, IWMB

Key Tasks	Actions	Timescale				Responsible authority
		Priority (2018-2020)	Short-term (-2022)	Mid-term (-2027)	Long-term (-2046)	
	publication, community interactions, etc.)					
E. Organizational and institutional arrangements	E1. Setting up tariff system	✓				IWMB
	E2. Management of solid waste database system (collection & arrangement of solid waste data in data base, implementation of waste quantity and quality survey twice a year wet and dry seasons)		✓	✓	✓	IWMB
	E3. Monitoring of the Regional Waste Management Plan	✓	✓	✓	✓	MoEPP, IWMB

3.12.4 Project implementation plan

3.12.4.1 Principal procurement options and procedures

The various procurement procedures, allowing for a different degree of competition as showing below:

a. **Open public tender** - takes place in a single stage and any interested party may submit a bid;

b. **Restricted public tender** - consists of two stages, and only the bidders selected by the contracting authority at the first stage will be invited to submit bids at the second stage;

c. **Competitive dialogue** - any interested party may submit a bid. The contracting authority may have a competitive dialogue only with the accepted candidates. Only the candidates selected by the contracting authority are invited to submit a final offer;

d. **Negotiation** – the contracting authority discusses and negotiates the contractual clauses, including the price, with the selected candidates from amongst suppliers, contractors and providers. The contracting authority may, or may not publish a notice for invitation to negotiations;

e. **Offer request** – a simplified procedure according to which the contracting authority requests offers from several suppliers, contractors, and providers, and;

f. **Competition for the award of a project** – it allows the contracting authority to retain a project that was selected by a jury on a competitive basis, especially in the territorial planning, urban and zoning areas.

Figure 3-79: The Guide to tendering

3.12.4.2 Procurement steps

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

⇨ **SPECIFICATIONS**

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

⇨ **SELECTION**

Rejection or selection of candidates based on:

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

⇨ **AWARD**

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

3.12.4.3 Selection of procurement procedure

The rules for applying the standard EU procurement procedures are summarized in the table below. They are divided between those for services (i.e. technical assistance, studies, provision of know-how and training), supplies (i.e., equipment and materials) and works (i.e. infrastructure and other engineering works). For the contracts that will be financed by national or local funds, national procurement rules will be applied.

The thresholds given in the table are based on the maximum budget for the contract in question (including any co-financing). Where contracts are subdivided in lots, the value of each lot shall be taken into account when calculating the overall threshold.

Regardless of the procedure used, the Contracting Authority must ensure that all the basic principles are respected (including eligibility, exclusion and selection criteria). Note that projects must not be split artificially to circumvent the procurement thresholds. Other procedures can be applied regardless the thresholds, for instance, negotiated procedures as long as the relevant conditions are met.

Table 3-115: EU Procurement thresholds (source PRAG 2016)

<table>
<tr><td>SERVICE CONTRACTS</td><td>- International restricted tender procedure</td><td colspan="2">< EUR 300 000 but > EUR 20 000
- Framework contract BENEF 2013
or
- Competitive negotiated procedure</td><td rowspan="3">EUR 20 000
- Single tender
A payment may be made against invoice without prior acceptance of a tender if the expenditure is EUR 2 500</td></tr>
<tr><td>SUPPLY CONTRACTS</td><td>EUR 300 000
- International open tender procedure</td><td>< EUR 300 000 but EUR 100 000
- Local open tender procedure</td><td><EUR 100 000 but > EUR 20 000
- Competitive negotiated procedure</td></tr>
<tr><td>WORKS CONTRACTS</td><td>EUR 5 000 000
- International open tender procedure
or
- International restricted tender procedure</td><td>< EUR 5 000 000 but EUR 300 000
- Local open tender procedure</td><td>< EUR 300 000 but > EUR 20 000
- Competitive negotiated procedure</td></tr>
</table>

3.12.4.4 Tender dossier (TORs and technical specifications)

The purpose of Terms of Reference (for service contracts) and Technical Specifications (for supply and works contracts) is to give instructions and guidance to contractors at the tendering stage about the nature of the project they will need to submit and offer for, and to serve as the contractor's mandate during project implementation. The Terms of Reference or Technical Specifications will be included in the Tender Dossier and will become an annex of the eventual contract awarded as a result of the tender.

The thorough preparation of the Terms of Reference or Technical Specifications is extremely important for the ultimate success of the project. It is important to ensure that the project has been properly conceived, that the work is carried out on schedule and that resources will not be wasted. Therefore greater effort during project preparation will save time and money in the later stages of the project cycle.

In particular, the budget for the standard service contract incorporates a fixed provision for incidental expenditure (for all, actual expenses not related to fees) as well as a provision for expenditure verification to be both determined in the tender dossier. Those provisions must correspond to the requirements of the Terms of Reference and must be carefully estimated. The Terms of Reference, Technical specifications and budget must afford equal access for candidates and tenderers and not have the effect of creating unjustified obstacles to competitive tendering.

Once the Tender Dossiers have been finalised the tender procedure should be launched. The Terms of Reference or Technical Specifications contained in a tender dossier – the basis for the project work-plan - must reflect the situation at the time of project start-up so as to avoid considerable effort having to be spent re-designing the project during the inception period.

The exact procurement plan and the relative timeplan for its implementation will be identified in more detail, during Feasibility study stage and application for co-financing.

3.13 LIST OF INDICATORS

3.13.1 Performance indicators

Waste management encompasses many issues that must be taken into account towards the establishment of a sustainable society. Performance indicators are the heart of a performance monitoring system, because they define the data to be collected to measure progress and enable actual results achieved over time to be compared with planned results. Thus, they are an indispensable management tool for making performance-based decisions about programmes strategies and activities. The main goal of the performance indicators is to measure the performance of the regional integrated solid waste system and help define and evaluate how successful the action plan is, in terms of making progress towards its long-term goals, covering all aspects of solid waste management, such as compliance with EU legislation, waste generation, recycling infrastructure, efficiency in relation to landfill targets, energy recovery and environmental awareness[46].

Waste generation and prevention

The amount of waste produced per unit of GDP/ GVA (kg/ €)

The correlation of waste generation and its relation to Gross Domestic Product (GDP) is one of the major issues concerning the waste management sector. In a general way, per capita waste generation is strongly correlated with income and social development but also affected by waste awareness and education; thus areas which concentrate more wealth tend to generate more waste per person. This indicator shows the quantity of waste per unit of income (€), and on a second basis, whether there has been any decoupling of waste generation from economic growth. GPD is usually expressed at market prices.

Number of environmental awareness raising events and percentage of population reached - surveys on knowledge about different aspects of waste and waste prevention

The number of the environmental awareness raising events is useful information, but it should be combined with population data in order to form an effective indicator. The percentage of the population targeted with the campaigns launched provides an insight on the campaign scale, but not on its intensity.

For Re-use: number and turnover of reuse organisations, number of sold second hand products

Collection and transport

The following table provides a clear overview of the impact of the proposed investment in relation to the improvement of the waste management system (and particularly the waste collection system).

Table 3-116: Performance indicators for collection and transport

	Indicator	Unit
1.	Percent of population connected to collection services in total and in urban, rural areas	%
2.	Percent of population connected to separate collection services (green waste, recyclables, WEEE, organic, etc.) in total and in urban, rural areas	%
3.	Total collected municipal waste	T / year
4.	Separately collected green waste	T / year
5.	Separately collected commercial waste	T / year
6.	Separately collected recyclable waste	T / year
7.	Provided container volume for waste	m^3 / inh x year

[46] BALKWASTE (2010). Action 7: *Study Regarding the Development of Indicators. Waste Network for sustainable solid waste management planning and promotion of integrated decision tools in the Balkan Region. LIFE07 ENV/RO/000686* [pdf]. Retrieved from http://www.balkwaste.eu/?page_id=90

	Indicator	Unit
	collection	
8.	No and volume of containers for mixed waste collection	m^3
9.	No of and volume of containers for separate waste collection	m^3
10.	No and capacity of collection vehicles	No and m^3
11.	No and capacity of press containers	No and m^3

The monitoring of the aforementioned indicators should be carried out on annual basis by the competent authorities and will give indications about the level of success of the system or the need to implement mitigation measures.

Recycling/recovery

The following table provides a clear overview of the impact of the proposed investment in relation to the improvement of the waste management system and particularly the waste recycling/recovery of packaging waste. The recycling rate is the percentage of recyclables that are collected and recycled divided by the total amount of recyclables that are generated. This is an indicator that can be used at regional and national level. The target for the recycling/recovery of packaging waste is a national target, which is apportioned to the Region.

Table 3-117: Performance indicators for waste recycling/recovery

	Indicator	Unit
1.	Total population in human settlements concerned	capita*1000
2.	Recycling rate for paper	% and t/ year
3.	Recycling rate for plastic	% and t/ year
4.	Recycling rate for glass	% and t/ year
5.	Recycling rate for metal	% and t/ year
6.	Recycling rate for wood	% and t/ year
7.	No and capacity of sorting plants	No and capacity
8.	Total recycling	% and t/ year
9.	Total recovery	% and t/ year

The monitoring of the aforementioned indicators should be carried out on annual basis by the competent authorities and will give indications about the level of success of the system or the need to implement mitigation measures.

Biodegradable fraction

The following table provides a clear overview of the impact of the proposed investment in relation to the improvement of the waste management system (and particularly the treatment of the biodegradable fraction of the waste).

Table 3-118: Performance Indicators for biodegradable waste treatment

	Indicator	Unit
1	Total population in human settlements concerned	capita*1000
2	Total diversion rate for biodegradable waste not disposed of in landfills	% and t / year
3	Amount of biodegradable waste diverted through home-composting	% and t / year

The monitoring of the aforementioned indicators should be carried out on annual basis by the competent authorities and will give indications about the level of success of the system or the need to implement mitigation measures.

Waste disposal - landfill

The following table provides a clear overview of the impact of the proposed investment in relation to the improvement of the waste management system (and particularly the waste landfilling).

Table 3-119: Performance Indicators for waste landfill

	Indicator	Unit
1	Total population in human settlements concerned	capita*1000
2	Amount of waste disposed of in compliant landfills	t/year
3	No and capacity of landfills compliant with EU standards	No and m^3

The monitoring of the aforementioned indicators should be carried out on annual basis by the competent authorities and will give indications about the level of success of the system or the need to implement mitigation measures.

The operation of the new regional landfill will facilitate the closing and environmental clearance of the existing non-compliant landfills.

Closing dumpsites

The following table provides a clear overview of the impact of the proposed investment in relation to the improvement of the waste management system (and particularly the waste landfilling).

Table 3-120: Performance Indicators for closing and remediation of landfills

	Indicator	Unit
1	Total population in human settlements concerned	capita*1000
2.1	No and volume of remediated urban landfills	No and m^3

The monitoring of the aforementioned indicators should be carried out on annual basis by the competent authorities and will give indications about the level of success of the system or the need to implement mitigation measures.

Special waste streams

The proposed indicators for this category are:

- Overall amount of WEEE collected per capita [tn/cap]*
- Amount of WEEE prep. for reuse/recycled [%]*
- Overall amount of construction and demolition waste collected per capita [tn/cap]
- Amount of construction and demolition waste prep. for reuse/recycled [%]
- Overall amount of waste oils collected per capita [tn/cap]*
- Amount of waste oils prepared for reuse/recycled [%]*
- Overall amount of waste batteries collected per capita [tn/cap]*
- Amount of waste batteries prepared for reuse/recycled [%]*
- Overall amount of end of life vehicles collected per capita [tn/cap]*
- Amount of end of life vehicles prepared for reuse/recycled [%]

Cost indicators

The proposed indicators for this category are:

Average cost per MSW collected (€/tn)

This indicator is one of the main indicators used by local authorities in order to monitor their collection costs.

Average cost per MSW treated (€/tn)
Accordingly to the previous indicator this one is of added value when used within a certain region.

Public awareness
The proposed indicators for this category are:
Number of environmental awareness raising events and percentage of population reached
The number of the environmental awareness raising events is useful information, but it should be combined with population data in order to form an effective indicator. The percentage of the population targeted with the campaigns launched provides an insight on the campaign scale, but not on its intensity.

Coverage of the environmental campaigns launched
This indicator provides the average population coverage of the environmental campaigns launched, and can be measured as follows:

$$\text{Population } Coverage = \frac{\sum Number\ of\ Campaings_{1-k} \times Population\ Coverage_{1-k}}{Total\ \ Number\ \ of\ \ Campaingns}\ \%$$

3.13.2 Sustainability indicators

The sustainability objectives and indicators are shown below.

Objectives of the RWMP	**Sustainability indicator**
Environmental and Health Objectives (Aim A)	
Sustainable use of land and other resources	Depletion of resources (wood, etc.) Land take
Minimization of greenhouse gas emissions	Emission of greenhouse gas
Minimization of negative impacts on air quality and public health	Dioxin emissions Emissions dangerous for public health Extent of odour problem Extent of dust problem Emissions injurious to public health
Minimization of negative impacts on water quality and water resources	Water pollution (concentrations of various substances) Quantitative and qualitative status of groundwater Eutrophication
Land and cultural heritage conservation	Visual impacts
Socio-Economic Objectives (Aim B)	
Provision of public awareness campaigns, enhancement of public involvement	No of public awareness campaigns and training activities which educate and involve the public
Optimization of waste collection system and minimization of local transport impacts	Ratio between kilometers run and the amount of waste collected
Employment opportunities	Number of job likely to be created