Reference case for the Region of Western Macedonia

Contents

1 Introduction

DIADYMA S.A. has the responsibility to organize waste management services at the region of Western Macedonia.

DIADYMA S.A. was founded in 1996 to serve the needs for Waste Management in the area, according to the Strategic Plan approved by the Regional Council in 1997.

The company's major task is to design, develop & operate the regional Integrated Waste Management System (IWMS) of Western Macedonia (12 municipalities, 300,000 residents).

The regional IWMS includes:

- Collection with special waste trucks
- Transfer stations and large transshipment vehicles
- Recovery and Recycling via a 4-bin system
- Mechanical treatment and Recovery (future plant)
- Sanitary Landfill
- Landfill restoration

2 Demographics and Waste Production

2.1 Location, Population

The region of Western Macedonia is situated in north-western Greece, bordering with the peripheries of Central Macedonia (east), Thessaly (south), Epirus (west), and bounded to the north at the international borders of Greece with the Republic of Macedonia (Bitola region) and Albania (Korçë region).

Although it covers a total surface of 9,451 km^2 (3,649 sq mi) (7,2% of country's total), it has a total population of 302,892 inhabitants (2.9% of the country's total), thus it is a low-density populated region (32 per km², as compared to the country's 79.7 relevant figure). This is mainly due to the mountainous nature of the Region, as 82% of the total surface is mountainous and semi-mountainous areas. This is also reflected in the population distribution, as the major part of the population (56%) lives in rural areas. Capital of the periphery is Kozani with 47,451 inhabitants. Other main towns are Ptolemaida (32,775), Grevena (16,704), Florina (14,318) and Kastoria (13,959).

The demographics data of the municipalities are presented in the following tables:

Table 1: Population in Western Macedonia region

Municipality	Residence	Municipality	Residence
Voio	**22.447**	**Kastoria**	**165.102**
Eordea	**46.540**	**Nestorio**	**18.625**
kozani	**68.680**	**Orestidos**	**9.918**
Servia Velvento	**17.657**	**Total**	**53.483**
Total	**155.324**	**Amynteo**	**18.975**
Grevena	**30.564**	**Prespa**	**2.511**
Deskati	**7.383**	**Florina**	**33.282**
Total	**37.947**	**Total**	**54.768**

Source: ELSTAT, 2001

According to the unofficial data from ELSTAT (2011) the total population in the Region is 282.120 Inhabitants, reduced by 6.5% compared with the 2001 data.

2.2 Waste streams and quantities

2.2.1 Quantity of MSW

Municipal solid wastes in the region are classified in three basic categories:

⇒ The mixed domestic wastes (from green waste bins),

⇒ The recyclable domestic wastes (packaging waste also included), that constitute of the following materials:

- paper,
- plastic,
- glass,
- metals (ferrous materials basically)
- aluminum

⇒ the bulky municipal solid wastes which include:

- Waste Electrical & Electronic Equipment (WEEE).
- The rest bulky waste which mainly include furniture equipment, bed layers, non metallic frames etc.

The implementation of the Intergraded Solid Waste Management System in the region of West Macedonia (ISWM) on July 2005 consists of the procedures of reloading and transportation of solid wastes, of collecting and processing the recyclables and of the sanitary landfilling of non-hazardous wastes.

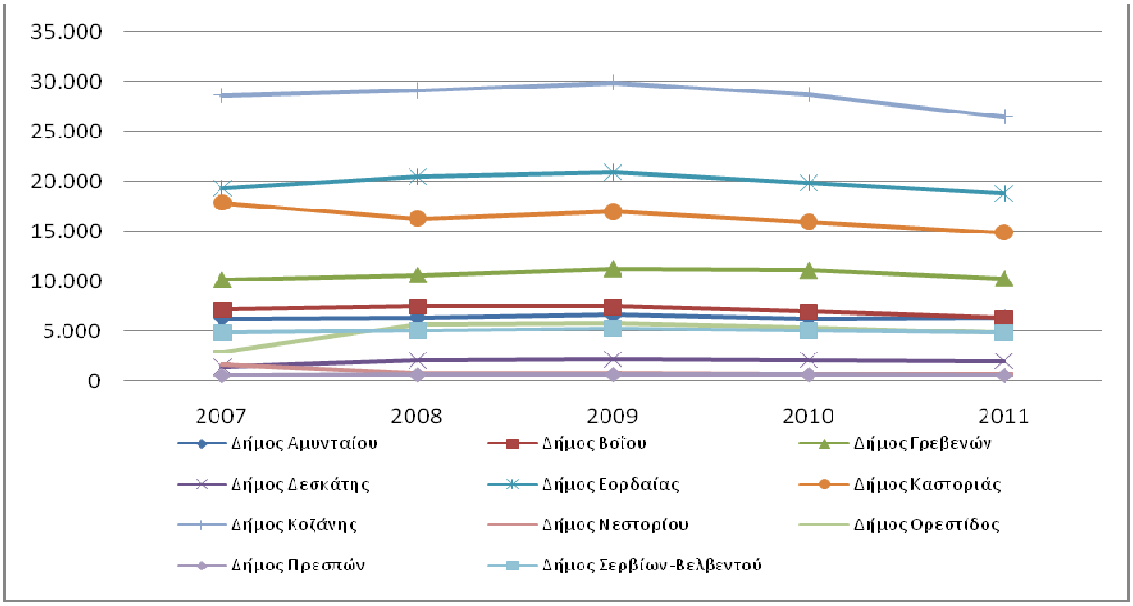
Through these activities DIADYMA have gained valuable real time data about the quantity of each type of waste that enters the transfer stations and the Sanitary Landfill. It should be noticed here that the first 18 months (July 2005 -December 2006) were a period of trial implementation so safe reliable data for the production of wastes are regarded those received after 2007 until today.

In the following table there is a representation of the annual production rates of municipal solid wastes, as well as those that -by nature- are of domestic origin and can not end up in waste bins but are loaded and manipulated as municipal solid wastes. The sources of these wastes are various enterprises of semi-industrial scale in the region of West Macedonia. These annual rates represent the waste production of 12 municipalities in the region of West Macedonia. Partial recycling with **source separation** is not included.

Table 2: Amount of Municipal Solid Wastes – data logger figures from Transfer Stations and Landfill

	MUNICIPALITIES	SOLID WASTES (tn/yr)				
		2007	2008	2009	2010	2011
1	M. Amynteo	6.305,70	6.408,50	6.643,00	6.323,10	6.400,70
2	M. Voio	7.170,80	7.495,30	7.453,00	6.965,80	6.348,60
3	M. Grevena	10.203,80	10.672,90	11.295,00	11.131,50	10.347,50
4	M. Deskati	1.456,40	2.116,50	2.239,00	2.163,30	2.055,90
5	M. Eordea	19.327,90	20.450,80	20.921,00	19.843,30	18.811,60
6	M. Kastoria	17.889,40	16.306,60	17.006,00	16.001,60	14.915,20
7	M. Kozani	28.642,80	29.108,80	29.902,00	28.760,70	26.517,20
8	M. Nestorio	1.663,40	773,7	803	763,3	720,9
9	M. Orestidos	2.973,60	5.708,80	5.864,00	5.452,10	4.905,00
10	M. Prespa	588,1	656,9	685	669,8	590,3
11	M. Servia-Velvento	4.926,70	5.107,40	5.341,00	5.137,40	4.894,20
12	M. Florina	13.444,30	13.562,00	13.762,00	13.211,80	12.435,40
	TOTAL	**114.592,90**	**118.368,20**	**121.914,00**	**116.423,70**	**108.942,40**

The following diagram shows the evolution of waste production in the region of Western Macedonia



The amount of recyclables (tons) collected is presented in the following table:

Table 3: Amount of recyclables collected in WMR

	2007	2008	2009	2010	2011 (estimation)
Paper	2.711	2.989	3.322	3.995	4.150
Plastic	0	0	0	48	300
Glass	0	0	0	119	180
Metal	0	0	0	2	8
Total	**2.711**	**2.989**	**3.322**	**4.163**	**4.638**

2.2.2 Composition of MSW

DIADYMA S.A. has been implementing since October 2005, periodical sampling and composition analysis of the municipal wastes that end up in the sanitary landfill of the region of West Macedonia.

The sampling has been planned and implemented according to the international ASTM D5231-92/2003 standard "Standard Test Method for Determination of the Composition of unprocessed Solid Waste", and the legislation RCRA (Waste Sampling Draft Guidance, EPA530-D-02-002). The method that was selected is that of Random Uniform Sampling.

The following table is a presentation of the composition results obtained after statistical processing in the period 2005-2011:

Table 4: MSW composition results after statistical processing of data from period 2005-2011

	2005	2011
Organics	**46,3%**	**46,1%**
Paper	**19,4%**	**20,3%**
Plastic	**14,4%**	**14,4%**
Metals	**2,2%**	**2,2%**
Glass	**1,9%**	**2,0%**
Leather and wood	**5,2%**	**5,0%**
Non classified	**10,6%**	**10,0%**
Total	**100,0%**	**100,0%**

We can see that the most significant changes in the composition of waste from 2005 are the small decrease of organic materials and the increase of the paper and glass.

2.3 Present waste management system

The Region of Western Macedonia is designed around one regional site (Waste Management Centre - WMC). The WMC is located in the area of a former lignite mine and includes a Sanitary Landfill for non-hazardous waste and a Regional Recycling Facility. It should be noted that due to the fact that recyclables are separated at source (4-bin system), the Regional Recycling Facility is actually a large Temporary Storage facility, where all collected recyclables are processed (removal of any unwanted materials), baled (paper and plastics) and stored prior their sale to end users.

In order to transfer waste or separated at source recyclables a network of transfer stations is in operation that consists of 10 Transfer Stations: 4 in the Regional Authority of Kozani, 2 in Grevena, 1 in Kastoria and 2 in Florina. The transfer stations also serve as local facilities for the Temporary Storage of Recyclables coming from the various municipalities, prior their transfer to the WMC.

The existing infrastructure for Mixed waste includes:

- 6day collection with municipal waste vehicles
- 10 Transfer Station
- 1 Sanitary Landfill for non hazardous residues

The existing infrastructure for Recyclables includes:

- Source separation in (4) distinct bins for paper, plastic, glass and metals.
- 10 Local Temporary Storages for recyclables (for paper, plastic, glass and metals)
- One Regional Recycling Facility

The infrastructure kerbiside collection includes five types of bins:

- **Mixed waste:** 4-wheeled bins-1.100L
- **Paper:** 2-wheeled bins-360L
- **Plastic:** 2-wheeled bins-360L
- **Glass :** 2-wheeled bins-360L
- **Metals:** 2-wheeled bins-360L

Collection vehicles for mixed waste and recyclables include:

- Waste Collection Vehicle with Press 16m3
- Waste Collection Vehicle with Press 12m3
- Waste Collection Vehicle with Press 8m3

The transportation of mixed waste from the network of Transfer Stations to the WMC is done with semi-trailers equipped with a compression system and a capacity of 36m^3.

3 Reference Case

3.1 Waste quantity and composition used in the Tool

3.1.1 Waste Quantity and Composition, future projections

Data for waste quantity were collected from the weigh-bridge data logger of the WMC and have been presented in Section 2.2, above. The District's reference year (2011) population has been established at 300.000 and the annual waste at 108.942 tn.

The following table shows the composition that has been used for the 1st period. Due to the fact that the change in waste composition is rather difficult to foresee, an assumption was made that for the rest of the 5-year periods (totally the Tool requests data for for periods of five years each), a steady annual increase of waste production equal to 0,5% was assumed, equal for all the different "ingredients" (organics, paper, etc), of the waste.

Table 5: MSW composition used in the Tool

COMPOSITION	%
Organic	46,10
Food waste	38,00
Garden and park waste	5,00
Other organics	3,10
Leather-Wood-Textile	5,00
Wood packaging	1,50
Other Wood	3,00
Textile	0,50
Paper	20,30
Packaging paper	8,00
Cardboard	4,50
Print paper	0,60
Other paper	7,20
Glass	2,00
Mixed packaging glass	1,50
Other glass	0,50
Metals	2,20
Ferrous metals packaging	0,80
Other Ferrous metals	1,00
Aluminum packaging	0,40

COMPOSITION	%
Plastic	14,40
Mixed packaging plastic	2,00
Other film	2,10
PET bottles	3,50
PVC bottles	2,30
Other dense plastic	4,50
Other	10,00
Drink Cartons	5,00
Inorganic	2,00
Fine materials less than 10mm	3,00
Total	

3.1.2 Rest of data

The Recovery rates (as a percentage over production), for the recyclable materials (recycling in the source of production) for the Reference Case are presented in the following table:

Table 6: Recycling rates incorporated in the Tool

Material	1st Period	2nd Period	3rdPeriod	4rd Period
Paper	18,920%	18,920%	18,920%	18,920%
Plastic	1,925%	1,925%	1,925%	1,925%
Glass	8,034%	8,034%	8,034%	8,034%
Metals	0,165%	0,165%	0,165%	0,165%
Organics	0,000%	0,000%	0,000%	0,000%

The technologies and equipment inserted in the Tool represent the current infrastructure of bins, vehicles, Transfer Stations, Temporary Storage facilities, recycling Centre and Sanitary Landfill:

- 10 Transfer Stations
- 10 Temporary Storage for Recyclables
- 10 Temporary Storage facilities for Glass
- 1 Recycling Centre
- 1 Sanitary Landfill for non hazardous residues

Distances

- Distances from Bins to Transfer Stations 7,5km
- Distance from Transfer Stations to Landfill 55 km

Bins

- ***For mixed Waste:*** 4- wheeled bins 1.100lt
- ***For Recyclables:*** 2-wheeled bins 360lt

Truck type

- ***From Bins to transfer Stations and to Temporary Storage Station:*** 16m3 diesel
- ***From Transfer station to Landfill:*** Truck TS 36m3

The cost for the collection, transfer, processing and disposal was also introduced in the Tool and represents the current prices of the waste management system as it is managed by DIADYMA S.A.

Also, the capital cost of the facilities (transfer stations, temporary storage, recycling centre (MRF) and Saniray Landfill) are the real ones (customized values and not default parameters of the Tool).

Finally, the capacity of all the above infrastructure has been indicated by the user for the four 5-year periods, while the rest of the available technologies were excluded. This way the Tool "run" as a solver and no alternative solutions appear at the "Pareto front" curve.

Table 7: Capacity and costs of existing system inserted in the Tool

	1 period	2 period	3 period	4 period
Annual cost (keuro):	8.207	10.578	12.957	15.349
Annual costs and income by category (keuro)				
Bins:	100	103	105	108
Transportation (capacity):	14	29	43	58
Transportation (operation):	13	13	13	14
Processes (capacity):	2.414	4.639	6.872	9.112
Processes (operation):	5.895	6.028	6.164	6.304
Income from recycle:	229	234	240	246
Income from electricity:	0	0	0	0
Investment costs				
Bins:	433	447	455	467
Transportation:	175	6	3	5
Processes:	30.103	27.742	27.836	27.933

3.1.3 Results

The net present cost for the 20-y period has been calculated **equal to 137,494 million euros**, while the overall CO_{2eq}. emissions amount up to **539 ktons for the 20-y period**.