

WASTES: Solutions, Treatments and Opportunities1st International Conference
September 12th – 14th 2011**WASTE MANAGEMENT IN PORTUGAL AND EUROPE – AN OVERVIEW OF THE PAST, PRESENT AND FUTURE**A. Ribeiro¹, F. Castro², M. Macedo³ and J. Carvalho⁴1 CVR – Centre for Waste Valorization, aribeiro@cvresiduos.pt.2 University of Minho/CT2M, fcastro@dem.uminho.pt.3 CVR – Centre for Waste Valorization, mcmacedo@live.com.pt.4 CVR – Centre for Waste Valorization/CT2M, jcarvalho@cvresiduos.pt**ABSTRACT**

As world society grows exponentially more and more wastes, have been created. Each year European Union throws away 3 billion tons of waste, and some 90 million tons of that are hazardous. It is clear that treating and disposing of all this material - without harming the environment - becomes a major trouble. In the early 90s, the amount of waste generated in Europe increased by 10%. Most of that was thrown away in incinerators, or dumped into landfill creating environmental damage. Landfill disposal not only takes valuable land space but also causes air, water and soil pollution, discharging carbon dioxide (CO₂) and methane (CH₄) into the atmosphere and chemicals and pesticides into the earth and groundwater. This situation is harmful to human health as well as to plants and animals. These events triggered urgency for a responsibility and appropriate legislation for correct waste management. EU and Portuguese policy main objectives in the waste management is to prevent and reduce waste production, and reduce their toxicity, through reuse and modification of production processes, adopting cleaner technologies. Waste management must also avoid or at least reduce its risk to human health and to environment. In Portugal, wastes sector was suffered a revolution on the last years, due to the appearance of the Strategic Plan for Solid Waste I (PERSU I) in 1997 and by the constant pressure from the EU for their state members and waste producers. In December 2006 it was created the PERSU II to correct all mistakes made in the previous plan. However soon realized that PERSU II had very ambitious goals and so unattainable that triggered the need to reformulate these objectives. The aim of this overview in waste management was to follow the goals outlined in PERSU II, identifying the progress of each operational system over the years. It was also a target to compare those results to European statistics tracing possible ways to permit compliance with EU objectives in future.

Keywords: Waste Management; PERSU I; PERSU II; Municipal Wastes (MW)**INTRODUCTION**

Municipal Wastes (MW) problem in Portugal have been getting worse over time and its resolution seems to be far away. In Portugal as well as worldwide, MW production has grown exponentially, and the main cause of this problem is the society growth, where the world consumerism prevails [1]. Thus, one of the most serious problems facing any urban center is the amounts of wastes generated. Solid wastes are presented with one of most environmental problems of actual society and the only way to solve this problem is creating an effecting management system [2]. Although an effective policy of Integrated Management of MW has been established in Portugal, this type of wastes is mostly sent to landfills and incinerators (end of line-treatments). Planning and Waste Management encompasses all types of wastes from different sources and constitute the aim of this environment polices [3]. In Portugal the legislation on MW has been amended several times in recent years as a reflection of its outdated compared to the demands of European Union. In fact, most of developed countries, usually more aware of these issues, built a complete legislative structure and framework for this problem [4]. In future, solid wastes must be seen not only as a

problem to solve in the most cost-effectively way, but also a potential resource of raw-materials. Final destination given to wastes presents, in a short timeframe, a great importance and therefore it is necessary to find the most efficient management system for them [5].

In this work it was identified and overviewed the waste management in Portugal over the years. It was analyzed the period before the implementation of PERSU I and the execution of PERSU II in present time. These results have also been compared with European statistics.

WASTE MANAGEMENT IN PORTUGAL – PAST

Portugal situation in 1995 with regard to solid waste management was characterized by total failure of the most basic requirements for environmental preservation, because MW were dumped in open landfills in 76% of cases and 14% in controlled landfills [1,6].

In 1996, MW management was based on the distribution in 275 systems in the municipalities which proceeded to the deposition on more than 300 waste landfills. That situation harmed the landscapes and soils and provided vehicles for spreading diseases in local populations. The exception to this scenario consisted in 13 places where the deposition was carried out controlled, and in 5 units for organic recovery, but mostly in a poor state of exploitation [1,5]. Table 1 shows the MSW management in Portugal in 1995.

Table 1 – Solid Waste Management in Portugal in 1995 (source: Russo [5])

	Solid Waste Management in Portugal [1995]	
	Ton/year	%
MW total production	3 340 000	-
Glass recycling	90 952	2.7
Paper/cardboard recycling	33 400	1
Composting	299 190	9
Other recycling	-	0.3

According to Russo [5] the characterization of Portugal state in 1995 (table 1) was made with the available data, although in some cases unreliable, particularly in MSW production. However it was identified a growth rate of 3% per year.

In 1997, waste sector in Portugal has undergone a revolution mostly due to the appearance and formalization of the Strategic Plan for Municipal Solid Wastes I (*in Portuguese* - PERSU I) and due to the constant pressure from European Union over the states and producers of wastes in the expectation that targets for recovery and recycling were achieved [1,7]. The main guidelines of PERSU I appointed to:

- i. Closure of all open air landfills and their environmental remediation;
- ii. Construction of infrastructure for MSW treatment;
- iii. Strengthening the selective collection and the multi-material recycling;
- iv. Achievement of goals for 2000-2005.

However, some of the goals outlined in PERSU I have not been realized, as can be seen in table 2.

Table 2 – Overview of PERSU I accomplishment between 2000 and 2004 (source: Russo [5])

Year	Reduction [%]	Recycling [%]	Landfills [%]	Open air dumps [%]	Incineration [%]	Composting [%]
Situation in 1995	0	4	14	73	0	9
PERSU I goals for 2000	2.5	15	41.5	0	26	15
Situation in 2000	0	6	55	12	22	6
Balance in 2000	-100	60	32.5	-100	-15	-60
PERSU I goals for 2005	5	25	23	0	22	25
Situation in 2004	0	6	71	0	20	8
Balance in 2004	-100	-76	>100	100	-9	-68

It is possible to verify that eradication of open air dumps and incineration goals established in PERSU I for 2005 were achieved. However, on reducing waste production the objectives established in PERSU I were not accomplished and there was none strategy for that [5,8,9]. Indeed there was no reduction of waste production, and recycling and composting did not reached the established levels, having been respectively -76% and -68% for targets. The elimination of waste dumps, presents itself as the great victory of the first generation of this plan [5,10].

WASTE MANAGEMENT IN PORTUGAL – PRESENT

With the beginning of a new cycle of planning associated with the National Strategic Reference Framework (*in Portuguese* - QREN) it was necessary the review of PERSU I to ensure continuity on national and community wastes policy. Some of the reasons for the revision of PERSU I are:

- Observed changes at the level of EU policy on waste (Directive N° 2006/12/CE);
- Approval by the Decree N° 178/2006, of the new General System of Waste Management, which showed changes in the legal sector;
- Commitment made by Portugal in relation to compliance with the Kyoto Protocol to reduce emissions and greenhouse gases.

Published through Decree N° 187/2007 on 12 February, PERSU II reviews the PERSU I, and it's the new benchmark for the horizon of 2007 to 2016. This plan reviews the strategy for reduction of Biodegradable Municipal Waste (BMW) that are sent to landfills (*in Portuguese* - ENRRUBDA, 2003) and the Intervention Plan for Solid Waste and Similar (*in Portuguese* - PIRSUE, 2006). The strategic guidelines presented in PERSU II are:

- i. Reduce, Reutilize and Recycle;
- ii. Separate at source;
- iii. Minimize landfill deposition;
- iv. "Waste to Energy" politic in not recyclable fraction;
- v. Valid information at useful time;
- vi. Sustainability in management systems;
- vii. Kyoto protocol [1, 4,5,7].

For the horizon established in PERSU II, strategy for MSW management is completely conditioned by the fulfillment of Community objectives set for the years: 2009, 2011 and 2016. The main goals determined by the EU directives are listed in table 3.

Table 3 – Goals of MSW management in Portugal (Source: Russo [5])

"Packaging" Directive N° 92/2006	"Landfills" Directive N° 152/2002
2011	2006
Total packaging waste valorization: ≥ 60%	Biodegradable Municipal Wastes reduction (BMW) to landfills by 75% related to total amount (by weight) of BMW produced in 1995
Total packaging waste recycling: 55-80%	
Glass waste recycling: ≥ 60%	2009
Paper and cardboard recycling: ≥ 60%	Biodegradable Municipal Wastes reduction (BMW) to landfills by 50% related to total amount (by weight) of BMW produced in 1995
Plastic recycling: 22,5%	
Metal recycling: ≥ 50%	2016
Wood recycling: ≥ 15%	Biodegradable Municipal Wastes reduction (BMW) to landfills by 35% related to total amount (by weight) of BMW produced in 1995

Municipal Wastes Production in Portugal

Table 4 shows the variation of municipal wastes productions in Portugal between 2005 and 2009.

Table 4 – Municipal Waste production in Portugal between 2005 to 2009 (source: APA [6]).

	Population					Total of MW ([tons]				
	2009	2008	2007	2006	2005	2009	2008	2007	2006	2005
Portugal	10.144 .940	10.135 .309	10.126.8 80	10.110.2 71	10.082.1 54	5.184.5 92	5.154.4 34	4.648. 22	4.641.1 03	4.470.8 69
Annual variation [%]	0.10	0.08	0.16	0.28	0.38	0.59	10.89	0.15	3.81	1.75

Total municipal wastes production in Portugal in 2009 was approximately 5.184.000 tons. Compared with calculated values for 2008, in 2009 it was observed an increase of 0.59% in MW production, which corresponds to 30.000 tons [6]. According to INE [3], in Portugal the amount of waste collected between 2004 and 2009 grow at an annual rate of 3%. The amount of collected wastes per capita also increased 3%, setting an annual MW production of 511 kg/person. These represent a daily MW production of 1.4kg per inhabitant. In terms of quantities of wastes generated per capita, Portugal is slightly below the EU average at 27 countries because in 2009 reached 524 kg per person.

Waste production by management operation

Waste management operations are classified due their final destination. These operations are divided into two distinct groups: waste recovery operations and waste disposal operations. In the first type of operation are contemplated the energy recovery (incineration), organic recovery (composting) and selective collection (recycling). In the second type of operations it is considered the final disposal of wastes in landfills [1,7]. Table 5 presents the MW production in Portugal by management operation.

Table 5 – Municipal waste production in Portugal by management operation between 2005-2009 (source: APA [6])

Year	Landfill		Energetic Valorization		Organic Valorization		Selective Collection		Total
	Tons	%	Tons	%	Tons	%	Tons	%	Tons
2009	3.200.676	62.0	958.883	18.6	418.404	8.1	606.629	11.7	5.184.592
2008	3.372.505	65.5	869.262	16.9	377.175	7.3	535.492	10.4	5.154.434
2007	3.014.311	64.8	825.938	17.8	318.264	6.8	489.703	10.5	4.648.222
2006	3.040.953	65.5	854.578	18.4	298.600	6.4	446.973	9.6	4.641.103
2005	2.838.373	63.5	937.102	21.0	310.433	6.9	384.961	8.6	4.470.869

In the period under review, selective collection and consequent recycling of wastes constitute the management operation that has the fastest growing verifying that more than 11% of wastes was been collected. Indeed between 2004 and 2009, quantities of selectively collected waste were clearly superior that total generated waste (3%) with an average growth rate of about 15% per year [3,6].

In the universe of undifferentiated collected wastes in 2009, the main final destination was landfill disposal (62%) followed by energy recovery (19%) and organic recovery (8%). Landfill disposal and energy recovery achieved average growth rates of 2% per year and organic recovery achieved 6%. In selectively collected waste (figure 1), glass was the material collected in larger amounts in 2005, representing almost half of the quantities collected in that year. In 2009, glass collection represents only 11% of total selectively collected waste. In that year the main collected material was paper and cardboard with an average growth of 18% per year [3,6].

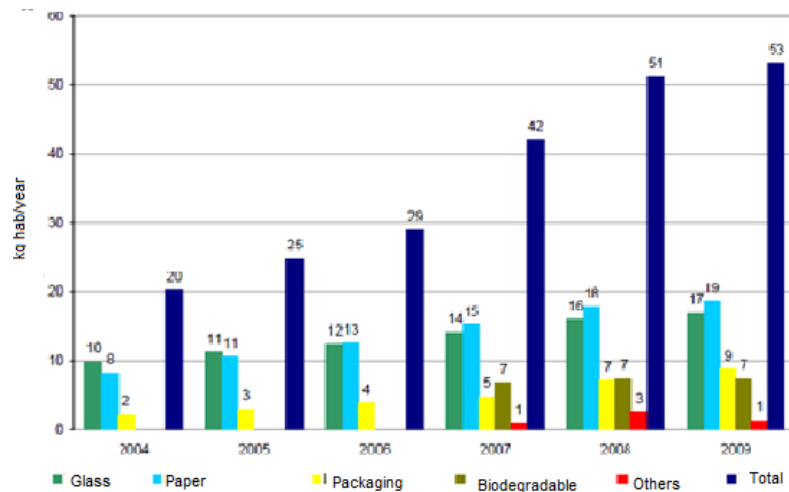


Figure 1 – Selective collection of MW in Portugal by material between 2004 and 2009 (source: INE [3]).

European statistics

According to released data by EUROSTAT there are some capable comparisons that can be made between Portugal and EU 27 for 2008 (latest year information available to EU). Figure 2 shows the amount of municipal wastes sent to landfill disposal on Europe in 2008 and figure 3 presents the quantity of municipal wastes recycled on Europe in 2008.

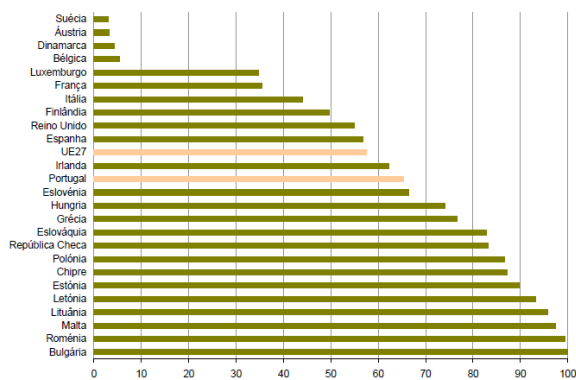


Figure 2 – Municipal wastes (%) sent to landfill disposal in 2008 (source: INE [3])

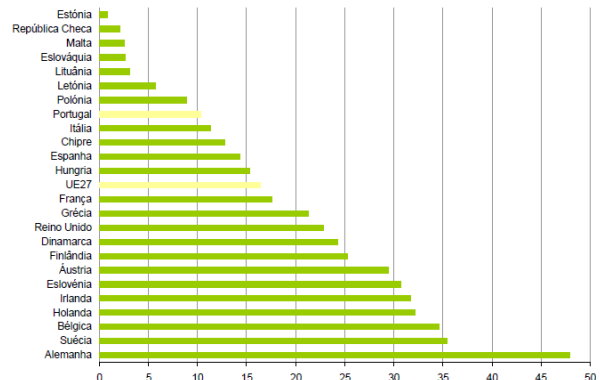


Figure 3 – Municipal wastes (%) recycled in 2008 (source: INE [3])

Landfill disposal represents 65% of undifferentiated collection in Portugal, which is almost 8 points above EU average at 27 countries. Although the proportion of MW sent to landfills was slightly higher than EU average, in Portugal the growth rate is lower than the total production of wastes which can presents a converging trajectory to EU average [6,11].

Regarding to MW recycling, between 2004 and 2008, Portugal doubles the quantities of materials sent to this type of operation achieving 10% of total selectively collected waste. In EU average that value is 17%. However the evolutionary trend in recent years indicates a path of convergence with EU average [6,11].

CONCLUSIONS

In recent decades waste generation has increased significantly mainly due to the excessive growth of world population and their changes of habits. The intensification of migration from rural to urban areas, the increase of disposable and packaging products and the high consumerism that

characterizes the contemporary society contributes to the exponentially growth of generated wastes.

The waste management in Portugal was faced significant changes through the years. Before implementation of PERSU I, waste management was at charge of municipalities and in most cases, wastes were dumped in open and not controlled landfills. In 1996 after creation of PERSU I, waste management in Portugal suffered several changes. However this proposed plan was not completed entirely. This scenario triggered the need to formalize a new plan – PERSU II. This new plan established targets for municipal solid waste management, over 2007 to 2016. However, soon was realized that PERSU II had very ambitious goals. In this work were verified some of these difficulties. Comparing Portuguese data with EU statistics it is possible to observe that Portuguese targets are below European average. Nonetheless, it is also possible to conclude that some of these goals indicate a path of convergence with EU average, as long as traced pathway is continued.

REFERENCES

- [1] J. Levy, A. Cabeças, *Resíduos Sólidos Urbanos – Princípios e Processos*, AEPISA, Lisboa (Portugal), 2006, 331 pp.
- [2] R. Oliveira, *Tecnologias de Controlo da Poluição*, 2010.
- [3] INE, *Gestão de Resíduos em Portugal, 2004 – 2009. O sector dos resíduos em Portugal. Destaque – Informação à Comunicação Social*, 2010, 15 pp.
- [4] M. Russo, *Tratamento de Resíduos Sólidos*. University of Coimbra – Science and Technology School, 2003, 196 pp.
- [5] M. Russo, *Avaliação dos processos de transformação de resíduos sólidos urbanos em aterro sanitário. PhD thesis in Civil Engineering*. University of Minho – Engineering School, 2005, 320 pp.
- [6] APA *Caracterização da Situação dos Resíduos Urbanos em Portugal Continental em 2009*, 2010, 11 pp.
- [7] G. Martinho, G. Gonçalves, *Gestão de Resíduos Urbanos. Universidade Aberta. Lisboa, 2002*.
- [8] M. Cruz, *A Caracterização de Resíduos Sólidos no Âmbito da sua Gestão Integrada, Master degree thesis in Environmental Science*. University of Minho – Science School, 2005, 223 pp.
- [9] S. Teixeira, *Estratégias de Gestão de Resíduos Sólidos Urbanos*. Master degree thesis in Environmental Engineering, University of Porto – Engineering School, 2004. 307 pp.
- [10] M. Russo, *Reorganização do sector dos Resíduos Urbanos em Portugal: Uma oportunidade de reestruturação do PERSU II*. *Valorização de Resíduos*, n.º 16 (2011), 4–9 pp.
- [11] APA *Sistemas de Gestão de Resíduos Urbanos*. DOGR-DRU, 2009.