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Universidade do Porto
Faculdade de Engenharia

UNIVERSIDADE CATÓLICA PORTUGUESA
Escola Superior de Biotecnologia

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Laboratório de Engenharia de Processos, Ambiente e Energia

# The effect on the GHG emissions of MSW management practices based on EU legislation targets – a municipal case study –

Susana Xará, Manuel Almeida, Margarida Silva, Carlos Costa

## 1. Introduction

In developed countries, waste management is governed by legislation. The European Commission recognizes the need of selecting management options taking into account the possible risks to human health and the environment (1). Based on the general legal framework, the community policy on waste is supplemented by a number of more specific directives that may be divided into two groups:

(i) directives aimed at reducing the impact of treatment and disposal by setting common technical standards for operation of treatment facilities as the

- directive on incineration (2000/76/EC)
- landfill directive (99/31/EC);

(ii) directives on specific waste streams covering both measures of prevention and common rules for separate collection and treatment, in particular the packaging and packaging waste directive (94/62/EC), among others (2).

The landfill directive states that biodegradable municipal solid waste landfilling must be reduced to (compared to 1995 levels):

- 75% by 2006 - 50% by 2009 - 35% by 2016

Member states that landfill over 80% of their MSW may postpone these targets by a period not exceeding 4 years (3).

One of the waste streams that the European Union gives special attention is packaging. The packaging directive includes measures aimed at preventing waste generation and increasing the recovery and recycling of packaging waste. This directive sets three targets:

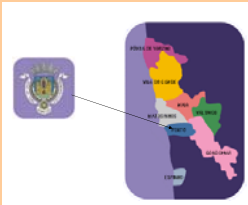
Target 1 requires Member States to reach a recovery level between 50% and 65% by weight of all packaging wastes. Recovery covers all kinds of recycling, energy recovery and composting.

For achieving Target 2, Member States must reach a recycling level of between 25% as a minimum and 45% as a maximum by weight of all packaging waste.

The obligation for Target 3 is reaching a minimum recycling level of 15% on specific packaging waste materials (4).

This legislation resulted in many changes on the waste management practices in Europe and obviously also in Portugal.

The present case study was developed for the municipality of Porto, the second largest city of Portugal located in the north of the country on the western coast.



In Portugal, the MSW management is commited to municipalities in some cases organized in multimunicipal associations for that purpose. MSW generated at the city of Porto is collected by the municipal services also responsible for its transport to the treatment units from LIPOR, a company participated by 8 municipalities of Porto region.

Due to legislative evolution, some changes have been implemented on MSW management practices since 1990.

This study presents MSW production and management practices, namelly collection systems and treatment units description, both on 1990 and 2000. The environmental impact from the management of MSW collected during 1 year, respectively in 1990 and 2000, is compared in terms of energy consumption and greenhouse gases emissions.

This evaluation is done in two steps;

- first, the model developed by White et al from Procter and Gamble (5) was used to quantify energy and emissions of carbon dioxide, methane and nitrous oxide, all gases with greenhouse effect;
- next, the greenhouse gases emissions were aggregated using the Global Warming Potentials (GWP) proposed by the Intergovernmental Panel on Climate Change (6). This aggregation leads to a single value for the GWP of each situation analyzed, allowing its comparison.

## 2. MSW production and management in Porto on 1990 and 2000

| | *1990* | *2000* |
|---|---|---|
| • Inhabitants | 302 500 | 280 000 |
| • Waste production (kg/person.year) | 383 | 518 |
| • Collection | kerbside mixed<br>- 99,1%<br>- bags, containers<br>- 6 X week | kerbside mixed<br>- 96,4%<br>- bags, containers<br>- 6 X week |
| | glass banks | kerbside collection of dry recyclables<br>- paper/cardboard (blue plastic bag, 1 x week)<br>- packages (yellow plastic bag, 1 x week) |
| | | central collection sites<br>collection banks<br>- packages, paper/paperboard and glass |
| • Treatment methods | composting (70%)<br>landfilling (30%)<br>recycling (glass) | composting (19,7% - mixed)<br>incineration (79,2%)<br>landfilling (1,1%)<br>recycling |






The waste composition in Porto had changed between 1990 and 2000. The values considered on this study are presented on Table 1 and were obtained from waste characterization procedures carried out by LIPOR (7, 8).

Table 1. Porto waste composition on 1990 and 2000 (% by weight).

| Waste component | 1990 | 2000 |
|---|---|---|
| Paper/paperboard | 21,9 | 18,8 |
| Glass | 4,1 | 6,1 |
| Metal | 2,8 | 1,5 |
| - ferrous | 93% | 87% |
| - non ferrous | 7% | 13% |
| Plastic | 8,5 | 12,0 |
| - film | 66% | 68% |
| - rigid | 34% | 32% |
| Textiles | 3,9 | 2,9 |
| Organics | 35,6 | 36,8 |
| Others | 23,3 | 21,9 |

## 3. Results and discussion

The results of energy consumption and emissions of carbon dioxide, methane and nitrous oxide, for both the 1990 and 2000 scenarios, are summarized on Table 2. The emissions of the greenhouse gases were aggregated using the Global Warming Potentials weighting factors according to the recommendations of the Intergovernmental Panel on Climate Change (6): 1 for carbon dioxide, 21 for methane and 310 for nitrous oxide. The results obtained are also presented on Table 2.

The energy consumption for 2000 is negative due to the electrical energy recovered at the incineration process. This is a large advantage of the management system used on 2000, contrary to the 1990 one that consumes energy.

In terms of greenhouse gases emissions the 2000 situation is worse than in 1990 in the case of carbon dioxide and better in terms of methane and nitrous oxide emissions. In 2000, the negative value for the nitrous oxide emission is due to the emissions avoided by producing electricity by a conventional power plant. Thus, it represents not only a saving of energy but also reducing the emissions associated with its production. When the greenhouse gases emissions are aggregated using the global warming potentials the results show a small advantage on the 2000 management system. However, expressing the results in 1990 and 2000 either by person or ton of waste, as in Figures 1 and 2, one concludes that global warming potential decreased less than 5% when expressed by person and 30% when expressed by ton of waste.

Table 2. Energy consumption and greenhouse gases emissions from the MSW management in Porto on 1990 and 2000.

| *Parameter* | *1990* | *2000* |
|---|---|---|
| Energy consumption (GJ) | 58 446 | -407 659 |
| Air emissions (kg): | | |
| CO2 | 2,16E+07 | 1,14E+08 |
| CH4 | 5,11E+06 | 5,44E+04 |
| N2O | 2,64E+01 | - 3,69E+03 |
| Global Warming Potential (kg CO2-eq.) | 1,29E+08 | 1,14E+08 |

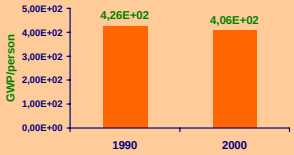



Figure 1. Annual contribution to GWP by person from waste management practices in Porto on 1990 and 2000.

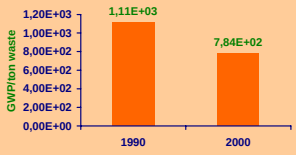



Figure 2. Annual contribution to GWP by ton of waste from waste management practices in Porto on 1990 and 2000.

## 4. Conclusions

Some changes on MSW management practices have been implemented in the municipality of Porto from 1990 to 2000 both in terms of collection systems and technologies of treatment. In terms of collection, the situation changed from mixed waste collection plus voluntary bring systems for glass to more participated solutions as kerbside collection of dry recyclables on special plastic bags twice a week, collection banks and central collection sites. Concerning the treatment methods available, the main changes include a central sorting unit and an incineration plant. The energy consumption and emissions of gases with greenhouse effect for both those years were computed using an existing inventory model.

As far as energy consumption is concerned, the results obtained show a clear advantage of the 2000 management system due to the energy recovered at the incineration plant.

For the global warming potential, results also show a clear advantage for 2000, particularly when GWP values are expressed either by person or by ton of waste, due to the decrease verified on the inhabitants of. the city and the increase on the waste amount produced per person.

## 5. References

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8. Informations obtained from personal contacts with LIPOR.

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