10.15 - 10.30: Dr. Konstantin Bravy (Israel): New Method of Management

Coffee Break

Computer presentations

10.50 – 11.05: Hakan Falk (Spain), Dr. Engelbrekt Isfält (Sweden): Energy Saving Now, Possibilities of Rapid Changes of Our Energy Consumption in Buildings by Using the Internet for Education, Information, Promotion and Communication
11.05 – 11.20: Prof. Dr. William Zadorsky (Ukraine): Technological Virtual Business Incubator Portal
11.20 – 11.35: Prof. Dr. William Zadorsky (Ukraine): Commercialized Technologies Virtual Market
11.35 – 11.50: Dr. Vladimir Kolotenko (Ukraine): Academy of Sustainable Development of Human and Society
11.50 – 12.00: "Cleaner Production Germany" Internet Portal
12.00 –12.10 New books about Sustainable Development

12.10 – 13.00: Discussion Groups: Social Aspects, Internet

Lunch

Roundtable 2: "Problems, Solution, Experience of Sustainable development in different countries" (the joint session with International scientific - practical conference "NATURE SAVING PROBLEMS, SUSTAINABLE DEVELOPMENT AND TECHNOGENOUS SAFETY")

14.00 – 14.15: Prof. Dr. Bernhard Gemende (Germany): Promoting Clean Products and Processes and the Cleaner Production Approach in Germany
14.15 – 14.30: Dr. V. Zaboristov. (Russia): Multi-recycling Concept. Ecological-economic Developments and the Experience of Their Realization in Synthetic Rubber Industry
14.30 – 14.45: Prof. Dr. Mikhail Ginzburg (Kazakhstan): MSW Management of the City of Almaty: Problems and Decisions (co-authors: A.G. Sarmurzina, F.H. Habebulin, B. Dusekov , M.R. Istamkulov, M.M. Arshidinov, E.H. Zuslina, K.A. Masena)
14.45 – 15.00: Susana Xará, Manuel Fonseca Almeida, Margarida Silva, Carlos Costa (Portugal): Life Cycle Inventory for Municipal Solid Waste Management Options
15.00 – 15.15: Dr. Victor Kovalenko (Ukraine): Solving the Waste Utilization Problem on the System Analysis Base
15.15 – 15.30: Igor Hadjamberdiev (Kyrgyzstan): Tienshan-Pamir-Fergana Region – A Knot of Supercivilization Conflicts

LIFE CYCLE INVENTORY FOR MUNICIPAL SOLID WASTE MANAGEMENT OPTIONS

Susana Xará *(1,2), *Manuel Fonseca Almeida*(1), *Margarida Silva*(2), *Carlos Costa*(1)

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Abstract

A case study was developed for a region similar to Porto (Portugal), in order to demonstrate the use of life cycle inventory as a tool for assessing the environmental impact of municipal solid waste (MSW) management systems, and obtain preliminary data on energy consumption and global warming potential associated with several MSW treatment options. Typical MSW production and composition of that region was assumed as well as eight different scenarios according to the treatment method used: landfilling, composting, incineration and biogasification. In the particular cases of composting and biogasification both alternatives of using the compost and either its landfilling or incineration were evaluated. The obtained results show a surplus of energy from incineration of all MSW as well as the compost, when there is no market for it. Landfilling presents the highest global warming potential followed by the incineration scenario.

1. Introduction

Municipal waste managers are usually faced with the need of justify~~ing~~ existing or planned waste management options. Also, European Commission recognizes strategic targets both in terms of waste management options and recycling rates, as well as the need of selecting management options taking into account the risks for environment and health [1].

Several models using life cycle assessment technique have been developed to predict and compare the environmental impact of MSW management systems, allowing the identification of environmental burdens, thus advantages and disadvantages associated with different waste management scenarios.

The objectives of the present case study is twofold: (i) follow the consequences of waste management policy taken for the region through its environmental effects; and, (ii) provide a preliminary data on the environmental consequences of two alternatives for treating organic matter in MSW, respectively biogasification and composting. The results obtained from the analysis of these different scenarios are also useful for the development of a life cycle inventory model for the region.

2. Model and methodology

An already established inventory model developed by White et al [2], whose assumptions are listed in Appendix, was used to quantify the energy consumption and emissions of carbon dioxide, methane and nitrous oxide associated with the MSW collected during one year in an hypothetical region similar to Porto, a city in the north of Portugal with a population of about 300 000 inhabitants. A MSW production of 300 kg/person.year with the composition shown on Figure1 was assumed as well as that MSW are commingled collected in plastic bags, every week days. Eight scenarios corresponding to different management options were established as shown in Table 1. Basic options consider landfilling, composting, incineration and biogasification. However, in both cases of composting and biogasification three alternatives were built, respectively using the compost as soil conditioner, or, by contrary, either landfilling or incinerating it. Compost may be difficult to market due to the quality requirements imposed and the excess of offer relatively to consumption.

The emissions of the greenhouse gases

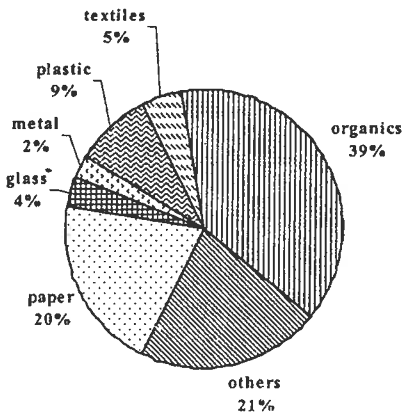

Figure 1. MSW composition for the region studied

Table 1

Summary of the management scenarios built

Scenario 1	Commingled collection Landfilling all MSW
Scenario 2	Commingled collection Incineration with energy recovery 90% of ferrous metals are recovered from bottom ash; ultimate residues are landfilled
Scenario 3a	Commingled collection Presort of all wastes categories other than paper and organics; 90% of ferrous metals are recovered Composting of paper and organics with market for the compost produced Landfilling of sorting residues
Scenario 3b	Commingled collection Presort of all wastes categories other than paper and organics; 90% of ferrous metals are recovered Composting of paper and organics; no market for the compost produced Landfilling of sorting residues and compost produced
Scenario 3c	Commingled collection Presort of all wastes categories other than paper and organics; 90% of ferrous metals are recovered Composting of paper and organics; no market for the compost produced Landfilling of sorted residues; compost incineration; ultimate residues (fly ashes and bottom ashes) are landfilled
Scenario 4a	Commingled collection Presort of all wastes categories other than paper and organics; 90% of ferrous metals are recovered Biogasification of paper and organics; market for the compost produced Landfilling of sorting residues
Scenario 4b	Commingled collection Presort of all wastes categories other than paper and organics; 90% of ferrous metals are recovered Biogasification of paper and organics; no market for the compost produced Landfilling of sorting residues and compost produced
Scenario 4c	Commingled collection Presort of all wastes categories other than paper and organics; 90% of ferrous metals are recovered Biogasification of paper and organics; no market for the compost produced Landfilling of sorting residues; compost incineration; ultimate residues are landfilled

Table 2

Annual energy consumption and greenhouse gases emissions

Scenarios	Energy consumption (GJ)	Air emissions (kg)			GWP
		CO_2	CH_4	N_2O	
1	66 431	2,14x10^{+7}	3,37x10^{+6}	5,35x10^{+1}	9,22x10^{+7}
2	-248 321	7,43x10^{+7}	0,00	- 2,39x10^{+3}	7,36x10^{+7}
3a	69 180	2,21x10^{+7}	4,05x10^{+5}	- 7,22x10^{+1}	3,06x10^{+7}
3b	70 202	2,55x10^{+7}	9,99x10^{+5}	- 7,13x10^{+1}	4,65x10^{+7}
3c	-12 047	4,67x10^{+7}	4,05x10^{+5}	- 6,73x10^{+2}	5,50x10^{+7}
4a	9 810	2,54x10^{+7}	4,05x10^{+5}	- 5,10x10^{+2}	3,37x10^{+7}
4b	10 423	2,74x10^{+7}	7,62x10^{+5}	- 5,09x10^{+2}	4,32x10^{+7}
4c	-38 926	4,02x10^{+7}	4,05x10^{+5}	- 8,70x10^{+2}	4,84x10^{+7}

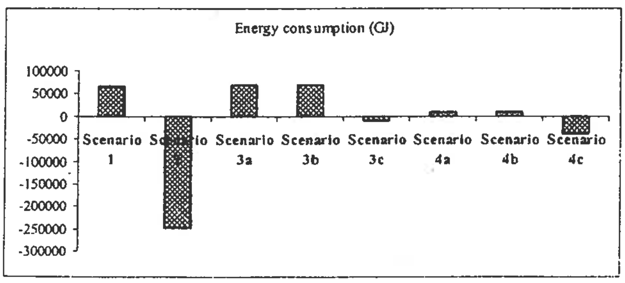

Figure 2. Annual energy consumption for waste management scenarios built

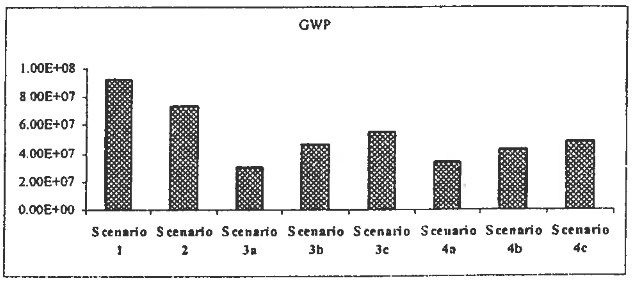

Figure 3. Annual contribution to global warming potential corresponding to the different scenarios

Appendix

Assumptions from the model used

(values expressed by ton is related to ton of wastes)

Landfill

Diesel consumption in the operation of landfill = 0,6l/ton
Collection efficiency of landfill gas = 40%
There is no energy recovered from landfill
Landfill gas volume produced by wastes (Nm^3):

- Paper = 250
- Glass = 0
- Ferrous metals = 0
- Non-ferrous metals = 0
- Plastic-film = 0
- Plastic-rigid = 0
- Textiles = 250
- Organics = 250
- Others = 0
- Compost = ~~0~~ 100
- Bottom ash = 0

Landfill gas composition (g/Nm^3):

- CO_2 = 883,93
- CH_4 = 392,86
- N_2O = 0

Flare exhaust gas (g/Nm^3):

- CO_2 = 1964,29
- CH_4 = 0
- N_2O = 0

Incineration

Transport distance to hazardous waste landfilll = 2 km
Transport distance to non-hazardous waste landfilll = 10 km
Filter dust production = 0,032 ton/ton
% of ash re-used = 0%
Electricity generation efficiency = 20%
Bottom ash production by wastes (ton/ton):

- Paper = 0,084
- Glass = 0,9
- Ferrous metals = 0,85
- Non-ferrous metals = 0,9
- Plastic-film = 0,09
- Plastic-rigid = 0,06
- Textiles = 0,075
- Organics = 0,077
- Others = 0,42

Electricity consumption = 70 kWh/ton
Natural gas consumption = 0,23 m^3/ton
CH_4 emission= 0 g/ton
N_2O emission = 0 g/ton
CO_2 emission by waste (g/ton):

- Paper = 1128500
- Glass = 0
- Ferrous metals = 0
- Non-ferrous metals = 0
- Plastic-film = 2336700
- Plastic-rigid = 2492500
- Textiles = 1209200
- Organics = 563900
- Others = 1025900

Composting

Fraction of paper and organics removed as residue during the pre-sort = 5%
Transport distance to landfill = 10 Km
Energy consumption = 30 kWh/ton
Compost production = 0,5 ton/ton
CO_2 emission = 320 kg/ton
CH_4 emission = 0 g/ton
N_2O emission = 0 g/ton

Biogasification

Fraction of paper and organics removed as residue during the pre-sort = 5%
Transport distance to landfill = 10 Km
Energy consumption = 50 kWh/ton
Compost production = 0,3 ton/ton
CO_2 emission = 440 kg/ton
CH_4 emission = 0 g/ton
N_2O emission = 0 g/ton

Fuel, electricity, raw materials and transport

Diesel production and use:

- Non-hazardous waste = 0,0057 ton/1000l
- Energy consumption = 44,1 GJ/1000l
- CO_2 emission = 3036258 g/1000l
- N_2O emission = 41 g/1000l
- CH_4 emission = 0

Polyethylene production:

- Non-hazardous waste = 0,0885 ton/ton
- Energy consumption = 98,1 GJ/ton
- CO_2 emission = 1691657 g/ton
- N_2O emission = 70 g/ton
- CH_4 emission = 0

Electricity production and use:

- Non-hazardous waste = 0,0491 ton/MWh
- Energy consumption = 9,5 GJ/MWh
- CO_2 emission = 441657 g/MWh
- N_2O emission = 70 g/MWh
- CH_4 emission = 0

Natural gas production and use:

- CO_2 emission = 2061211 g/1000m^3
- CH_4 emission = 0

Diesel consumption of a 20ton truck = 0,321l/km
Savings from ferrous metals recovery:

- Energy consumption = 12,4 GJ/ton
- CO_2 emission = 0
- N_2O emission = 176 g/ton
- CH_4 emission = 0

corresponding to these scenarios were aggregated using global warming potential weighting factors according to the recommendations of the Intergovernmental Panel on Climate Change [3]: 1 for carbon dioxide, 21 for methane and 310 for nitrous oxide.

3. Results and Discussion

The results obtained are summarized on the Table 2 and Figures 1 and 2.

Regarding to energy consumption, scenario 2 - incineration of all MSW - shows a clear surplus of energy. Scenarios where compost is not marketable and is incinerated, also present a positive balance, but not so high. Landfilling and composting, with market for the compost, or its landfilling, are the most energy consuming situations with equivalent values.

In the point of view of global warming potential, scenarios 1 and 2, respectively landfilling and incineration, accounts for the major contribution when compared to the scenarios where organic and paper fractions are subjected to a biological treatment. In this case there is no significant difference between composting and biogasification, despite a small advantage for the biogasification option. When not considering the end-use of compost produced, the compost incineration - scenarios 3c and 4c - has more global warming potential than its landfilling - scenarios 3b and 4b.

4. Conclusions

As far as energy consumption is concerned, the results obtained through this inventory model show a clear advantage of incineration, since it has a very positive balance. With this respect the worst situations are landfilling and composting of organics and paper fractions, except when compost is further incinerated.

In terms of global warming potential, the most favorable situation is the biological treatment of organics and paper followed by using the compost produced as soil conditioner. This advantage is shortened when compost is not marketable, thus must be either landfilled or incinerated.

Biogasification presents a visible advantage over composting in terms of energy consumption.

5. References

[1] Anonymous, A UE e a Gestro dos Resнduos. Servio das Publicaзxes Oficiais das Comunidades Europeias, Luxembourg, 2000.

[2] White et al, Integrated Solid Waste Management: A life cycle inventory, Blackie A&P, Glasgow, U.K., 1995.

[3] IPCC, Guidelines for National Greenhouse Gas Inventories, volume 3, Intergovernmental Panel for Climate Changes, 1996.

USE OF SUSTAINABLE DEVELOPMENT INDICATORS FOR ASSESSMENT OF THE SUSTAINABILITY OF SOCIAL-ECONOMICAL SYSTEM

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Complication and many-side of Sustainable Development Process, enwrapping other unconnected aspects complicate the monitoring process of achieved progress. In this connection the necessity of use such mechanisms arise, as on the one hand reliable and understandable informational basis would be submitted, on the other hand the main problems would be identified and elaboration of adequate and effective solution in accordance with long-term aims of Sustainable Development would be capacitated. Such mechanisms are the Sustaineble Development Indicators.

The United Nations Development Programme (UNDP) in the working program on development of indicators has determined the goals: they should be tools for a manual of acceptance of political solutions, directional on sustainable development, meliorating of the information and data gathering and to allow to conduct comparative analysis and analysis in concrete country on a state and advance in achievement of sustainable development.

By the UN Commission on Sustainable Development is designed in 1995 and proposed the list from 130 detecting indicators permitting to value a state and dynamics of usage of a natural potential as on national and at a regional level. To the advantages of this system of indexes it is possible to refer it integral nature: the system of the proposed detecting instruments is constructed by a principle DSR - driving forces-state-reaction. Besides for it the accessibility of the information and comparability at an international level is characteristic. Such countries as Canada, Belgium, Tunis use the system of indexes of the UN Commission on Sustainable Development (CSD) for ecological monitoring of programs of development. In anticipation of 10th anniversary of acceptance of the Program of progressing of the states of a planet on so-called RIO+10 process, 22 countries of a world, the members of the UN CSD are involved in the process of testing of the proposed detecting instruments with the purpose of eliciting lacks and poposals on upgrading the list. The countries of Central Asia, including Kazakhstan, within the framework of the pilot project UNDP