Environmental Engineering and Management Journal
November 2013, Vol.12, No. S11, Supplement, 65-68
http://omicron.ch.tuiasi.ro/EEMJ/

"Gheorghe Asachi" Technical University of Iasi, Romania

WASTE PLASTICS MANAGEMENT IN MUNICIPALITIES: LOGISTICS AND PROCESSES IN LOMBARDIA (NORTHERN ITALY)

Extended abstract

Stefania Carcione[1], Placido Alfredo Lanza[1*], Giovanni Albetti[2], Pamela Canzi[3], Francesco Drago[2]

[1]*University of Palermo, Faculty of Engineering, DICAM, Viale delle Scienze, 90128 Palermo, Italy*
[2]*SERUSO SpA, via Piave 89, 23879 Verderio Inferiore (LC), Italy*
[3]*C.E.M. Ambiente SpA, Località Cascina Sofia, 20873 Cavenago di Brianza (MB), Italy*

Background

A partnership of 49 Municipalities lying in Lombardia (Northern Italy) and belonging to the District "Monza and Brianza" has entrusted the management of the Municipal Solid Waste (MSW) to two Public Companies: "C.E.M. Ambiente S.p.A." - which owns and operates a *transfer station* and a *multi-material centre* - and "SERUSO S.p.A.", whose single facility is set up and equipped for a high performance factory sorting of the dry fraction of the urban waste.

The catchment area is populated by 448 000, living in an area of 366 km^2. The management system starts with household sorting for multi-bin curbside collection; followed by hauling to selection and physical treatment facilities; and last, transport of the selected fractions to final destinations.

The yearly throughput of "C.E.M. Ambiente" is about 296 000 t, of which over 70% home-sorted. Extra-CEM customers add to this amount about 40 000 t/yr. When calculated on the partner municipalities, the waste generation rate is almost 1.8 kg/capita per day including waste from craftsmen and workshops. Less than 1% of the collected waste goes to landfill and about 8% to incineration with energy recovery (WTE). Since "C.E.M. Ambiente" operates mainly the logistics, however; and part of the materials recovery is actually made downstream its gate at "SERUSO" facility, where some by-products are unavoidably generated; the overall share of WTE will be slightly higher.

Electric energy produced from the combustible by-products of "C.E.M. Ambiente" and "SERUSO" covers largely the energy needs of the recovery and cleaning processes. It is worthwhile stressing that in this district also waste from street sweeping – as much as 8 200 t/yr – is turned into sand, gravel and like for civil works. "C.E.M. Ambiente" uses also fuel energy, to operate collection and hauling vehicles and factory handling machines, all of them powered by Diesel engines. Fuel requirements for TS and MMC in 2011 were 78 405 and 14 605 litres, respectively. Regrettably, these needs cannot be satisfied in any way with recovered energy.

Objectives

This article describes the MSW management system in Year 2011, as the core of three; and reports on its materials, fuel and electric energy flows, with particular emphasis on waste plastics. The calculation of embedded energy and carbon footprint, assumed as ecological indicators, has been shifted to a following paper. Materials and energy balances are obviously the basis for evaluating the performance of the system in terms of ecological and economical benefits.

* Author to whom all correspondence should be addressed: e-mail: placidoalfredo.lanza@unipa.it

Methods and results

The data to draw the materials flows and balances were taken from the ordinary records of the two Public Companies "C.E.M. Ambiente S.p.A." (Canzi, 2012) and "SERUSO S.p.A." (SERUSO, 2013) and worked. The Fig.s of the integrated system for year 2011 are shown in Fig. 1.

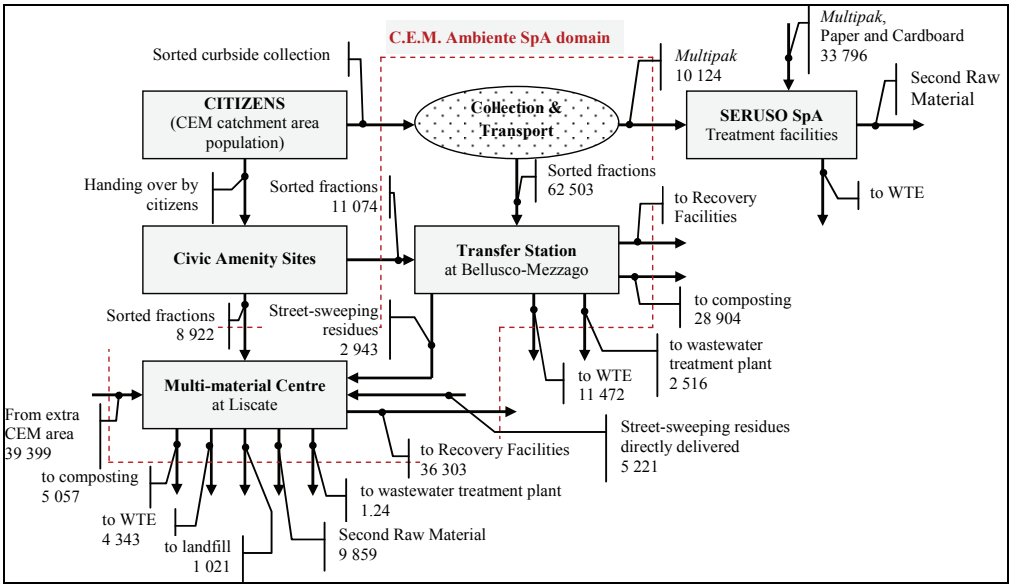

Fig. 1. Fluxes of urban waste in the District of Monza and Brianza, Lombardia (IT) – Year 2011 (figures in tons)

More than 73 000 tons of MSW were carried to the *transfer station* (TS) at Bellusco Mezzago. The output of the plant was constituted mainly by the following fractions: almost 9 000 tons of glass, 18 000 of wood and 29 000 of wet waste; 3 000 tons of earth from street sweeping were salvaged. Destinations of this output fractions were: 40 % to recovery and to composting; 15.6 % to incineration with energy recovery (WTE).

The *multi-material centre* (MMC) at Liscate received more than 56 400 tons of MSW; its more valuable output was almost 27 400 tons of glass and 5 800 of glass and tins mixed. Destinations of the output fractions were approximately: 64 % to recovery, 9 to composting, 7.7 to WTE facilities, 1.8 to landfill and 17.5 % to sale as secondary raw materials. The electric energy needs amount to about 412 800 kWh.

On the whole, the MMC at Liscate carries out more sophisticated and selective operations; while the TS at Bellusco - Mezzago makes – among others - the heavy work of shredding and grinding bulky and tough waste.

A source-sorted fraction of MSW of special interest is the one made up by plastics and metals packaging, paper and cardboard which is named *multipak*. In the last three years about 10 000 tons per year have been generated, that gives a mean value of 61 g per capita and day. The absolute amounts of *multipak* produced in the CEM service district – along with their breakdown into fractions - are drawn in Fig. 2.

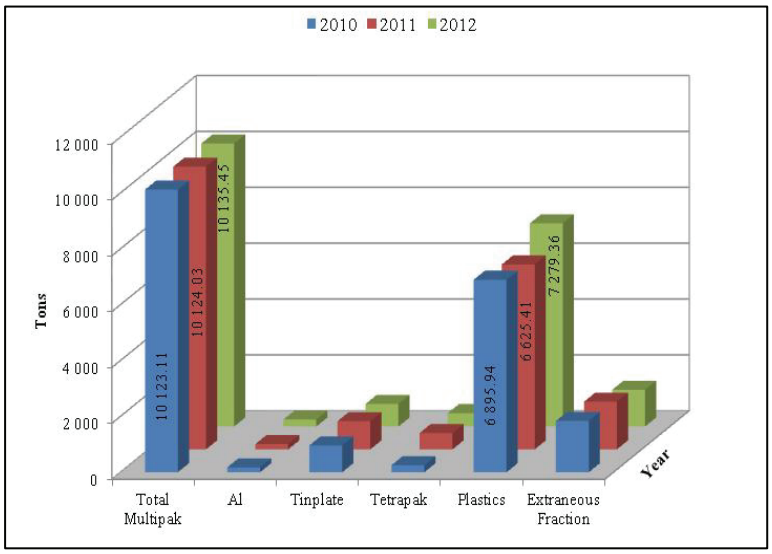

Fig. 2. Amounts of *multipak* and of its fractions produced in the CEM service district

Processing *multipack* is the duty of SERUSO, and will be treated in detail later in this paper. Table 1 below shows the integrated routing of waste fractions made by the two MMCs of the District.

Table 1. Waste output from Transfer Station and Multi-material Centre

Description	***Source***	***EWC Codes for the Output from the Selection Facility of:***		***Destination***
		Liscate	***Bellusco - Mezzago***	
Mixed munic. waste	Non sorted urban waste	20 03 01	20 03 01	Incineration
Street sweeping residues	Materials from street sweeping	---	20 03 03	Recovery plants
Wet waste	Biodegradable kitchen waste		20 01 08	Composting
Glass	Glass packaging curbside collection	15 01 07	15 01 07	*Co.Re.Ve.(°)*
Wood	Wood non containing dangerous substances		20 01 38 19 12 07	*Rilegno (°°)*
Leachate Rain water	Leachate from various sources First flush water Leachate from glass-tins heaps	19 07 03 19 09 02	19 07 03 19 09 02	Wastewater treatment plant
Plastic packaging	Bulky waste from Civic Amenity Sites		15 01 02	Recovery facilities
Metals			20 01 40	
Paper and cardboard			20 01 01	
Wood Mattress			20 01 11	
Other waste			19 12 12	WTE
Plastics			20 01 39	Recovery facilities
Lubricating oils	Used oils from fork lifts		13 02 08	Recovery facilities
Aluminium and tinplate	*multipak* from curbside collection	15 01 04	15 01 04	Recovery facilities with *CIAL (°°°) and C.N.A. (+)*
End-of-life tyres	Sorted urban waste		16 01 03	Recovery facilities
Non-ferrous metal	Waste from maintenance		16 01 18	
Aluminium	Sorted urban waste		17 04 02	
Waste from sewage	Waste from sewer cleaning		20 03 06	Wastewater treatment plant
Inorganic production scraps	Residues from treatment of glass and street sweeping materials	19 12 12	---	Recovery facilities
Organic production scraps	As above	19 12 12	---	WTE
Glass	Glass from neon tubes treatment	19 12 05	---	Recovery facilities
Ferrous metals	Material from glass, tins, neon tubes treatments	19 12 02	---	C.N.A. Recovery facilities
Non-ferrous metal	Material from neon tubes treatments	19 12 03	---	CIAL
Sludges from treatment of industrial waste water	Material from street-cleaning activities	19 08 14	---	Landfill / Recovery facilities
Inorganic waste (rocks)	Material from street-cleaning treatments	19 12 09	---	Recovery facilities
Hg powders	Material from neon tubes treatments	19 12 11*	---	Landfill
Waste batteries	Sorted urban waste	20 01 34*	---	Landfill
Expired drugs		20 01 32*	---	WTE
Syringes		18 01 03*	---	WTE
TV monitor		20 01 35*	---	WEEE disassembling and recovery
Refrigerator		20 01 23*	---	
Electronic compon.		20 01 36	---	
Sand, gravel	Treatments o f materials from street sweeping	sold	---	Asphalt production
Glass “oven-ready”	Material from glass treatment	sold	---	Glassworks
Toner		08 03 18	---	Recovery
Lead batteries		16 06 01*	---	Recycle facilities

(°),(°°),(°°°), (+) are institutional Syndicates aimed at standardizing quality and prices of recovered materials in Italy.
In order: glass; wood; aluminium; and steel.

Sorting *multipak* is the main task of the SERUSO facilities, where also selected paper and cardboard are delivered from extra-CEM customers. This source - sorted dry waste stream is made of: plastics cutlery and tableware; bottles and food boxes labelled PE, PET, PVC, PP; caps of PE, PET, PP and silicone; *tetrapak*; steel as

spray cans; aluminium foil and like (Rigamonti and Grosso, 2009). Fractions of *multipack* delivered from CEM area are illustrated in Fig. 2: plastics represent the major fraction, 68%, followed by *extraneous fraction*, 16%, and tinplate, 9%. If paper and cardboard are considered, *multipak* composition entering SERUSO facilities becomes: 60% plastics, 14% paper and cardboard, 12% extraneous fraction, 8% tinplate, almost 4% Tetrapak and almost 2% Aluminium.

In the SERUSO plant, *multipak* is machine processed to two output streams: homogeneous plastics fractions sent to recycling industries as secondary raw materials; and *extraneous fraction* sent to energy recovery. The principal unit operations put in practice are: screening by rotary and ballistic screens; followed by magnetic and optical separation; and finally baling of the selected materials. The activities carried out by SERUSO have consumed, in year 2011, about 2 100 MWh of electrical energy and about 63 000 litres of diesel fuel, used by mechanical equipments for handling the material to be processed.

The extraneous fraction (EWC Code 19 12 12) has a LHV (Lower Heating Value) of about 10 000 kJ/kg, up to 15 000; it is delivered to a near WTE facility to produce electrical energy and heat. The amount was 6 316 tons in year 2011 and 4 886 in the year 2012, with a decreasing trend all over the last three years. In the year 2012, the incineration plant has produced about 708.5 kWh_{el} per ton of waste processed. Since the plant receives waste also from extra-CEM catchment area, this Fig. comes out considering the total waste delivered to the plant (86 100 tons) and the total electrical energy produced (61 000 MWh_{el}).

The virtual amount of electrical energy produced at the incineration plant from SERUSO extraneous fraction only – apart from heat for district heating – is estimated 4 670 MWh, largely sufficient to satisfy the energy requirements of the selection plants. A resource use too often underrated in the eagerness for zero-waste is that of water. In the TS only, in year 2011, there was a water consumption of about 43 073 m^3.

Discussion

The data recorded by the two Companies and worked in this research demonstrated that source-sorted MSW is a good basis to get second raw materials with high efficiencies: i.e., 53% of materials recovery; 23% organic waste processed to compost, and 11% energy recovery (weighted averages). Minor amounts of valuable materials were directly sold.

The unit electric energy needs for mechanical separation at CMM amount to about 7.3 kWh/t; those at SERUSO are just 0.05. All these can be satisfied with energy coming from combustion of non-recyclables. The same does not hold for transport, although all the sites making up this integrated system lie within a less than 30 km reach.

Water use corresponds to 0.76 m^3 per ton of waste processed. Treated wastewater reuse accounted for about 70 % of the supply, the remaining being groundwater.

Concluding remarks

The high recovery MSW management in the District investigated is made possible by the circumstance that within a few dozen kilometres reach the treatment facilities and the industrial factories lie, to which materials are delivered. WTE plants – when limited in throughput to 10 – 20% of waste generated – are not competitors with recycling, and contribute to the sustainability of the system. All these data will be used in a following paper to calculate the CO_2 emissions and to quantify the environmental benefits of this integrated waste management system.

Keywords: municipal dry waste; waste plastics; waste treatment sustainability

Acknowledgements

The authors wish to thank Salvatore Nicosia, PhD, Associate Professor in Environmental Engineering at the University of Palermo (Italy), for driving and contributing to this paper from its beginning and for his useful suggestions.

References

Canzi P., (2012), *Environmental Report 2012 (Dichiarazione Ambientale 2012)*, CEM Ambiente SpA, Italy, On line at http://www.cemambiente.it//downloads.aspx?id=10

Rigamonti L., Grosso M., (2009), *Waste recycling. Packaging Life Cycle Analysis* (in Italian), Dario Flaccovio Editore S.r.l., Palermo, Italia.

SERUSO S.p.A, Italy, (2013), private communication (all sources in Italian).