

# Economic-financial analysis of the Italian packaging waste management system from a local authority's perspective

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## 1. Introduction

Waste management represents a great challenge for local authorities, which have the responsibility to provide the collection and proper treatment of municipal waste. In Italy, starting from the late 90's, there has been a significant effort to increase the recovery of waste at the expenses of its disposal. Despite some huge improvements of the system, landfilling remains the main destination of municipal waste, counting for about 40% of the total waste delivered without any preliminary sorting (ISPRA, 2013).

In this regard, the recovery of packaging waste has been an aspect of great concern among the European Member States, not only to decrease the environmental impact related to its disposal,

but also to reduce the consumption of raw materials and possibly limit the impact of their price increase. The recovery of packaging waste is an objective of the Community with clear targets set in the European law. In 1994, the 94/62/EC Directive on Packaging and Packaging Waste (PPW) was adopted and subsequently amended by 2004/12/EC and 2005/20/EC Directives, with its targets updated. By 2008, the Member States should have recovered a minimum of 60% by weight of total packaging waste, with 55% being achieved by material recycling and the remaining by energy recovery. Individual material recycling targets were also set for metals (50% by weight), paper and glass (60% each), plastics (22.5%) and wood (15%). The Italian Government has set more stringent targets for the recycling of plastics (26%) and wood (35%) (Ministero dell'Ambiente e della Tutela del Territorio e del Mare, 2012).

Some previous studies focused on costs and scenario analysis of waste management operations. For example, the impact of the PPW Directive in the Member States was analysed by RDC and Pira

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## Acronyms

ANCI	Associazione Nazionale Comuni Italiani (National association of Italian municipalities)	IPCC	Intergovernmental Panel on Climate Change
CAC	Contributo Ambientale CONAI (CONAI Environmental Contribution)	ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale (National institute for environmental defence and research)
CIAL	Consorzio Imballaggi ALLuminio (National consortium for aluminium packaging recovery)	LCA	Life Cycle Assessment
COMIECO	Consorzio nazionale recupero e riciclo degli imballaggi a base cellulosica (National consortium for paper packaging recovery)	LCC	Life Cycle Costing
CONAI	Consorzio Nazionale Imballaggi (National Packaging Consortium)	MBT	Mechanical-Biological Treatment
CO.RE.PLA	Consorzio nazionale per la raccolta, il riciclaggio e il recupero degli imballaggi in plastica (National consortium for plastic packaging recovery)	OECD	Organisation for Economic Co-operation and Development
CO.RE.VE	Consorzio RECupero VETro (National consortium for glass packaging recovery)	O.R.SO	Osservatorio Rifiuti Sovraregionale (Regional waste observatory)
EPR	Extended Producer Responsibility	PET	PolyEthylene Terephthalate
FSLA	Financial Support for Local Authorities	PPW	Packaging and Packaging Waste
HDPE	High Density PolyEthylene	RICREA	Consorzio nazionale riciclo e recupero imballaggi acciaio (National consortium for steel packaging recovery)
		RILEGNO	Consorzio nazionale per la raccolta e il recupero e il riciclaggio degli imballaggi di legno (National consortium for wood packaging recovery)
		UK	United Kingdom

(2003). The study aimed to achieve optimal recycling rates taking into account the costs associated with the implementation of the PPW Directive and the environmental benefits. Jamasb and Nepal (2010) applied a social cost–benefit analysis on some waste treatment options with energy recovery and compared them with coal power equivalent under low-carbon price. Massarutto et al. (2011) performed an economic assessment of alternative scenarios differing by combinations of energy and materials recovery from MSW. The chosen approach was an economic life cycle assessment (LCA), often referred to as Life Cycle Costing (LCC, Reich, 2005). Assamoi and Lawryshyn (2012) carried out a financial analysis and an LCA for two waste treatment options (incineration and landfill). More recently, Cossu and Masi (2013) focused on the effect of the economic instruments (incentives and penalties) on the Italian packaging waste recycling system.

In the Italian context, previous research (Rigamonti et al., 2009, 2010) showed that there are real energy and environmental benefits in recycling some types of packaging waste, namely aluminium, iron, paper, glass and selected plastic polymers, such as polyethylene terephthalate (PET) and high density polyethylene (HDPE). In contrast, for wood and mixed plastic streams the picture is not so well defined, with the true benefits of their recycling being strictly related to the hypotheses adopted on the type of substituted primary materials. For such streams, energy recovery might play a role, provided that high energy conversion efficiency is achieved in waste incineration plants or via co-combustion in industrial plants. In any case, the common target is the progressive phasing out of landfill as a disposal option, where no recovery takes place except for a very small contribution of the landfill gas generated by the degradable fraction of waste (only the paper, when considering the packaging waste). But such a landfill gas is seldom completely collected (Antognazza et al., 2011), thus yielding a partial release to the atmosphere, which corresponds to a relevant emission of greenhouse gases (methane, which constitutes about half of the landfill gas, has a Global Warming Potential equal to 25 – IPCC, 2007).

The recovery process involves additional costs both for private (the packers/fillers) and public (e.g. waste management authorities) sector stakeholders (Massarutto et al., 2011). Moreover, the logistic chain of recovery is usually quite complex and the set-up of

an effective system implies high up-front costs (investments in new facilities for packaging waste collection and sorting) and more waste handling (residual waste collection can have direct links between drop-off containers and landfills but the separated waste must be transported from the separate collection container/facility to the sorting facility and then delivered to the recycling plants). Unquestionably, these extra-costs<sup>1</sup> have to be internalized either by higher fees/taxes of waste management or by higher prices of packaged goods (or both) and all this process (mainly due to an increase and extended collection circuits) will bring some environmental impacts (Rives et al., 2010; Larsen et al., 2010).

Although there are extra-costs (operational and up-front investments) associated with the recovery system of packaging waste, in Italy this process has been supported by financial transfers<sup>2</sup> from the industry and there are also relevant economic benefits, namely at the environmental and social levels. Despite the conflicting aspects, one should also bear in mind that, nowadays, recovery can be a source of technological innovation or job creation, among others.

In this study, building up from an extensive, rich and unique data collection for the Italian packaging waste system, an economic-financial analysis of the packaging waste management system in Italy from the perspective of local authorities was carried out. The costs incurred by the local authorities due to the procedures, equipment and infrastructure necessary to provide the recovery of packaging waste were matched with the financial support of the industry. The cost savings that local authorities attain by diverting waste from residual waste collection services and disposal were included, too. Therefore, the final aim of the study is the comparison between the extra-costs and the benefits from the perspective of the local authority, in order to understand if the former are completely covered by the latter. The issues revised and discussed in this work can easily be compared with other countries and systems around the world.

<sup>1</sup> Hereinafter “extra-costs” are the costs related to local-authorities’ recovery activities.

<sup>2</sup> Financial transfers are the revenues from the sorted materials, which in Italy are paid by CONAI to the local authorities.

Ultimately, this research opens a debate on whether or not the shared responsibility principle is being achieved. The Extended Producer Responsibility (EPR, which states that producers should be responsible for their products' end-of-life) and the polluter-pays principles are actually the main drivers behind the PPW directive. However, while some studies show that the mandatory recycling targets had no major macro-economic impacts within the European Union (Ecolas and Pira, 2005), there is still a lack of research on the micro-economic impacts of this directive on each Member State. In particular, it is unclear whether the industry (producers of packaging or packaged goods) is covering the extra-costs incurred by local authorities due to the packaging waste recovery system. The current study aims to contribute to this debate.

After this introduction, the paper is organised as follows. Section 2 provides an overview of the whole life-cycle of packaging waste in Italy, integrated with the related institutional and legal framework. The data and methods of the economic-financial analysis of packaging waste recovery are given in Sections 3 and 4. Section 5 provides the analysis of the results whereas Section 6 reports a comparison between the results obtained for some case studies where the same method of analysis was adopted. Finally, Section 7 highlights the major concluding remarks.

## 2. Context of the study: the packaging waste management system in Italy

The life-cycle of packaging waste begins when it is discarded by the final consumer. Two options are then available:

- the packaging waste is separated at the source and delivered to sorting centres and then to recovery;
- the packaging waste is not separated at the source, and then it will end up in the residual waste, which is routed to different recovery and disposal options.

According to ISPRA (2012), in Italy in the year 2010, which was taken as a reference for this study, 32% of the residual waste was treated in mechanical-biological treatment (MBT) facilities, 10% was incinerated and 58% was landfilled. The residual waste delivered to MBTs might be sorted for further material recovery. Thus, the packaging included in this flow can be sent back to the recovery system. Regarding the incineration process, the combustible packaging materials in waste (such as plastic) will contribute to energy production due to their high calorific value, while metallic packaging recovered from bottom ash can also be sent back to the re-recovery system. Finally, no packaging waste can be recovered from the landfilled residual waste.

Waste collection is carried out by kerbside and/or bring systems. The drop-off centres contribute with just a small percentage of packaging waste collected for recovery. Moreover, packaging waste can be collected either as a mono-material or as a multi-material<sup>3</sup> stream (ISPRA, 2013), the latter meaning that two or more material fractions are collected together in a single bin. A number of different multi-material schemes exist in Italy, for example:

- paper and plastic;
- paper, plastic, aluminium and ferrous metals;
- plastic, aluminium and ferrous metals;
- glass, paper, aluminium and ferrous metals;
- glass, aluminium and ferrous metals;
- paper, glass, plastic and aluminium.

<sup>3</sup> Multi material is defined as more than one fraction of recyclable materials (glass, paper, metal, plastics).

When multi-material collection is in place, the packaging waste streams require a preliminary step of separation between the different materials (Giugliano et al., 2011; Rigamonti et al., 2013). In general, this separation step is somewhat different from what is usually referred to as the true material sorting phase. Obviously some specific cases will exist, where sorting of single material streams takes place at the same site of multi-material separation, but Fig. 1 illustrates the general sorting and recycling scheme in Italy.

The responsibility for the management of packaging waste in Italy is generally transferred by the industry to CONAI, the National Packaging Consortium. CONAI is a private non-profit organization established in 1997 with the aim of promoting separate collection, sorting, recovery and recycling of packaging waste in Italy. For the recovery operations of individual materials, CONAI co-ordinates the activities of the six Material Consortia: RICREA for steel, CIAL for aluminium, COMIECO for paper, RILEGNO for wood, CO.RE.PLA for plastic, and CO.RE.VE for glass (CONAI, 2013a). As previously mentioned, a number of targets are set for both material recovery (recycling) and energy recovery which, together, make up the total recovery level.

The general principles on which CONAI operates are the "polluter pays" and the "shared responsibility". According to the first, whoever is responsible for environmental pollution must also bear the costs of "decontamination", which in the case of packaging waste is the cost of collection and recovery or landfilling. Companies that produce goods have been given the responsibility for the pollution and, thus, they should bear the greater part of the cost of packaging waste management. But other players in the system hold part of the responsibility, and they should share the costs proportionally.

This means that companies cannot be totally and unconditionally charged with costs and, in the specific case of packaging waste, the local authority must organise the separate collection "efficiently and economically", and householders should follow the directions of the local authority regarding the proper sorting of the materials prior to their collection.

Two important points are then established: a) the "management" of householders is the exclusive task of the local authority; b) the CONAI system contributes economically to the expenses for a proper (i.e. efficient and economic) waste collection and management by paying a collection fee to the local authorities. It does not pay excess costs due to poor quality collection, inefficient sorting, over-costly transport, etc. The amount of the collection fee depends, in fact, on the quality of collected packaging waste, with higher fees paid for "cleaner" materials (see the Supplementary Material).

CONAI itself is funded through the "CONAI Environmental Contribution" (CAC in Italian) applied to the packaging sold by the last Producer<sup>4</sup> to the first User.<sup>5</sup> CONAI will then transfer such amount to the competent Material Consortium, after deducting a certain percentage for its own administration. The value of the contribution for each material is defined every year by the CONAI Board of Directors (Table 1).

The CONAI System manages the collection, sorting and recovery of post-consumption packaging in two different ways, according to its origin:

<sup>4</sup> "Producers" are defined as: manufacturers and importers of raw materials for packaging, manufacturers and importers of half-processed products for packaging, the producers of empty packaging, importers, retailers of empty packaging.

<sup>5</sup> "Users" are defined as: dealers, distributors, fillers, users of packaging and importers of filled packaging.

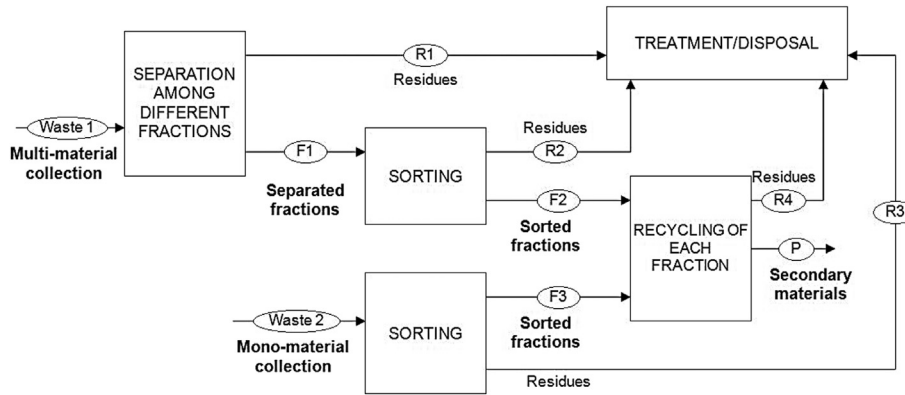


Fig. 1. General scheme of packaging waste separation, sorting and recycling in Italy (R = residues; F = fractions; P = products).

- primary packaging from municipal waste separate collection is managed on the basis of the agreement with ANCI (Associazione Nazionale Comuni Italiani—National association of Italian municipalities), described below;
- secondary and tertiary packaging originating from private premises (industry, shopping malls, etc.) are managed optionally through a platform system.

When it comes to the management of primary packaging separately collected from municipal waste, local authorities wishing to adhere to the CONAI System must sign a contract with the respective Material Consortium. This will allow the local authorities to receive the “collection fee”, paid by the Consortia, for each tonne of material collected and delivered to the relevant Consortium (Fig. 2).

Fees, methods and procedures are dictated by the agreement between ANCI and CONAI (ANCI-CONAI, 2009), updated every five years, which defines:

- the collection fees for each packaging material collected and taken back by the relevant Consortium; this is based on the quality of the collected material, i.e. to the impurities it contains (see the Supplementary Material). Quality is checked through analyses carried out periodically. No collection fee is payable if the percentage of impurities exceeds the maximum threshold, and the Consortium might opt not to take back the material;
- any other charges payable to local authorities depending on distance and transport costs, or other additional costs (compressing, sorting/cleaning etc.).

In a 10 year timeframe, the recovery rate of packaging waste in Italy has increased significantly (from 33.2% in 1998 to 68.6% in 2008), with a further increase to 74% in the year 2012 (CONAI, 2013). As can be seen from Table 2, the latest figures on recycling and recovery of packaging waste in Italy show that the global targets of the PPW Directive were easily achieved, also taking into

consideration that specific national targets for plastic and wood are more ambitious than those set by the European Union.

### 3. Economic-financial analysis: methods

The method used for performing the economic-financial analysis was the same as the one adopted in Cruz et al., 2012 who have developed a method to assess if the principles of the Directive on Packaging and Packaging Waste are being fulfilled in practice. The economic perspective includes the opportunity costs, i.e. the costs related to the packaging waste management in a scenario with no selective collection or sorting. The financial perspective only considers the financial costs and benefits of the packaging waste management system. The aim of Cruz et al. (2012) was the same as that of the present study, but applied to Portugal.

All expenditures and revenues relative to the separate collection and sorting of municipal packaging waste carried out by the local authorities in 2010 were, thus, taken into account.

For the cost measurement, the following components were considered:

- operational expenses (taking into account the costs of separate collection and sorting);
- the depreciation of assets (allocated to the separate collection);

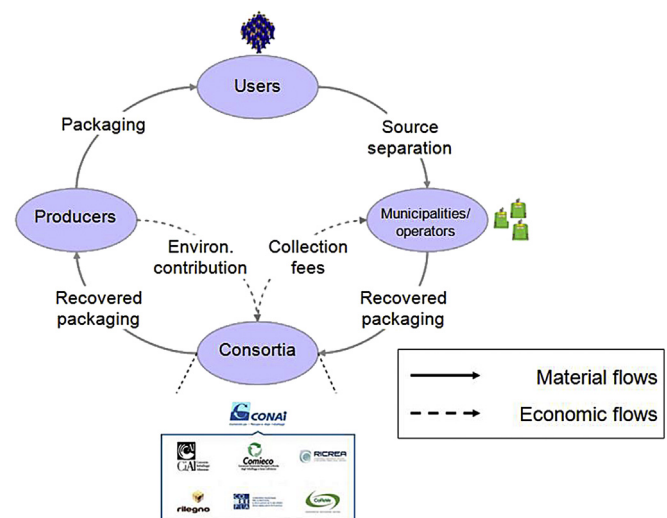


Fig. 2. Management of packaging waste in Italy and the role of CONAI and of the Material Consortia.

Table 1  
CONAI Environmental Contribution: values in €/t (CONAI, 2012).

Material	Year 1998	Year 2010
Steel	15.49	31.00
Aluminium	51.64	52.00
Paper	15.49	22.00
Wood	2.58	8.00
Plastic	72.30	160.00
Glass	2.58	15.82

**Table 2**

Recycling and recovery in Italy in 2012 (Source: CONAI, 2013b) compared with the 2008 targets set for Italy.

Material	Packaging waste put in the market (kton)	Recycling (kton)	Energy recovery (kton)	Total recovery (kton)	Recycling rate (%)	Total recovery rate (%)	Recycling targets 2008 (%)
Steel	440	333	–	333	75.7	75.7	50
Aluminium	68.5	40.7	3.5	44.2	59.4	64.5	50
Paper	4290	3420	319	3739	79.7	87.2	60
Wood	2163	1055	80	1135	48.8	52.5	35
Plastic	2052	753	704	1457	36.7	71.0	26
Glass	2206	1570	–	1570	71.2	71.2	60
Total	11220	7172	1107	8279	63.9	73.8	55

- the return on capital employed, concerning the investment allocated to separate collection.

Regarding the (financial) benefits quantification, the following contributions were considered:

- the financial support for local authorities (that is, the collection fees paid by CONAI);
- other revenues (which are attained for non-packaging materials);
- subsidies to investment (that is, those allocated to separate collection and sorting assets).

Moreover, the savings that derive from the diversion of packaging waste from residual waste collection and disposal activities were included as an economic benefit.

Note that in the analysis the 'net take-back values' which correspond to the financial transfers between the CONAI (who owns the packaging waste after paying the collection fee) and the guarantors/recyclers were not taken into account. One would have to consider these amounts (as benefits) if the objective was to compute the extra-cost of recycling from the industry point of view. Indeed, the aim of this assessment is the quantification of the extra-cost incurred by local authorities due to the procedures, equipment and infrastructure necessary to provide the recovery of packaging waste. Afterwards, this value was compared with the benefits attained by the local authorities for the same purpose.

#### 4. Economic-financial analysis: data

The economic-financial analysis was applied to the management of the materials specified in sub-Section 4.1. Sub-sections from 4.2 to 4.6 describe the costs and benefits included in the analysis. All of them concern the year 2010.

##### 4.1. Waste included in the analysis

The economic and financial analysis of recovery comprises the measurement of the costs and benefits relative to the six packaging materials (steel, glass, aluminium, plastics, paper and wood) collected from public areas in the year 2010 and managed directly by the Material Consortia (Table 3). Both mono- and multi-material

**Table 3**

Direct management by CONAI in 2010.

Material (Consortium)	% Inhabitants	% Municipalities
Steel (RICREA)	73	61
Glass (CO.RE.VE.)	82	73
Aluminium (CIAL)	73	60
Plastics (CO.RE.PLA.)	96	90
Paper (COMIECO)	89	80
Wood (RILEGNO)	71	59

collection schemes were considered. Non-packaging waste made of paper and wood were also included, as the local authorities receive financial support for those streams, as well.

##### 4.2. Operational costs

Operational costs include collection and transport costs and costs of sorting and disposal of resulting residues.

###### 4.2.1. Collection and transport costs

National average collection and transport costs were derived from the "Rapporto rifiuti 2013" (Waste Report) edited annually by ISPRA. They are compiled in Table 5.

###### 4.2.2. Costs of sorting and disposal of the residues

The multi-material collection is first separated among the different fractions and then each material fraction is delivered to a dedicated sorting plant (Fig. 1).

The definition of the different quality levels for each material, which affects the amount of the collection fee, might also affect the responsibility for paying for the disposal of the sorting residues (see the Supplementary Material). This applies only to steel, paper and plastic. As a general approach, when a good quality of collection is achieved, the disposal of residues will be paid by the Consortium, while for poor quality levels, the disposal is borne by the local authority. This gives a double penalisation to the local authorities, thus encouraging all efforts to reach a very high quality of the collected materials. Table 6 shows the general situation about the responsibility for paying the sorting and the disposal of the sorting residues.

With reference to the year 2010, the following costs were included:

**Table 4**

Materials included in the analysis.

Material	Amount of collected material [t]	Amount sent to recovery [t]
Steel	114,733	106,038
Glass	1,214,269	1,100,789
Aluminium	5974	5974
Plastics	614,190	596,000
Paper	401,557	391,036
Paper non-packaging	1,058,959	1,031,214
Wood	139,614	139,614
Wood non-packaging	376,647	376,647
Residues from separation <sup>a</sup> of the multi-material fraction	217,487	–
Total	4,143,430	3,747,312

<sup>a</sup> When multi-material collection is in place, the packaging waste streams require a preliminary step of separation between the different materials (Fig. 1). In general, this separation step is somehow different from what we usually refer to as the true material sorting phase.

**Table 5**

National average collection and transport costs for the source separated materials (calculated from data reported in ISPRA, 2013).

Material	Euro/t
Multi-material collection	86.5
Steel	165.0 <sup>a</sup>
Glass	67.4
Aluminium	— <sup>b</sup>
Plastics	161.1
Paper	96.1
Paper non-packaging	95.1
Wood	77.3
Wood non-packaging	50.8

<sup>a</sup> Source: O.R.SO. (Osservatorio Rifiuti SOvraregionale) database.

<sup>b</sup> Aluminium in 2010 was collected only as a multi-material stream.

- costs for the separation of the multi-material collection and for the disposal of residues;
- costs for steel sorting and for the disposal of residues arising from the sorting of steel collected together with glass (the so-called “heavy” multi-material scheme).

Based on information gathered at some plant operators, an average cost of 45 € per input tonne was assumed for sorting, and 100 € per tonne for the disposal of separation and sorting residues.

#### 4.3. Depreciation of assets and return on capital

For the evaluation of the depreciation of assets and of the return on capital, the following entries were considered:

- depreciation costs of the waste bins and collection trucks;
- depreciation for relinquished financial assets and others;
- cost of accruals;
- costs related to the return on invested capital.

According to the “Rapporto Rifiuti 2013” (ISPRA, 2013), the sum of such entries for the year 2010 was 14.3 € per tonne of collected waste as a national average. Such value is calculated for the whole waste managed and not for the sole packaging waste source separated. As this value concerns the collection phase only, this simplification looks plausible.

#### 4.4. Financial support and other revenues

The financial support for local authorities (FSLA) corresponds to the collection fee paid by CONAI to the local authorities for the separate collection of packaging waste that they carry out (see the

**Table 7**

Financial support and other revenues for the collection shown in Table 4.

Material	Financial support (€)
Steel	6,464,008
Glass	36,691,627
Aluminium	2,635,939
Plastics	142,139,000
Paper	32,528,399
Paper non-packaging	19,789,296
Wood	482,499
Wood non-packaging	1,301,672
Total	242,032,440

Supplementary Material). This assumes that the collected packaging will be recovered, in terms of material recycling and energy recovery, so as to fulfil the legal obligations of the PPW Directive.

As previously explained, packaging waste can be collected both as a mono-material stream and as a multi-material stream. When multi-material collection is in place, the packaging waste streams require a preliminary step of separation between the different materials. The collection fee is paid in both cases, but when multi-material collection is in place, the payment is based on the quality of the materials after multi-material separation.

The overall financial support paid in the year 2010 by CONAI to the local authorities for the collection of the materials reported in Table 4 amounts to 242 million Euros (Table 7), which corresponds to 58 € per tonne of collected waste. Out of this amount, 5 € were considered in the analysis as “other revenues”, which are associated to the collection of non-packaging paper and wood.

The data sources were the ANCI-CONAI Agreement (CONAI, 2008), the Special Prevention Programmes and the Yearly Management Reports of each Material Consortium (CIAL, 2012; COMIECO, 2011 a, b; Consorzio nazionale riciclo imballaggi acciaio 2011 a, b; CO.RE.PLA. 2012; CO.RE.VE. 2011 a, b; RILEGNO, 2011), and some direct interviews with representatives of the Material Consortia.

#### 4.5. Subsidies to the investments

There are no systematic subsidies granted to the municipalities beyond the financial support for packaging waste collection, but only some dispersed initiatives that might be related, for example, to very specific emergency situations. This entry was then not considered in the calculations.

#### 4.6. Benefits from the diversion of the waste from disposal

The benefits obtained from the diversion of waste from disposal were calculated by considering the costs of residual waste collection and of its treatment and disposal. The avoided cost amounts to

**Table 6**

Responsibility for paying the sorting and the disposal of the residues.

Category	Sorting	Disposal of the sorting residues
Multi-material fraction	Local authority	Local authority
Steel	Local authority	It depends on the quality of the collected material (see Table 1 of the Supplementary Material)
Glass	Glasswork or who prepares the glass cullet for the glasswork	Glasswork or who prepares the glass cullet for the glasswork
Aluminium	No sorting (the material - resulting from the separation of the multi-material fraction - is always in category A, i.e. content of other fractions $\leq 4\%$ ) <sup>a</sup>	—
Plastics	Consortium	It depends on the quality of the collected material (see Table 4 of the Supplementary Material)
Paper	Paper mill	It depends on the quality of the collected material (see Table 5 of the Supplementary Material)
Wood	No sorting	—

<sup>a</sup> This is true for the year 2010.

191 € per 1 tonne of packaging material that is separately collected rather than remaining in the residual waste (ISPRA, 2013). This avoided cost was considered an “opportunity cost” and accounted for as an economic benefit.

### 5. Results

Results of the assessment of the economic analysis from the local authority's perspective are shown in Fig. 3, expressed in terms of waste collected and of waste recovered, taking into account the efficiency of the services.

On average, the local authority benefits 250 € per tonne of packaging waste separately collected, i.e. 276 € per tonne sent to recovery. However, when a strictly financial perspective is adopted, the benefits are significantly reduced to 58 € and 65 € per tonne of waste collected or sent to recovery, respectively. When it comes to the costs, the services of separate collection and sorting of packaging waste account for 121 € per tonne collected for the local authority (134 € when referred to one tonne sent to recovery after sorting).

The cost coverage is then around 207% when considering an economic perspective, but it falls to 48% if the cost savings due to the avoided disposal (“Opportunity cost” in Fig. 3) are not taken into account. The question about the fairness of financial transfers needs to be raised. Following an economic perspective, the CONAI financial support in 2010 could have been eliminated. However, if the industry had to be 100% responsible for the processing of their packaging waste, the financial support should have increased by about 119%. In fact, only 48% of the cost is being supported by the industry in Italy.

Fig. 4 shows the breakdown of the operational costs. On average, 84% of these are incurred by the local authority for the collection (separate collection + transport to the first treatment plant). “Operational cost of separation” (10%) represents the cost of the separation of the multi-material collection into the individual material fractions. Operational cost due to sorting is a small percentage (1%), as the local authorities in 2010 paid only for the sorting of steel (see Section 4.2.2). The “operational cost of disposal residues” includes the costs for the disposal of residues arising from the separation of the multi-material fraction and from the sorting of steel collected together with glass.

Finally, Fig. 5 shows the operational costs expressed per one tonne of each collected material. Aluminium is not explicitly present as in 2010 it was not collected within a mono-material scheme,

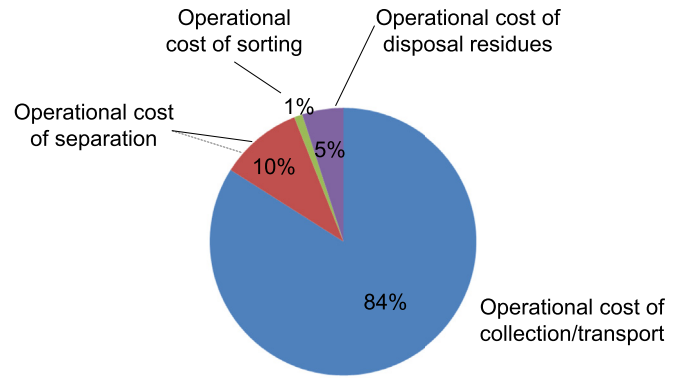


Fig. 4. Composition of the operational costs.

thus falling into the “multi-material” bar. Plastics, multi-material fraction and steel are the most costly fractions. For plastics and steel this is due to the high cost of collection, while for the multi-material fraction the costs are mainly due to the collection (55%) and the separation activities (29%).

### 6. Discussion

According to the EPR principle (an overriding guideline of the PPW Directive), all economic producers that put packaging or packaged products on the market are responsible for their management and recovery (OECD, 2001). As an alternative to developing their own packaging waste management system in order to comply with the recycling and recovery targets laid down by the European law, producers of packaging can transfer their responsibility to another entity (e.g. a Green Dot company or, in Italy, CONAI). In general, the producers of packaged products opt for the second option. This leads to the need of establishing a system of financial transfers between the industry and the local governments (mostly due to the costs involved with separate collection and sorting).

Although the ultimate objective (the recovery and recycling targets prescribed in the PPW Directive) is similar for all Member States, the operational strategies for achieving the targets vary considerably from country to country (European Commission, 2006). By taking this into account, this study applied the same method for the economic-financial analysis used for the cases of

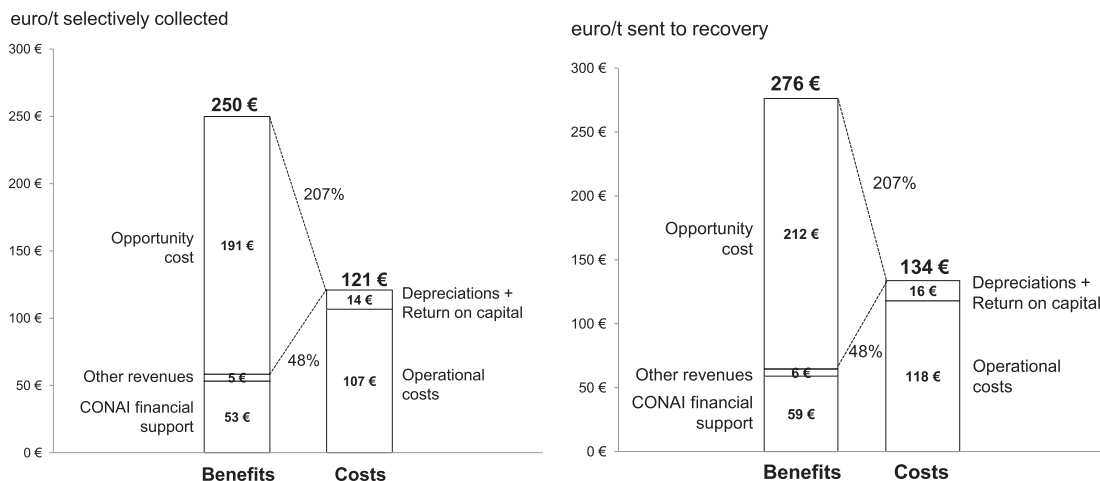


Fig. 3. Cost coverage considering the tonnes collected (top) and sent to recovery (bottom).

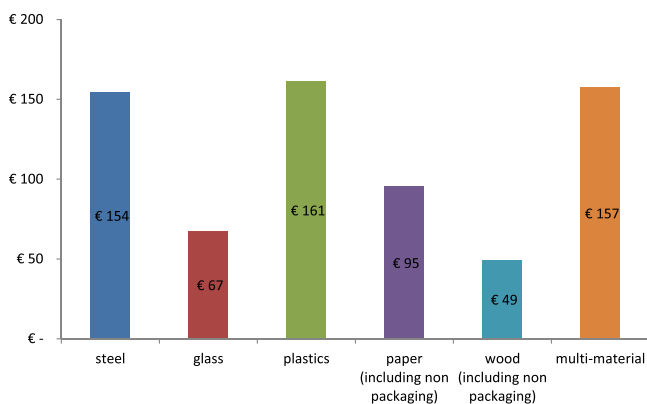


Fig. 5. Operational costs per tonne of packaging waste collected.

Portugal (Cruz et al., 2012), France (Cabral et al., 2013), Belgium (Marques et al., 2014a), Romania, and the United Kingdom (UK) (Marques et al., 2014b). For the UK case, the data gathered represented only around 2% of the population. In Romania, most packaging waste managed by Eco-Rom Ambalaje (i.e. the non-profit Green Dot company operating in this Country) comes from the industrial flow. Therefore, results from these two countries are not comparable with the remaining case studies. The results for Portugal, France, Belgium and Italy point out that the industry is not paying the net financial cost of packaging waste management. In fact, if the savings attained by diverting packaging waste from other treatment (e.g. landfilling or incineration) are not considered, it results that the industry should increase substantially the financial support to local authorities (by 35% in Portugal, 121% in France, 11% in Belgium and 119% in Italy). The results are consistent in all countries analysed, which means that the implementation of the EPR principle, one of the Directive's goals, is not being fulfilled.

However, if the avoided disposal costs are considered as a benefit for the local authorities, the costs of the system are fully covered by 128% in Portugal (i.e. the FSLA could be reduced by 43%), 135% in France, 204% in Belgium, and 207% in Italy. For the last three countries the FSLA could therefore be virtually removed.

As a consequence, any assertion regarding the adequacy of the financial transfers carried out by the compliance schemes depends on the adopted perspective. If one accepts that the savings attained by diverting waste from other treatment (e.g. landfilling or incineration) should be seen as a benefit of the local authorities, then the financial support by the industry could be reduced or even removed. Conversely, if the EPR principle was to be strictly followed, the transfers to the local authorities would have to be increased. The costs that are not covered by the industry or by other revenue are actually covered by public money. The decision makers frequently see only the financial results. For an economic activity it is important that revenues exceed the costs (financial analysis). Nevertheless, the economic analysis draws attention to the "bigger picture". From the society and from the local authority's point of view it is important to consider other benefits attained from the diversion of recyclables from final treatment.

## 7. Conclusions

This research investigated the viability of the recovery system of packaging waste in Italy, by means of an economic-financial analysis focused on the household flow. An extensive data collection for the Italian context was performed to fulfil the aim of the study.

The adoption of an economic rather than a (strictly) financial perspective for the analysis has led to distinct conclusions,

diverging between a sustainable and unsustainable service, respectively. According to the economic perspective, the local authority benefits 250 € per tonne of packaging waste separately collected and sent to recovery. The major contribution is given by the opportunity costs, i.e. the avoided disposal cost of residual waste that in Italy is very high, with an average of 191 € per tonne including collection, transfer and disposal. In contrast, if a strictly financial perspective is considered, thus excluding such opportunity costs, the benefits are significantly reduced to 58 € per tonne of waste collected.

Regarding the cost perspective, the services of separate collection and sorting of packaging waste represent 121 € per tonne collected for the local authority.

As a final result, the above reported figures show that the cost coverage is around 207% when adopting an economic perspective, but it falls down to 48% if the cost savings due to avoided disposal are not taken into account.

We can conclude that in Italy the industry is not paying for the full costs of packaging waste management, because it is only thanks to the savings of the avoided disposal that the financial support along with other financial benefits can cover the costs supported by local authorities. The EPR principle, one of the PPW Directive's cornerstones, is not being fulfilled, in a strictly financial perspective.

Some measures should then be implemented to prevent the lack of economic sustainability of the packaging waste management systems. This balance is not easy to achieve, however compared to other countries in Europe, some conclusions can be reached: the Green Dot fees should be calculated based on concepts of eco-design, the FSLA should be calculated based on the efficiency and the peculiarities of each packaging waste system. Moreover, the implementation of a Pay-As-You-Throw (PAYT) system (like in Belgium, as reported by Marques et al., 2014a) allows to achieve better results, because the economic instruments play an important role in driving the behaviours.

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## Appendix A. Supplementary data

Supplementary data related to this article can be found on line.

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