Original Research

Financial Flows in the Recycling of Packaging Waste: The Case of France

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Abstract

Each country in the European Union has its own packaging waste management system. However, there is still lack of evidence concerning the true costs of packaging waste recycling and how these costs have been distributed among stakeholders. This paper addresses these issues using the financial transfers undertaken by the French Green Dot company Eco-Emballages as a case study to focus the analysis. To accomplish this, we use data from 45 local authorities. We compare the financial transfers coming from the Eco-Emballages Group with the costs incurred by the local authorities and provide a discussion on the suitability and fairness of the system. If we consider the economic savings attained by diverting packaging waste from the refuse collection and final treatment activities, the financing model of the French "recycling system" was sustainable in 2010. However, if we adopt a strictly financial approach, the results suggest that the industry only covered around 56% of local authorities' costs.

Introduction

The 'waste hierarchy' concept[1] has been embedded in European Union (EU) waste legislation since the 1970s [1]. Since then, recycling has taken a leading position in the waste management systems of all EU member states [2]. The Directive 94/62/EC on Packaging and Packaging Waste (PPW) emphasized this waste management strategy by setting challenging recycling targets to all member states. Some countries decided to embrace the recycling strategy and clearly exceed the provisions of the PPW directive (Germany, for instance [3]). Other countries are still striving to attain the mandatory targets (e.g. Poland).[2]

Currently, the recycling rates in France meet the targets of the directive. However, a new piece of legislation on environmental issues (known as the Grenelle Act) aims to push the French system further toward recycling (by setting the overall recycling target of 75% of total packaging waste produced).

The present study aims to determine the cost and benefit structures of the local authorities that carry out selective collection and sorting of packaging waste in France. It also illustrates the French recycling scheme to highlight its strengths and weaknesses (which are crucial at the European level). In theory there should be an optimal value for recycling rates [4], where the added costs are balanced

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[1] Priority should be given to the following strategies (in order): reduce, reuse and recover (first recycling and then energy recovery) before the final disposal.
[2] EUROSTAT. Environmental Data Centre on Waste. Accessed in March 2012.
http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/introduction/

by the benefits generated by this management strategy. Among many elements, this rate should be contingent on the type of material, consumption patterns, population density, and current technology [5]. However, determining an optimal recycling rate for France is not the purpose of this paper.

The literature includes many economic evaluations of urban solid waste management and treatment. Many papers compare different options of final disposal and provide guidelines for decision-makers. In general, these studies have similar findings. Landfilling is frequently the least costly waste disposal option, even when the benefits attained with energy recovery in incineration plants are considered [6]. As for the case of incineration with energy recovery, selective collection and sorting facilities (essential to direct packaging waste for material recycling) imply additional financial costs for waste management operators. However, many authors argue that (potential) environmental benefits achieved outweigh the financial costs incurred [7, 8]. The monetization of environmental benefits achieved through the recycling of packaging waste remains an important but controversial issue that is beyond the scope of this paper. Nevertheless, the argument that if one takes external costs and benefits into account, no single solution is optimal (i.e. waste management should be integrated, where landfilling and energy and materials recovery should coexist) has been gaining traction in the literature [4]. In fact, energy recovery can be an important element for renewable energy policy [9], and recycling has been deemed essential for the case of packaging waste [10].

The Extended Producer Responsibility (EPR, which states that producers should be responsible for their products' end-of-life) and the polluter-pays principles are the main ideas behind the PPW Directive. While some studies show the mandatory recycling targets had no major macro-economic impacts within the EU [11], there is still a lack of research on the institutional [12] and micro-economic impacts of this directive on each member state (MS). In particular, it is unclear whether the industry (producers of packaging or packaged goods) is covering the full costs of the recycling systems. The current study makes a contribution to the literature on this issue.

The topic of this paper is relevant for an international audience for three reasons. First, while all member states are required to design recycling systems and implement them to achieve the ambitious EU targets, the actual costs of selective collection and sorting of packaging waste remains unknown for most countries; uncovering these costs is important to assess the suitability of the targets and to establish benchmarks that would allow for assessing the efficiency of the different national strategies. Second, excluding exceptional cases such as Germany (where a dual system exists for managing packaging waste), the UK (where a market-based system based on packaging recovery notes was developed) and Denmark (where no EPR system is enforced and a deposit system runs for beverage packaging) the EPR system established in France for managing packaging waste (the Green Dot System) was also adopted by the majority of the remainder MS. And third, the particulars of the French system (particularly the finan-

cial mechanisms to reimburse local authorities) and the lessons learned by this country may be useful for decision-makers from other jurisdictions wishing to improve their current systems.

The Life Cycle of Packaging Waste

The life cycle of packaging waste begins with its selective collection by kerbside and/or by drop-off containers [13]. In France, according to the collection system implemented by local authorities (which usually have legal responsibility for the management of household waste collection and treatment services), the different packaging waste materials can be collected through three main methods:
(1) bi flow (composed of glass and multimaterial flows)
(2) tri flow (represented by glass, multimaterial packaging, and newspapers/magazines flows)
(3) corps creux/corps plat (constituting a tri flow composed of glass flow, paper/cardboard, and newspapers/magazines, and a third flow of metal and plastic packaging)

The selectively collected packaging waste is sent to sorting stations and then to recycling centres. The packaging waste flows have different sorting efficiencies and percentages of waste rejected (which is usually incinerated with energy recovery). Nevertheless, a significant portion of packaging waste still enters the undifferentiated flow; this portion is subject to other types of treatment that do not necessarily lead to better economic or environmental outcomes. However, the greatest environmental impacts are related to plastic packaging [14] because of its high resistance to the natural action of the environment when landfilled. In fact, landfilling should be the last disposal option because of its negative environmental impacts and the loss of potential revenue streams from the disposal of useful material. For instance, the incineration of plastic packaging waste, rather than disposal, allows for energy production (because of its high calorific value) and metal packaging can always be recycled through the slags. In mechanical and biological treatment (MBT) facilities, the undifferentiated fraction is usually sorted, and some of the packaging included in this flow can be taken back to the recycling system. A simplified scheme of the life cycle of packaging waste in France is shown in Fig. 1.

In general, the greatest environmental and financial impacts of recycling are related to the fuel consumption associated with waste transportation and collection [15]. Furthermore, a recent study [16] concluded that the collection costs may vary substantially depending on the packaging waste flow and the method of collection (kerbside, drop-off, etc.). The average costs of collection of each packaging waste flow are presented in Table 1.

In our approach, we widen the scope of the 'traditional' financial life-cycle cost by including an evaluation of the impacts of recycling in an economic perspective ('*Data and Methodology*'). In the current study the positive and negative environmental effects of packaging waste recycling will not be considered.

The French Institutional Framework

The PPW Directive, which came into force in 1994 and was revised in 2004, had the objective of providing a high level of environmental protection, reducing the consumption of raw materials and reducing harmful emissions, particularly from landfilling. Moreover, it is also intended to ensure the functioning of the internal market, setting minimum and maximum targets for recovery and recycling and securing the free movement of packaged goods within the EU. All member states (including France) had to recover a minimum of 60% as well as recycle a minimum of 55% (with a maximum of 80%) by weight of packaging waste by 2008 and onwards (although some member states were allowed to postpone the 2008 deadline). Regarding each specific material flow, the minimum recycling rates were 60% of total packaging waste by weight for glass and paper/cardboard, 50% by weight for metals, 22.5% by weight for plastics, and 15% by weight for wood.

The Decree No. 92-377 (regulating household packaging) and the Decree No. 94-609 (dealing with industrial and commercial packaging) were the first legal instruments on packaging waste management implemented in France to attain the PPW directive targets. In 2007 French stakeholders joined government and other groups to work on the Grenelle Environnement to take environmental protection measures and to pursue sustainable development. The Grenelle Act established an overall recycling target of 75% of total packaging waste produced to be fulfilled by 2012, where the industry will have to cover 80% of net benchmark costs for an optimal service of packaging waste collection and sorting [18].

The Agency for Environment and Energy Management (ADEME in the French acronym) is the waste authority in France. It has the responsibility to define strategies for the waste sector to prevent waste production and to encourage recycling operations. Therefore, ADEME provides financial support to local authorities for waste collection and disposal. Furthermore, it also manages the information regarding the quantities of packaging placed into the national market and of packaging waste collected and recovered (and reports them to the EU).

Table 1. Average costs of collection per packaging waste flow [17].

Waste flow	Bring system (€/t)	Curbside (€/t)
Plastic/metal/cardboard/ newspapers/magazines	–	419
Plastic/metal/cardboard	750	749
Plastic/metal	788	–
Cardboard/newspapers/ magazines	167	–
Newspapers/magazines	131	228
Glass	72	180

According to national law, the responsibility for the management of packaging waste can be transferred by the industry to an entity duly licensed for this activity. Eco-Emballages, the French Green Dot company, is a nonprofit private organization that promotes the selective collection, sorting, recovery, and recycling of French household packaging waste. In countries with green dot schemes, the economic operators (mainly industries that produce packaging or packaged goods and place them on the market) transfer their EPR obligations to these not-for-profit entities that take on the responsibility of managing the end-of-life of packaging (this implies coordinating and funding the whole logistics chain). To transfer their responsibility to Eco-Emballages, the economic operators have to pay a fee to this entity (the green dot fee), which is contingent upon the type and quantity of packaging placed on the market. At the same time, Eco-Emballages sets agreements with local authorities and pays for the packaging waste sent for recycling. In fact, the responsibility of Eco-Emballages regarding the collection and recovery of packaging waste is set through contracts with local authorities (for instance, inter-municipal public entities with and without the ability to set taxes) and with guarantors and/or recyclers of packaging materials [19]. Note that some specific flows of packaging waste are not the responsibility of Eco-Emballages.

Undifferentiated collection

Selective collection

Fig. 1. The (simplified) French life cycle of packaging waste.

Table 2. Infrastructure and equipment for urban waste management in 2008.

Landfills	256
Incinerators with energy recovery	112
Incinerators without energy recovery	17
Composting facilities	518
Sorting stations	330
Drop-off centres	4,310*

*data from 2007

For instance, packaging waste from the pharmaceutical sector does not enter municipal systems; instead, it is managed by a specific recovery program known as Cyclamed. Moreover, the non-household packaging waste flow has been supported by packaging recyclers through voluntary based specific structures in order to help enterprises to comply with the national regulations [20].

Table 2 provides an overview regarding the current infrastructure assigned to waste management operations in France [21].

The overall recycling rate of packaging waste in France has gradually increased over the last 10 years (from 42% in 1999 to 56% in 2009, by weight) as reported to the EU (EUROSTAT data). Table 3 [22] shows progress against the global, as well as the specific targets imposed by the PPW Directive (to be achieved by France until the end of 2008). Moving toward the fulfillment of the Grenelle Act, Eco-Emballages had a relevant increase in 2009 in terms of recycling, reaching 64% of total packaging waste produced.

The Financial Transfers

Overview

In France, household packaging waste recycling through the Eco-Emballages system has been supported by industry contributions (green dot fees), the sale of sorted material, and public money [23] (Fig. 2).

According to the French system for 2010, the transfers from Eco-Emballages should cover 60% of the net optimized costs of collection and treatment services carried out by local authorities. Therefore, the financial support for local authorities has been calculated based on their performance and the take-back quantities for different packaging materials under agreements (called Barèmes). To achieve the new national target of a recycling rate of 75% (imposed by the Grenelle Act), a new agreement (Barème E) was established for the period 2011-16. In this sense, Eco-Emballages raised its financial supports to cover 80% of the efficient benchmark costs of packaging waste services [24].

Green Dot Fee

The green dot fee comprises a variable component (weight fee) and a fixed component (unit fee). The weight fee is determined by multiplying the total weight of each packaging placed onto the market by the respective fee (according to the type of material) [17]. Table 4 presents the fees for 2010.

The unit fee depends on the value obtained for the weight fee. In 2010, if the weight fee was greater than or equal to € 0.0014 (per package), the unit fee was a flat rate of € 0.0014. If the contribution on weight was less than € 0.0014, the unit fee was equal to the weight contribution and the total fee was twice the weight fee. In the case of packages weighting more than 1 kg, their contributions to the weight fee were limited to 1 kg.

Financial Support for Local Authorities

In 2010 the financial support for local authorities (FSLA) was calculated based on the Barème D (Table 5). As mentioned before, the FSLA model was based on the recycling performance of local authorities and on the efficiency of packaging waste sorting. The support and performance levels vary with the type of packaging material [25] (Table 6).

When local authorities have different selective collection structures for coloured and colourless glass, the later was paid 7€ per ton taken back. The FSLA for the coloured glass was determined according to the model presented in Table 4.

Table 3. Recycling and recovery of packaging waste in France in 2009.

Material	Packaging waste generated (ton)	Total recycling[a] (ton)	Total recovery[b] (ton)	Recycling rate (%)	Recovery rate (%)
Glass	3,133,377	1,966,000	1,966,000	62.7	62.7
Plastic	2,046,728	460,540	1,167,525	22.5	57.0
Paper/cardboard	4,283,537	3,721,400	4,124,698	86.9	96.3
Metals	717,684	432,289	437,088	60.2	60.9
Wood	2,641,660	500	673	18.9	25.5
Total	12,822,986	7,080,229	8,368,311	55.2	65.2

[a] Total recycling includes material recycling and other forms of recycling like composting.
[b] In France, total recovery includes total recycling and incineration with energy recovery.

Table 4. Green dot fees for 2010.

Material	2010 fees by packaging material (€/kg)
Glass	0.0045
Plastic	0.2222
Paper and cardboard	0.1526
Steel	0.0282
Aluminium	0.0566
Others	0.1526

Other Financial Supports

According to Barème D, Eco-Emballages also supported the composting and the incineration of packaging waste with energy recovery [17]. These financial supports were calculated based on ton treated considering a unit support fee (in €/t) provided in Table 7.

Furthermore, local authorities could increase their funding if they served a restricted group of population (buildings and/or dispersed rural housing). Eco-Emballages also provides supports for optimization if local authorities choose to report all costs of the waste management systems, along with the identification of technical, economic and social factors for improving those systems. The supports paid for communication required local authorities to report an annual communication plan, defining all resources needed for increasing public awareness. Local authorities also received 10,000 € per year and per sorting ambassador if they reported all communication activities carried out by the ambassadors [25].

Sale of Sorted Materials

In France, the sale of sorted packaging waste to recyclers is conducted through specific take-back schemes. Each local authority can choose among three take-back options for the different materials [26]:
(1) Option Filières
(2) Option Federations
(3) Option Individual

The average take-back prices can vary significantly in the last two options as the negotiation of materials price is made directly with the recycling industry. However, the quality of materials should not differ greatly in the three options because, in general, the recycling operators are the same [27].

Table 8 shows the take-back prices of several packaging materials applied in 2010 for each take-back option [28].

Public Money

In addition to the financial supports (undertaken by Eco-Emballages) and the sale of packaging waste materials, local authorities receive subsidies for investment (from the French government) which may be (partially) allocated to the selective collection and sorting activities.

Table 5. Financial support by local authority performance.

Level	Performance (P) in Kg/inhabitant/year	Financial support (S) in €/ton
1	P ≤ Nb	$S = Sb$
2	Nb < P ≤ Nh	$S = \dfrac{(Nb \times Sb) + (P - Nb) \times Si}{P}$
3	Nh < P ≤ Np	$S = \dfrac{(Nb \times Sb) + (Nh - Nb) \times Si + (P - Nh) \times Sp}{P}$
4	P > Np	$S = \dfrac{(P - Np + Nb) \times Sb + (Nh - Nb) \times Si + (Np - Nh) \times Sp}{P}$

Sp – plafond support, *Si* – intermediary support, *Sb* – bottom support, *Nb* – lower level, *Nh* – high level, *Np* – plafond level.

Fig. 2. Funding model for the recycling of household waste in 2010.

Table 6. Variables to calculate the FSLA per material.

	N_b	N_h	N_p	S_b	S_i	S_p
	(-)	(-)	(-)	(€/ton)	(€/ton)	(€/ton)
Steel	1	2	7	45	62.5	80
Aluminium	0.1	0.2	1	230	280	330
Paper/Cardboard[1]	4	8	18	120	200	280
Plastic	1.6	3.2	8	310	575	840
Glass	15	30	45	3	5	7
EMR[2]	4	8	18	60	100	140

[1]Mixture of various qualities of used paper and cardboard packaging, free from newspapers and magazines and liquid packaging cardboard.
[2]Mixed recovered paper and board (unsorted paper and board, separated at source).

Table 7. The unit support fee for metals from incineration and composting.

	Incineration (€/t)	Composting (€/t)
Steel	12	45
Aluminium	75	230

Moreover, the tax or rate-payers contributions also partially fund the cost of municipal waste collection and treatment (in particular, packaging waste), as seen in Fig. 3 [29].

In France, local authorities can opt to finance the services through a tax or a fee on household waste disposal and/or through their general budget [26].

Data and Methodology

The methodology used is based on an economic-financial balance between the costs and benefits allocated to the activities of selective collection and sorting of packaging waste, carried out by local authorities. On the costs side, we accounted for the operational and maintenance costs, the costs of financing fixed assets allocated to the activities mentioned above (which may be left out in a strictly financial analysis), as well as the depreciation of these fixed assets. On the benefits side, we considered the FSLA (provided by Eco-Emballages), the sale of packaging waste materials (through the different take-back schemes), the financial support and sale of non-packaging waste materials (such as newspapers and magazines) and government grants (where applicable) [30]. Furthermore, the savings from the diversion of packaging waste of refuse collection circuits and landfilling were also considered as another economic benefit (which may also be left out in a strictly financial analysis). The results obtained will be represented in a standard graphic, as shown in Fig. 4 [31].

The variables indicated in Fig. 4 were calculated based on the information gathered in the account and activity reports (for the year 2010) of 45 French local authorities. The opportunity costs ("other benefits") were determined by considering the refuse collection and other types of treatment and disposal costs according to the following equations:

$$\text{Costs avoided with refuse collection} \left(\frac{€}{\text{year}}\right) = \qquad (1)$$
$$\text{Quantity of waste selectively collected} \times \text{Unit cost of refuse collection}$$

Table 8. Take-back prices in 2010.

Material	Option Filières	Option Federations		Option Individual	
	Price	Avg Price	Price Range	Avg Price	Price Range
	(€/ton)	(€/ton)	(€/ton)	(€/ton)	(€/ton)
Steel from selective collection (packs)	111.6	126.4	79-174	159.3	124-195
Steel from bottom ashes	41.5	49.3	6-93	69.1	47-92
Aluminium from selective collection	451	499.3	348-651	337.9	205-471
Aluminium from bottom ashes	552	635.8	573-698	n.a.	n.a.
Plastics	196.3	189.6	151-229	n.a.	n.a.
Paper/cardboard	72.3	75.6	55-96	51.4	35-68
Glass	22.42	n.a.	n.a.	n.a.	n.a.

n.a. – not available

Costs avoided with waste treatment $\left(\dfrac{€}{year}\right)=$ (2)

Quantity of waste recovered × Unit cost of treatment and disposal

Regarding the unit costs of refuse collection and treatment/disposal, we assumed the averages (Table 9) stated in the Eco-Emballages' study [16]. In addition, we also considered the sorting efficiencies taking into account the different types of collection, as mentioned in '*The Life Cycle of Packaging Waste*,' to estimate the quantities of waste rejected. In France, the material rejected during sorting is usually sent for incineration, which is an unavoidable cost. Hence, the cost of rejected treatment was included in our variable "operational costs." Finally, the return on capital employed was calculated through equations (3) and (4):

Return on capital employed $\left(\dfrac{€}{year}\right)=$ (3)

(Depreciation − subsidies) × Useful life of the assets × WACC[3]

WACC (%) =   (4)

Cost of equity $\times \dfrac{\text{Equity}}{(1 - \text{marginal corporate tax})}+$ Cost of debt × Debt

Considering the following values:
- Useful life of the assets = 9.6 years
- Cost of equity = 6%
- Equity in the capital structure = 19%
- Marginal corporate tax = 11.1%
- Cost of debt = 4.5%

The Costs and Benefits of the French Recycling System

The results of the balance between the economic and financial costs and benefits of selective collection and sorting activities are shown in Fig. 5 (weighted average). The results were weighted by the tons of packaging waste collected for each of the 45 French local authorities. Two different analyses were performed, the first is based on the packaging waste collected (the one internationally used) and the second on the packaging waste taken back, taking into account the services' efficiency (this allows us to know the real cost of each ton of packaging waste that gets recycled).

Obviously, the costs and benefits per ton taken back are significantly higher (about 60%) than the cost per ton collected. In the first case, local authorities benefited 526 € per ton of packaging waste sorted and sent for recycling in 2010. In a strictly financial perspective (not taking into account the opportunity costs), the benefits represented only 223 € per ton. On the other hand, each ton of packaging waste sent to the recycling system of local authorities had a total cost of 389 €. Based on tons collected, the economic costs and benefits are 232 € per ton and 314 € per ton, respectively.

From Fig. 6 we may observe that the overall cost of sorting is 142 € per ton collected, effectively sent for sorting, and the overall cost of selective collection is 144 € per ton collected. These results suggest that the recycling costs (selective collection + sorting), mainly of paper/cardboard and plastic/metal flows, will increase significantly compared with the costs of glass flow, which is unsorted.

Benefits account for around 135% of total cost from an economic perspective, but only 57% of total cost if the cost savings owing to recycling are not taken into account. Assuming that the financial transfers should follow an economic approach, the FSLA for 2011 could be eliminated. If the industry was entirely responsible for processing their packaging waste, and excluding government grants (Fig. 7), the sustainability of the service would require an increase of 125% of the FSLA and the public money could be invested in other services.

According to our analysis, we can also conclude that on average the FSLA only covered 35% of the packaging waste services costs in 2010, when the Eco-Emballages funding model set a cost recovery of the optimized service of 60%. However, note that the costs conveyed by the local authorities in their annual reports do not correspond to the ones defined as "benchmark costs" (i.e. local authorities might not be operating efficiently [32]).

Complet cost of
public service of

Sale of industrial products

Fig. 3. General funding scheme of household waste collection and treatment.

[3]Weighted average cost of capital

Table 9. Values used in the methodology.

Unit costs of refuse collection	85 €/t
Unit cost of other treatment (incineration, landfill, MBT)	96 €/t
Sorting efficiency:	
Glass	99%
BCMPJ	80%
BCMP	80%
BMP	76%
CJ	95%
J	98%

Critical Discussion and Policy Implications

Our calculations are based on historical data retrieved from the audited annual reports of 45 local authorities. However, to assess the sensitivity of the results to changes on the "other benefits" and "return on capital employed" components, we changed the underlying variables by 10% (in a direction that would create higher imbalances between total costs and benefits). Changing these variables does not have a significant impact on the balance between costs and benefits. In fact, increasing the cost of equity or the amount of equity in the capital structure by 10% has practically no impact on total costs. However, if the useful life of the assets or the cost of debt increased 10%, total costs would also increase by around 0.5%. In a scenario where the unit

Fig. 4. The benefits and costs of recycling in France.

costs of refuse collection and other waste treatment (used to estimate the opportunity costs) were 10% lower, total benefits would decrease about 5.7% (i.e. from an economic perspective, the cost coverage would decrease to 129%).

As we have pointed out, the current study does not account for the environmental costs and benefits involved in the several possible final destinations for packaging waste. We believe, however, that this does not hinder the significance of our results. According to the PPW Directive, the (efficient) costs undertaken by waste management operators with the selective collection and sorting of packaging waste should be covered by the industry (environmental factors that were not converted into taxes or prices do not enter the equation). Whether the industry should cover these costs from an economic or a financial perspective is a major part of the discussion (that should be decided and clarified by EU policy-makers). We believe this paper makes a useful contribution to this discussion. In truth, consumers pay for the extra costs of recycling either through higher waste management tariffs, higher taxes (when tariffs do not cover 100% of the costs), higher prices of packaged products, or a combination of these. Thus, an estimation of the potential environmental benefits attained through recycling is useful to compare these benefits with consumers' willingness to pay (which is not the objective of this study).

Very few studies make an analysis similar to the one carried out in this paper. Nevertheless, some recent results highlight the same issues demonstrated by our results, mainly [31]:

(1) the imbalance between the costs undertaken with selective collection and sorting and the funds coming from the industry

(2) the savings that waste management operators attain from a global perspective because of the packaging waste diverted from landfills

(3) the difficulty to devise a system that ensures that costs reported by local authorities are efficient (since the industry is not responsible for the inefficiencies of the waste management system)

In France, the implementation of the PPW Directive has been relatively successful (at least in terms of recycling rates). Local authorities have been effectively encouraged to educate their citizens so they can adopt better practices in terms of urban waste management. In this regard, a new agreement (called Barème E) between Eco-Emballages and local authorities was established to tackle the new recycling targets (75% until the end of 2012) imposed by national legislation (the Grenelle Act). This national effort aims to adjust the mechanism of financial support for local authorities to encourage a better performance of waste collection and treatment of public services in the next years [26]. The incentives toward efficiency and effectiveness embedded in the financial support scheme are good practices that should be considered by other EU countries (e.g. selective collection support, citizen awareness support, support for the sustainable development of the performance of the selective collection, support for the performance of recycling, and support for other recoveries beyond selective collection).
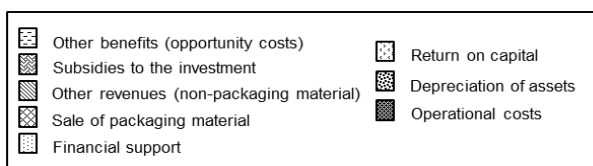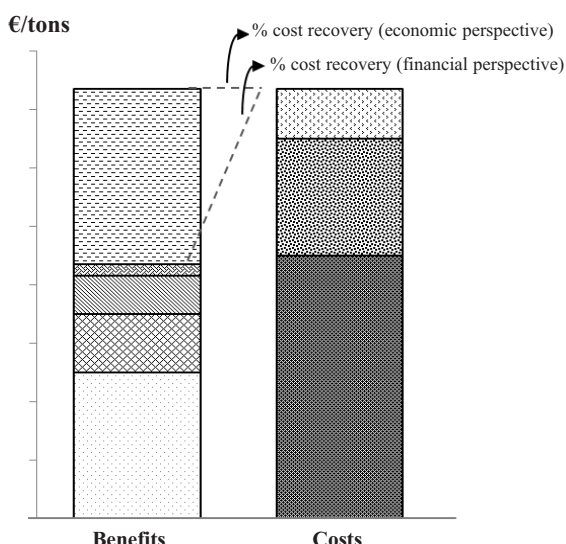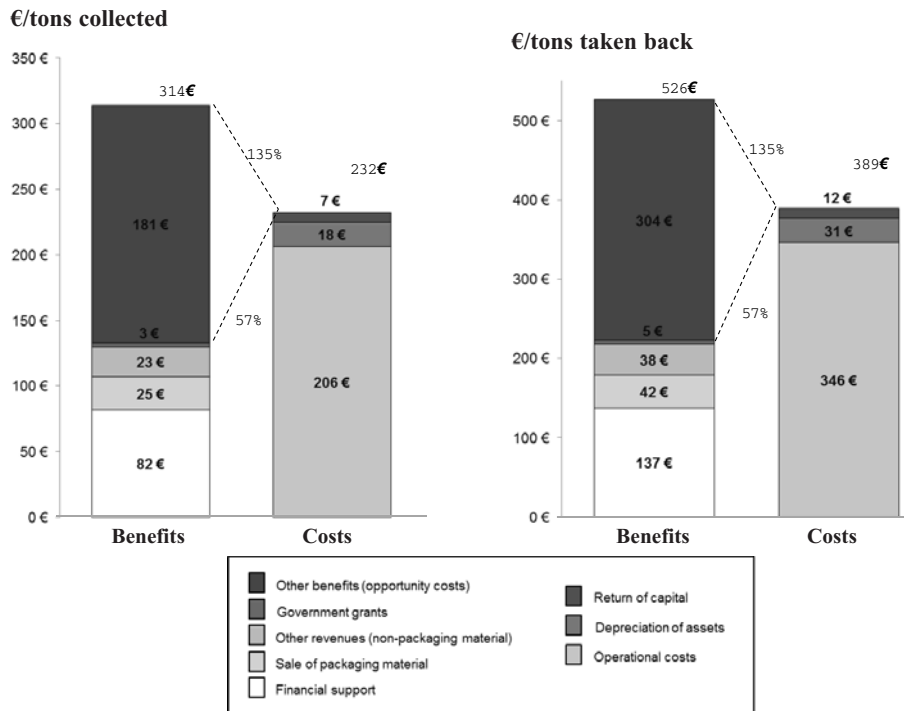
€/tons collected

€/tons taken back

Fig. 5. Service cost recovery considering quantities collected and taken back.

Conclusions

This study presents the costs and benefits of packaging waste recycling in France. It describes the methodology implemented and considers two components that are usually not accounted for in a strictly financial analysis. Indeed, the return on capital employed (debt and equity) regarding the financing of the assets allocated to the packaging waste services and the opportunity cost of refuse collection and landfilling are often excluded from these assessments.

The evaluation of the opportunity cost (of not recycling) in the economic-financial balance of selective collection and sorting of packaging waste seems particularly relevant for France, as the cost of refuse collection and waste treatment avoided with packaging recycling are significant (181 € per ton collected). Adopting this perspective, one might conclude that the financing model of the French "recycling system" was sustainable in 2010. In contrast, adopting a strictly financial approach (arguably, the approach prescribed by the PPW Directive), the results suggest that industry only covered around 56% of
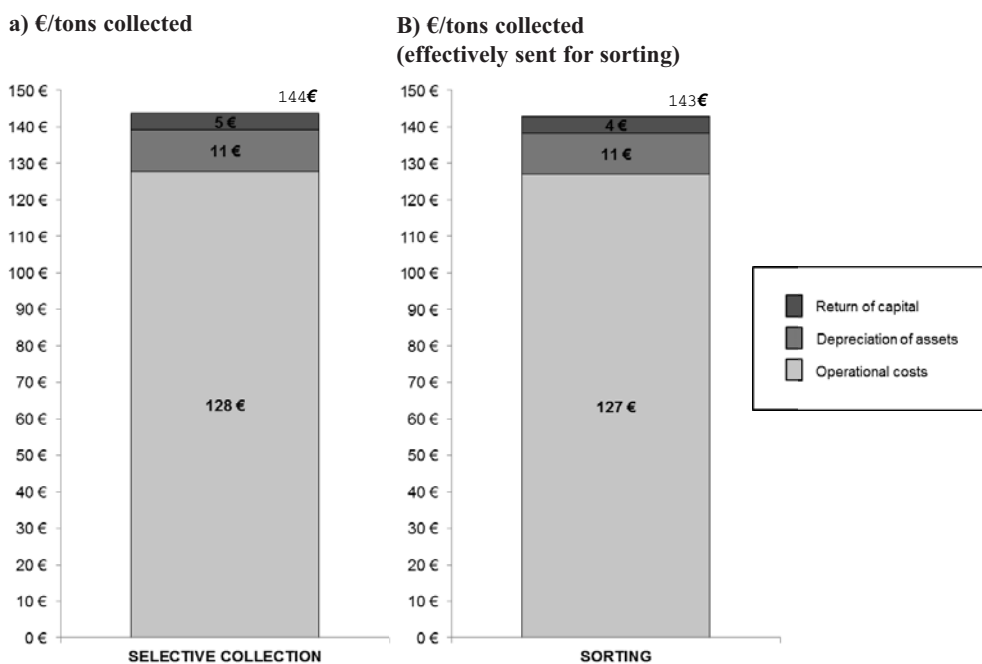
a) €/tons collected

B) €/tons collected
(effectively sent for sorting)

Fig. 6. Cost of a) selective collection and b) sorting for recycling system.

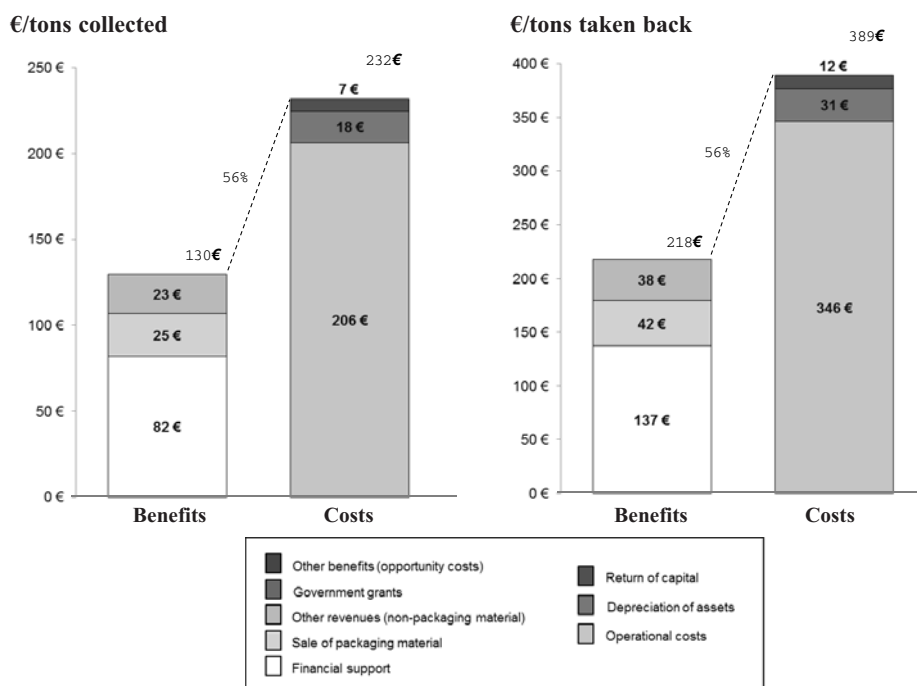€/tons collected

€/tons taken back

Fig. 7. Cost recovery of local authorities excluding subsidies and other benefits.

the total service costs. Thus, this paper poses two pertinent questions:

(1) Should the costs of the 'recycling system' be entirely borne by the industry?

(2) Should public money be allocated to the collection and sorting of packaging waste?

Finally, we highlight that public authorities should protect the environment and municipalities ought to educate their citizens so they can adopt better practices in terms of municipal waste management [33]. In this sense, the (new) Barème E was established between the Eco-Emballages and local authorities to foster a better performance of waste public services for the coming years.

Acknowledgements

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