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## Systems of Packaging Waste Recycling in the EU: Comparing Five Different Case-Studies

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# *Systems of Packaging Waste Recycling in the EU: Comparing Five Different Case-Studies*

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## **Abstract**

All European Union (EU) member states have to comply with the demanding recycling rates targets that were set for the recovery of packaging waste in the Directive 94/62/EC. Nevertheless, each country has its own system for accomplishing these targets. Some already had national legislation when the Directive entered into force. Others had to “start from scratch”. Indeed, many countries have experienced massive improvements in the waste management systems in the last years; these include the closing of dumps and the construction of complying sanitary landfills. The “maturity levels” of the waste management frameworks are different for the diverse EU countries. Evidently, this has consequences for the efficiency and effectiveness of the recycling system. Moreover, one can observe very different approaches for managing household packaging waste, although there is still a lack of evidence regarding the outperformance (if one considers economic and environmental aspects altogether) of any approach over another. This paper presents and discusses the pros and cons of the recycling systems of household packaging waste for five EU countries, namely: France, Germany, Portugal, Romania and the UK. We compare institutional frameworks, recycling rates, green dot fees and, whenever possible, recycling costs and benefits (i.e. the costs of selective collection and sorting on the one hand, and the financial transfers performed by the industry along with the product of the sale of recyclables on the other). To provide a verdict on the overall performance of any system is not straightforward. We are, however, able to underline several of the national best practices.

**Keywords:** France; Germany; green dot; packaging waste; Portugal; recycling; Romania; UK.

## **INTRODUCTION**

Waste is defined by the Waste Framework Directive (75/442/EEC), as “any substance or object which the holder disposes of or is required to dispose of”. This Directive was last amended in 2008 (2008/98/CE) where the definition of waste remained the same. With the amount of waste accumulating in dump sites, European Union (EU) authorities realized that new waste management strategies were required to protect the environment and public health. However, due to the many tasks involved (e.g. collection, sorting, storing, treatment and/or final disposal), the several origins of waste (e.g. households, small and medium-sized

businesses, healthcare premises, industry and agriculture) and the vast array of stakeholders (e.g. local and national authorities, manufacturers, packers and fillers, retailers and citizens/customers), waste management is a fairly complex issue (Walls, 2005). In 2010, the EU member states produced over 252 million tons of municipal waste<sup>1</sup>, representing around 502 kg *per capita*.<sup>2</sup>

The rise in the rate of waste production over the last decades has had strong implications in the European waste management policy.<sup>3</sup> In fact, European member states have been dedicating special attention to diverting waste from landfills. The particular case of packaging waste was emphasized due to the escalating tipping fees and taxes, the environmental impacts of landfilling this type of material (e.g. a significant portion of packaging waste is non-biodegradable) and the possibility of using this waste as a resource (avoiding the consumption of raw material).

Since the publication of Directive 94/62/EC on packaging and packaging waste (PPW), practically all member states have been undertaking major investments in their recycling systems (e.g. in selective collection and sorting equipment and infrastructure).<sup>4</sup> According to the Extended Producer Responsibility (EPR) principle (an overriding principle of the PPW Directive), all economic operators placing packaging on the market are responsible for their management and recovery.<sup>5</sup> In addition to the possibility of developing their own packaging waste management system (this must be approved by each National Waste Authority) to comply with the recycling and recovery targets laid down by the European law, producers of packaging waste can transfer their responsibility to another entity (e.g. a Green Dot company). Traditionally, Green Dot companies are created as an initiative of the industry.<sup>6</sup> In general, these entities are responsible for managing the logistic chain of packaging waste. The producers of packaged products pay a financial contribution for their packaging and, in return,

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<sup>1</sup> “Municipal waste consists to a large extent of waste generated by households, but may also include similar wastes generated by small businesses and public institutions and collected by the municipality” Eurostat).

<sup>2</sup> Eurostat (2012). Eurostat News Release 48/2012: Environment in the EU27. Eurostat Press Office, Luxembourg.

<sup>3</sup> Bailey I (1999). Flexibility, harmonization and the single market in EU environmental policy: The packaging waste Directive. *J Common Mark Std* 37:549-571

<sup>4</sup> One should note, however, that some countries already had national legislation on recycling/recovery of packaging waste (e.g. Germany was the forerunner on producer responsibility schemes). Furthermore, the particular case of Denmark, where no EPR system is enforced and a deposit system runs for beverage packaging, should also be highlighted.

<sup>5</sup> OECD (2001). *Extended producer responsibility: A guidance manual for governments*. OECD, Paris

<sup>6</sup> ARGUS (2001). *European Packaging Waste Management Systems. Final Report*, European Commission, Brussels, Belgium

transfer away their responsibility to manage and recover the waste (and, in most cases, they earn the right to put a “green dot” trademark on their packaging).

Although the ultimate goal (the recovery and recycling targets as described in the PPW Directive) is similar for all member states, the actual strategies for achieving the targets vary considerably from country to country.<sup>7</sup> Taking this into account, this paper analyzes the institutional frameworks and recycling systems of five European countries, namely, France, Germany, Portugal, Romania and the UK. Currently on different “maturity stages”, these five cases are representative of the overall reality in the European Union. Most countries have publicly-owned utilities responsible for the collection, sorting, treatment and final disposal of urban waste (including packaging waste).<sup>8</sup> Usually, these waste management operators receive a financial support from the Green Dot company to compensate for activities such as selective collection and sorting. The unit values of the financial support and the overall functioning of the systems are often prone to some criticism. To address this issue, we carry out an economic analysis on the costs and benefits of recycling in France, Portugal and Romania for the year 2010.<sup>9</sup> By comparing and contrasting the costs and benefits undertaken by waste management operators in these countries, we are able to provide an assessment of the added costs of recycling and to account for the influence of different systems.

The paper is organized as follows: after this introduction the main figures of packaging waste recycling are presented along with a broad description of the national EPR schemes for the five countries studied; this section also presents the methodological approach adopted in the estimation of the costs and benefits of recycling for France, Portugal and Romania (which have similar EPR schemes). The third section contains the results, their discussion and some normative stances that derive from the analysis. The concluding remarks are presented in the fourth and final section.

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<sup>7</sup>European Commission (2006). Implementation of Directive 94/62/EC on packaging and packaging waste and its impact on the environment, as well as on the functioning of the internal market. Report from the Commission to the Council and the European Parliament, European Commission, Brussels

<sup>8</sup> Municipalities or regional authorities are generally in charge of waste management. These public authorities might, nevertheless, contract out these services. In any case, the ultimate responsibility lies with the public sector (as the provider of this essential service).

<sup>9</sup> As discussed in the following section, due to the competitive nature of the recycling schemes in Germany and the UK, it was not possible to obtain reliable data regarding financial costs and benefits of recycling for these countries.

## MATERIAL AND METHODS

### Recycling of packaging waste in numbers

The variation of municipal waste produced in European countries is substantial, ranging from 304 *kg per capita* in Latvia up to 778 *kg per capita* in Cyprus (Eurostat 2010 data). For the countries analyzed in this paper the municipal waste generated per person in 2010 was the following: 532 *kg* in France, 593 *kg* in Germany, 514 *kg* in Portugal, 365 *kg* in Romania and 521 *kg* in the UK. To some extent, the European policies aimed at dissociating waste production from economic growth have been successful given that in 10 years (1998 to 2008, just before the economic crisis) waste generation only grew 9% while GDP increased 55% for the 27 EU countries (EU-27).

In 2010, a total of 147,5 million tons of municipal waste was landfilled or incinerated in the EU-27 (see table 1). Of that amount, only 25% was recycled. Of the five countries analyzed in the present paper, Germany achieved the highest recycling rate (around 44,6%) and the lowest landfill rate (only 0,4% of all municipal waste was landfilled).

Table 1– Municipal waste production and treatment in 2010

	<b>Waste generated</b> (10 <sup>3</sup> tons)	<b>Landfilled</b> (10 <sup>3</sup> tons)		<b>Incinerated</b> (10 <sup>3</sup> tons)		<b>Recycled</b> (10 <sup>3</sup> tons)		<b>Composted</b> (10 <sup>3</sup> tons)	
EU-27	252.095	93.527	37,1%	53.975	21,4%	60.809	24,1%	35.936	14,3%
France	34.535	10.745	31,1%	11.730	34,0%	6.143	17,8%	8.234	23,8%
Germany	47.691	186	0,4%	18.020	37,8%	21.251	44,6%	5.917	12,4%
Portugal	5.464	3.335	61,0%	1.058	19,4%	630	11,5%	395	7,2%
Romania	7.830	6.214	79,4%	0	0,0%	79	1,0%	4	0,1%
UK	32.450	15.870	48,9%	3.750	11,6%	8.050	24,8%	4.550	14,0%

A generalized drop in landfill capacity combined with a high volume of household waste in Europe led to a “silent revolution” of EU waste legislation starting in the 1970s. The waste hierarchy (prevention, reuse, recycling, energy recovery, and, at last, disposal) was first introduced by the Waste Framework Directive (1975). It was also during this decade that several important concepts, such as the “polluter pays” principle, were set as major guidelines of the EU waste management policy. However, it was in the 1990s (and early 2000s) that several decisive Directives were published to frame waste management in Europe. The PPW Directive (94/62/EC) was perhaps the one that had higher impacts both for the industry (manufacturers, packers, fillers, etc.) and waste management operators. The development of this piece of legislation was, to a great extent, influenced by the German Packaging Waste

Ordinance.<sup>10</sup> Indeed, the PPW has two main drivers: (1) reduce the impact of packaging waste on the environment, while (2) ensuring the functioning of the European market (both of packaged products and of packaging waste). The PPW Directive and the targets set for all member states were updated in 2004 (see table 2).

Table 2 – Recycling and recovery targets (by weight of packaging waste) for EU member states

Directive	Deadline	Recovery targets	Overall	Recycling targets				
				Glass	Paper / Cardboard	Metals	Plastic	Wood
94/62/CE	31/12/2001	50% (65%)	25% (45%)	15%	15%	15%	15%	(–)
2004/12/CE	31/12/2008	60%	55% (80%)	60%	60%	50%	22,5%	15%

Note: maximum rates are shown in parenthesis.

The maximum recovery and recycling rates shown in table 2 were set to avoid distortions of the internal market and not hinder compliance by other Member States (caps can be exceeded if provisions are taken to prevent this). There were also exceptions to the deadlines mentioned in table 2 for Greece, Ireland and Portugal (mainly due to their specific features, such as the large number of small islands or the presence of rural and mountain areas). For these three countries the 2001 targets should be attained by the end of 2005, while the de 2008 targets should be attained by the end of 2011. The new European member states were allowed to postpone the targets of PPW Directive.<sup>11</sup>

Table 3 contains data on the generation of packaging waste for the EU-27 and for the five countries analyzed in this paper. Some of the official figures presented for the case of Romania are somewhat unexpected. For instance, there is no clear explanation for the difference observed for the quantity of packaging waste as a fraction of municipal waste. Could it be the case that the data available for this country is being biased due to the “free-riding” problem? Packers/fillers or other economic operators covered by the EPR principle that do not declare their packaging (and do not pay the license fees to the entities in charge of managing the logistic chain of packaging waste recycling, e.g. Green Dot companies) are

<sup>10</sup>Eichstadt T, Kahlenborn W (2000). Packaging Waste: German Case Study. Final report for TEP project, European Commission Framework Programme IV, Ecologic - Centre for International and European Environmental Research, Berlin  
<sup>11</sup> No later than 31 December 2012 for the Czech Republic, Estonia, Cyprus, Lithuania, Hungary, Slovenia and Slovakia; 31 December 2013 for Malta and Romania; 31 December 2014 for Bulgaria and Poland; and 31 December 2015 for Latvia.

commonly called free-riders. This phenomenon undermines the whole economic sustainability of the systems and creates market distortions.<sup>12</sup>

Table 3 – Packaging waste generated in 2009. Source: Eurostat.

	Packaging waste (all materials)			Paper & cardboard	Plastic	Wooden	Metallic	Glass
	(tons)	(kg per capita)	% municipal waste)	(% packaging waste)	(% packaging waste)	(% packaging waste)	(% packaging waste)	(% packaging waste)
EU-27	76.590.310	153,1	30	39	19	15	6	21
France	12.277.691	190,3	36	36	15	20	5	19
Germany	15.052.100	183,8	31	44	17	14	5	23
Portugal	1.719.274	161,7	31	41	22	6	6	25
Romania	998.690	46,5	13	27	29	19	6	24
UK	10.786.827	174,5	33	35	23	10	8	18

As can easily be observed in figure 2, the PPW Directive led to an impressive increase of the recycling rates of all Member states. In fact, all countries have transposed this directive into national legislation. The actual operational approaches, however, can differ significantly from country to country. The countries that already had recycling legislation in force before the enactment of the PPW Directive are easily recognized (the ones with high recycling rates early on).

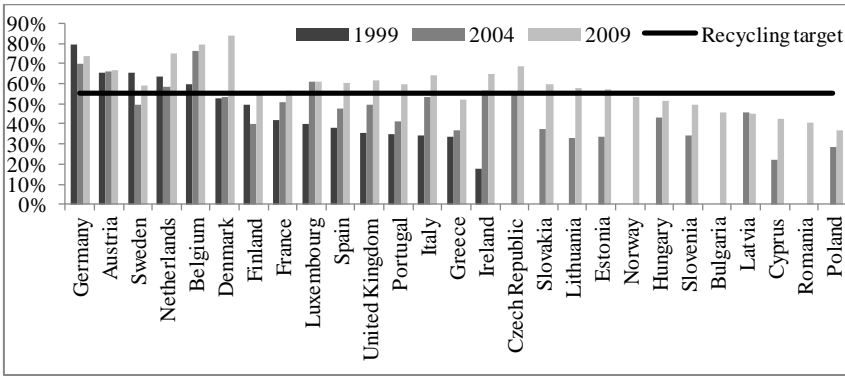


Figure 1 – Packaging waste recycling rates in 1999, 2004 and 2009 in EU-27. Source: Eurostat.

Most countries comply with the overall recycling target. Details regarding recycling in the five countries analyzed in this paper are presented in table 4. Germany is a recycling “champion”, France, Portugal and the UK are “average” countries, and Romania is a “newcomer” (note that the most recent data report to 2009 and the deadline for this country is 2013).

<sup>12</sup>Yau Y (2010). Domestic waste recycling, collective action and economic incentive: The case in Hong Kong. Waste Management, 30, 2440-2447.

Table 4 – Packaging waste recycled in 2009

	Packaging waste (all materials)		Paper & cardboard	Plastic	Wooden	Metallic	Glass
	(tons)	(%)	(%)	(%)	(%)	(%)	(%)
EU-27	47.824.672	62,4	83,3	32,2	37,7	69,4	67,7
France	6.924.754	56,4	85,6	25,0	12,9	64,3	68,1
Germany	11.058.240	73,5	91,1	48,4	30,8	91,7	82,5
Portugal	1.030.551	59,9	79,5	25,5	65,3	64,4	55,3
Romania	404.200	40,5	68,7	23,8	13,2	56,4	48,2
UK	6.662.316	61,8	83,9	24,1	76,9	54,9	61,7

Note: recycling rates not respecting the targets of the PPW Directive are italicized.

## Institutional and regulatory framework of the case-studies

### *France*

In France the PPW Directive was transposed into national legislation in 1994. According to this legislation, each producer/importer placing packaged goods in the market had to inform the Agency for Environment and Energy Management about the quantity of packaging waste generated each year. Moreover, these economic operators had to (1) carry out collection through a deposit system, (2) carry out collection and treatment of their packaging waste by themselves, or (3) transfer their take-back obligation to a compliance scheme.<sup>13</sup> Indeed, most producers of fast moving consumer goods opt to transfer away their responsibility for managing packaging waste to the Eco-Emballages group (the French Green Dot company).

Eco-Emballages is a non-profit organization that manages the logistics chain of household packaging waste on behalf of producers (packers, fillers, importers, etc.). Unlike other Green Dot agencies, Eco-Emballages does not have any intervention on packaging waste of industrial products.<sup>14</sup> Eco-Emballages supports the selective collection and sorting of household packaging waste through contracts with the local authorities that are responsible for waste management operations. In 2010, this company had firmed contracts with 1.167 local authorities representing 36.312 municipalities. The financial support provided to local authorities comes from the financial contributions of economic operators (the Green Dot fee). The Green Dot fee has 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 on the market by the respective fee (that differs with the type of material, as table 5 shows). In 2010 the unit fee depended on the value achieved for the weight fee. If the weight fee was greater

<sup>13</sup>EIMPack (2012b). The Economics of Packaging Waste Recycling: The Case of France. EIMPack project, Instituto Superior Técnico, Lisbon

<sup>14</sup> The non-household packaging waste flow has been supported directly by recyclers. In 2008, around 63% of the packaging placed on the market was non-household packaging and more than 50% was recycled.



than or equal to 0,0014€, the unit fee was a flat rate of 0,0014€. If the weight contribution was lower than 0,0014€, the unit fee was equal to the weight contribution and the total fee was twice the weight fee.<sup>15</sup> The unit fee had the goal of encouraging industry to produce more environmental friendly packages.

Table 5 – Green Dot fees in France for 2010

Fees by packaging material	(€/ton)
Glass	4,5
Plastic	222,2
Paper and cardboard	152,6
Steel	28,2
Aluminum	56,6
Others	152,6

According to the French system in 2010, the financial support for local authorities (FSLA) should cover 60% of the efficient benchmark costs of the selective collection and treatment services carried out by waste management operators.<sup>16</sup> During this year, the FSLA was calculated based on their performance and on the take-back quantities for different packaging materials (see table 6).

Table 6 – FSLA in France for 2010.

Level	Performance (P) Kg/inh./year	Financial Support (S) in €/ton					
1	$P \leq N_b$						
2	$N_b < P \leq N_h$						$S_p$ – plafond support; $S_i$ – intermediary support; $S_b$ – bottom support;
3	$N_h < P \leq N_p$						$N_b$ – lower level; $N_h$ – high level;
4	$P > N_p$						$N_p$ – plafond Level.
	Material	$N_b$	$N_h$	$N_p$	$S_b$	$S_i$	$S_p$
	Steel	1	2	7	45	62,5	80
	Aluminium	0,1	0,2	1	230	280	330
	Paper/Cardboard	4	8	18	120	200	280
	Plastic	1,6	3,2	8	310	575	840
	Glass	15	30	45	3	5	7
	EMR	4	8	18	60	100	140

In addition to this main financial instrument, other complementary supports are paid to local authorities by Eco-Emballages (e.g. for incineration with energy recovery). The remaining costs (the other 40%) should be covered by the sale of sorted materials and local taxes. The take-back prices for 2010 are presented in table 7 according to the type of trading system chosen by the local authorities (who own sorted packaging waste).

<sup>15</sup> When packages weighted more than 1kg their contribution to the “weight fee” was limited to 1kg.

<sup>16</sup>Eco-Emballages (2011).Annual and Sustainable Development Report 2010.Eco-Emballages, Paris.

Table 7 – Take-back prices in France for 2010.

Material	Option Filières	Option Federations		Option individual	
	Price (€/ton)	Average (€/ton)	Range (€/ton)	Average (€/ton)	Range (€/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
Aluminum from selective collection	451	499,3	348-651	337,9	205-471
Aluminum from bottom ashes	552	635,8	573-698	<i>n.a.</i>	<i>n.a.</i>
Plastics	196,3	189,6	151-229	<i>n.a.</i>	<i>n.a.</i>
Paper/cardboard	72,3	75,6	55-96	51.4	35-68
Glass	22,42	<i>n.a.</i>	<i>n.a.</i>	<i>n.a.</i>	<i>n.a.</i>

### Germany

The PPW Directive was transposed into German legislation by the Packaging Ordinance of 21 August 1998. However, Germany had already packaging legislation in force before the Directive was enacted (the Ordinance on the Avoidance of Packaging Waste of 1991). Germany has set higher targets than the PPW Directive regarding household sales packaging through the 5<sup>th</sup> amendment of the Packaging Ordinance in 2009. The minimum recycling targets for each material of household sales packaging established in the Packaging Ordinance are the following: paper/cardboard (70%), glass (75%), aluminum (60%), tinplate (70%), plastic (36%), and composites (60%). Sales packaging is defined in the Packaging Ordinance as “the packaging that is made available as a sales unit and arises at the final consumer (...) shall also include such packaging provided by retailers, restaurants and other service providers as facilitates or supports the transfer of goods to the final consumer”.

In Germany, packaging manufacturers and distributors of packaging are completely liable for their waste and have to comply with a system that ensures its recycling and recovery operations. In this regard, the Der Grüne Punkt – Duales System Deutschland GmbH (DSD, the German Green Dot company and the first of its kind) was created in 1990 as a non-profit agency.<sup>17</sup> The recycling system is 100% financed by the industry. There is no public money financing the selective collection and sorting of packaging waste. A dual (separate) system for the collection was established for managing packaging waste. Until 2004, DSD coordinated the packaging waste collection with the local authorities across the country and was responsible for the sorting and recovery of all sales packaging.<sup>18</sup> In 2004 the market was liberalized and DSD was privatized (i.e. producers are no longer the shareholders, as in most Green Dot companies). The objective was to introduce competition in the recycling market.

<sup>17</sup>DSD (2011). Der Grüne Punkt - Duales System Deutschland GmbH. <http://www.gruener-punkt.de>.

<sup>18</sup> DSD has been carrying out this activity by contracting private and municipal waste management companies (PRO-Europe, 2010).

Currently, there is a total of nine (for-profit) dual systems companies licensed to manage packaging waste. DSD continues to be the major player with the highest market share.<sup>19</sup>

The packaging waste management operations are financed by the license fees paid by the dual systems' clients (see table 8). DSD is the Green Dot company, however with nine dual system companies the use of the Green Dot marking is not mandatory and companies which want to use the symbol on their packaging have to pay a trademark fee in addition to the license fee based on the weight and material of the packaging. Note that, currently, license fees are not known for any of the dual systems for competition reasons. Likewise, the costs of managing packaging waste are also unknown to the general public.

Table 8 – License fees in Germany for 2010

<b>Material</b>	<b>€/ton</b>
Glass	74
Paper / cardboard	175
Tinplate	272
Aluminum, other metals	733
Plastic	1,296
Composites cartons with special acceptance and recycling guarantee	752
Other composites	1,014
Natural materials	102

Since 2004, DSD has tendered collection services and organized the collection infrastructure in three-year contracts which have been shared by the remaining dual systems. The cost sharing regarding packaging waste collection is performed on a market share basis. After collection, the waste is delivered to each dual system company (being processed in a transfer station), according to the corresponding market share. In Germany, unlike the other countries analyzed in this paper, all the costs and the responsibility for the packaging waste management were transferred to the industry.

*Portugal*

In Portugal, the PPW Directive was first translated into national legislation during 1997-1998. As in the other case-studies, the economic operators' responsibility can be transferred to a licensed company. The Sociedade Ponto Verde (SPV, the Portuguese Green Dot company) is a non-profit private entity responsible for the packaging waste management. This company was licensed in 1997 by the Ministers of Economy and the Environment to act on behalf of the

<sup>19</sup>EIMPack (2012a). Framework, Evolution and Economics of Packaging Waste Recycling: The Case of Germany. EIMPack project, Instituto Superior Técnico, Lisbon

economic operators regarding the management of municipal packaging waste. Later on, SPV extended its reach to the trade and industry packaging waste (the industrial flow).<sup>20</sup> However, the Portuguese law states that municipalities are the competent authorities regarding municipal waste management. In most cases, selective collection, sorting and waste treatment activities are carried out by public regional companies.<sup>21</sup> Economic operators pay a Green Dot fee that supports SPV's financial scheme. The Green dot fees are contingent on the material, weight and packaging classification (primary, secondary and tertiary). It depends also if it belongs to the household or industrial flow (see table 9).

Table 9 – Green Dot fees in Portugal for 2010 (municipal flow).

Packaging material (municipal flow)	Primary (€/ton)	Secondary (€/ton)	Tertiary (€/ton)
Glass	18,3	–	–
Paper and cardboard	86,3	35,2	7,0
Plastic	228,2	92,3	23,8
Composite Packaging	129,4	–	–
Steel	96,0	41,7	24,4
Aluminum	164,4	–	–
Wood	15,4	14,2	9,1
Others	260,0	260,0	260,0

The value paid by the SPV to the local authorities (FSLA) in 2010 is displayed in table 10. This payment is calculated according to the material and the *per capita* quantities of packaging waste selective collection and sorting by local authorities. The FSLA model is based on the efficiency of the waste management systems and their *per capita* potential (SPV, 2010). In table 10, X1 represents the national average of waste taken back carried out by the local authorities; X2 corresponds to the take-back *per capita* required to comply with the targets of the PPW Directive; X3 is the potential market for packaging (total packaging produced in Portugal divided by the population). There is one crucial difference on the Portuguese Green Dot system: once SPV pays the FSLA, it owns the packaging waste. Hence, SPV deals directly with recyclers regarding the selling of sorted packaging material.

### Romania

In Romania the PPW Directive was implemented through the Government Decision (GD) no. 621/2005 (amended by the GD no. 1872/2006 and GD no. 247/2011) on PPW management and through the Order no. 927/2005 on data reporting procedures regarding PPW. According

<sup>20</sup> The intervention of SPV on the industrial flow is only indirect (it mainly entails the collection of data through an “information and motivation fee”, see EIMPack, 2011).

<sup>21</sup> Cruz N; Simões P; Marques R, (in press). The hurdles of local governments with PPP contracts in the waste sector. Forthcoming in Environ Plan C

to the legislation “economic agents that place commercial packaging on the market are responsible for these packaging”. The recycling and recovery objectives can be achieved by the economic agents individually, through the collection of packaging waste produced or, once again, by delegating their responsibilities to an authorized company (compliance scheme). During this transitional period (ending in 2013), Romania has also national targets for the period 2005-2013 (see Table 11).

Table 10 – FSLA in Portugal for 2010.

Material	Kg/inhabit/year			€/ton		
	X1	X2	X3	P1	P2	P3
Glass	14,3	24,5	40,8	35,0	48,0	60,0
Paper/cardboard	8,0	10,0	15,0	122,0	136,0	149,0
Plastic	2,1	3,6	15,3	732,0	782,0	832,0
Steel	0,4	0,7	4,1	540,0	580,0	619,0
Aluminum	0,02	0,04	0,86	689,0	914,0	1155,0
Composite Packaging	0,3	1,8	3,0	693,0	741,0	788,0

Table 11 – Gradual increase of the Romanian recycling and recovery targets. Source: EIMPack (2012c)

Year	Recycling objective (%)	Recovery objective (%)	Recycling targets by material (%)				
			Paper/Cardboard	Plastic	Glass	Metals	Wood
2005	18	22	15	–	–	–	–
2006	26	32	15	–	15	15	–
2007	26	34	60	10	22	15	5
2008	33	40	60	11	32	50	7
2009	38	45	60	12	38	50	9
2010	42	48	60	14	44	50	12
2011	46	53	60	16	48	50	15
2012	50	57	60	18	54	50	15
2013	55	60	60	22,5	60	50	15

Currently, there are seven companies licensed for the management of packaging waste and to comply with the recycling and recovery targets. Eco-Rom Ambalaje (ERA) is the non-profit Green Dot company operating in Romania and is also the company with responsibility over the biggest share of the packaging placed on the market. ERA has been supporting the implementation of a selective collection system at the national level through contracts established with local authorities and municipal waste management operators. In order to achieve the national recycling and recovery targets, ERA also firms contracts with private companies that collect and recycle industrial and commercial packaging waste. All contracts entail a financial support for the packaging waste management services carried out. In exchange, they have to declare all the quantities of packaging waste collected and sent to recycling and recovery. In the household flow, a three-party agreement has been established between ERA, waste management operators and local authorities. The compliance schemes activity is financed by the license fees which are paid by the industry. According to the model

adopted by ERA for financing packaging waste management, the companies performing the waste management operations receive a financial support (called bonus payment). The Green Dot fees charged and bonus payment by ERA for the year 2010 are presented in table 12. These fees should cover the costs of collection and recycling/recovery services performed by authorized public and private companies.

Table 12 – Green Dot fees, bonus payment and average price per material in Romania for 2010.

<b>Packaging Material</b>	<b>Green Dot Fees (€/ton)</b>	<b>Bonus payment (€/ton)</b>	<b>Average price €/ton</b>
Glass	16,29	23,89	6,9
PET	21,47	32,40	333,5
Plastics	11,68	15,39	253,0
Cardboard paper	13,27	13,67	126,5
Steel	10,27	13,88	218,5
Aluminum	10,27	13,89	977,5
Wood	10,53	10,60	29,9

The costs of selective collection and treatment (including sorting and baling operations) are only partially supported by the Green Dot fees. Waste management companies also rely on the sales of sorted packaging waste material. These companies receive the payment directly from the recycling industry (see table 12 for the average price of recyclables in 2010).

### *The United Kingdom*

The goals of the PPW Directive were transposed into the UK legislation through the Producer Responsibility Obligations Packaging Waste Regulations in 1997. These regulations introduced the concept of shared responsibility by all economic operators involved in the life cycle of packaging. This includes importers of packaging, manufacturers of packaging and packaging materials, packers, fillers and retailers (thus, significantly different from what happens in other countries). This country has set more ambitious targets than the PPW Directive. In each step of the packaging life-cycle, the amount of packaging waste to be recovered depends on the class of the producer. Each class has a corresponding percentage (manufacturer 6%, convertor 9%, packer/filler 37%, seller 48%, secondary provider 85%, and service provider 85%) that is multiplied by the amount of packaging handled and the respective recovery and recycling targets.<sup>22</sup> The national recovery and recycling targets concerning packaging waste for the period 2010-2012 are presented in table 15.

<sup>22</sup> The amount of packaging waste to be recovered/recycled is equal to the coefficient of the producers class multiplied by the amount of packaging handled by the producer in the preceding year and the recycling/recovery target for that year.

Table 13 – National recovery/recycling targets in the UK.

Year	Recovery (%)	Min. recycling (%)	Recycling targets by material (%)					
			Paper	Glass	Aluminum	Steel	Plastic	Wood
2010	74	29	69,5	81	40	69	29	22
2011	74	29	69,5	81	40	71	32	22
2012	74	29	69,5	81	40	71	32	22

Once again, in the UK, local authorities are responsible for the collection of municipal waste and the development of waste management plans that encourage waste prevention and recycling.<sup>23</sup>The producers of packaging and/or packaging materials can transfer their responsibilities to an authorized company (compliance scheme). There is a total of 22 compliance schemes in the UK, where Valpak is (the Green Dot company) is one of many players. The economic operators (or the compliance schemes) have to prove that they respect the recovery and recycling obligations by submitting yearly certificates/statements of compliance and operational plans through an electronic database(the National Packaging Waste Database). Operational plans must contain information demonstrating that “sufficient financial resources and technical expertise will be available to enable the performance of the recovery and recycling obligations of the producer” as well as “how the recovery and recycling obligations will be performed as regards each of the packaging materials relevant to those obligations”.

Certificates/statements of compliance are obtained through the Packaging Recovery Note (PRN) system. The PRNs are issued by accredited reprocessors of packaging material. The economic operators which fail to meet their recovery and recycling obligations individually can “outsource” these obligations paying for an equivalent amount of packaging. The Packaging Export Recovery Notes (PERNs) are certificates issued by companies which export packaging waste to be treated abroad and they are also accepted as compliance proof regarding recovery and recycling obligations. At the beginning of each year, demand for PRNs is fixed and supply depends on the amount of packaging materials to recycle. The UK recycling system was thought to rely on competition. When the recycling capacity is reaching its maximum, the PRN price tends to increase and demand exceeds supply. This encourages more suppliers to enter into the market, increasing supply. Thus, it will also increase the collection and recycling rates, reducing the PRN price again. Average PRN prices, by type of

<sup>23</sup>Adams KT; Phillips PS; Morris JR. (2000). A radical new development for sustainable waste management in the UK: the introduction of local authority Best Value legislation. *ResourConservRecycl* 30:221-244

material, predicted by Valpak in 2010 are presented in Table 16. These prices are subject to change and represent the best-case scenario costs.

Table 14 – Average PRN prices for 2010 (€/ton).

Material	Average PRN price (€/ton)
Paper	3,80
Plastic	5,00
Glass	23,29
Steel	21,82
Aluminum	16,10
Wood	1,20

### Methodology implemented

The methodology applied to analyze the recycling systems of France, Portugal and Romania is based on an economic-financial model which compares the costs and benefits associated with selective collection and sorting activities. Our major aim is to answer the following question: are the extra-costs arising with the recycling of packaging waste being supported by the consumer (i.e. by the industry which reflects its costs on the price of the products) or by citizens in general (i.e. through higher waste management fees of local taxes)? The data concerns household packaging waste with the exception of Romania where the industrial flow was also considered (since it represents the biggest share of packaging waste managed by ERA).

Regarding the financial benefits, the items taken into account were: the FSLA (carried out by the compliance schemes), the sale of packaging materials, the sale of non-packaging materials (as non-packaging paper) and Government grants (where applicable). We also include in the analysis a benefit usually disregarded in strictly financial analysis:<sup>24</sup> the savings that derive from the diversion of waste from refuse collection and landfilling activities (“other benefits” or opportunity costs). This last component was calculated according to equations 1 and 2. The values used in these equations are presented in table 17.

$$\text{Costs avoided with refuse collection (€/year)} = \text{Quantity of waste selectively collected (ton/year)} \times \text{Unit cost of refuse collection (€/ton)} \quad (1)$$

<sup>24</sup> Pires JS (2011). Avaliação dos custos acrescidos com a recolha selectiva de embalagens. The Water and Waste Services Regulation Authority, Lisbon



$$\text{Costs avoided with waste treatment (€ /year)} = \frac{\text{Quantity of waste recovered (ton/year)}}{\text{Unit cost of treatment and disposal (€ /ton)}} \quad (2)$$

Table 15-Values used to estimate the “other benefits” of recycling.

Variable	Portugal	France	Romania
Unit costs of refuse collection	49 €/t	85 €/t	12 €/t
Unit cost of other treatment (landfill, incineration, etc.)	54 €/t	96 €/t	15 €/t
Efficiencies of sorting:			
Glass	95%	99%	90%
Paper/cardboard	93%	95%	45%
Other packaging	63%	76-80%	45%

Regarding the financial benefits, the items taken into account were: the costs of operation and maintenance, and the depreciation of fixed assets (in both cases, only concerning the selective collection and sorting activities). Once again, we include in the analysis a cost that is not always considered when public entities (in our case, local authorities) are carrying the investments: the return on capital employed (debt and equity) in the financing of fixed assets allocated to selective collection and sorting. This last parcel was calculated through equations 3 and 4.<sup>25</sup> The estimates for the variables are presented in table 18.

$$\text{Return on capital employed (€ /year)} = \text{Depreciation - subsidies (€ /year)} \times \frac{\text{Useful life of the assets (years)}}{\text{WACC (\% /year)}} \quad (3)$$

$$\text{WACC (\%)} = \text{Cost of equity (\%)} \times \frac{\text{Equity (\%)}}{\text{1 - corporate tax (\%)}} + \text{Cost of debt (\%)} \times \text{Debt (\%)} \quad (4)$$

Figure 3 shows the various variables assumed in the economic analysis. If one interprets the EPR policy present in the PPW Directive in a strictly manner, it seems that the first three parcels of the benefits (FSLA plus sale of sorted packaging waste plus sale of non-packaging material) should match all the (efficient) costs in figure 3. The costs and benefits were calculated based on quantities of packaging waste collected (i.e. unit costs and benefits). All data were collected through surveys and the annual account reports of waste management operators reporting to the year 2010. Our sample includes a total of 45 French local authorities in charge of selective collection and sorting of household packaging waste. These local authorities are supported by Eco-Emballages and cover about 20% of the French

<sup>25</sup>WACC – Weighted Average Cost of Capital.

population. In Portugal the data refers to all 27 local authorities covering the entire population. In Romania the data were obtained from the waste management operators belonging to the ERA system.

Table 16 – Values used to estimate the return on capital employed. Source: EIMPack<sup>26</sup>

Variable	Value	Observation
Useful life of the assets (years)	9,6	This value was achieved considering the assets and its depreciation. This value was weighted by the waste selectively collected.
Cost of equity (%)	6,0	This value takes into account a non-risk (of 3%) and a risk premium (of 3%, related to the German Treasury Bonds).
Equity in the capital structure (%)	19	This value was defined taking into account the weight that equity has on the capital structure of the utility (i.e. in relation to the liabilities). This value was weighted by the waste selectively collected.
Marginal corporate tax (%)	-	This value varies among the case studies
Cost of debt (%)	4,6	This value was achieved considering the average interests paid for the utilities' loans. This value was weighted by the waste selectively collected.

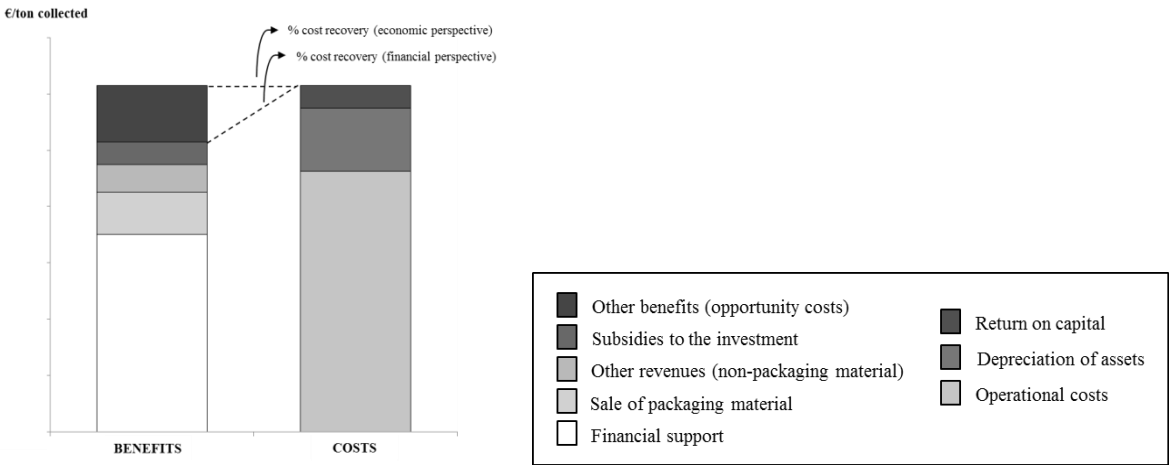


Figure 2 – Benefits and costs of recycling of packaging waste (waste management operators perspective).

### Results and discussion

We applied the methodology depicted in figure 3 to Portugal, France and Romania. The sale of packaging material was not considered for Portugal because SPV owns the packaging

<sup>26</sup>EIMPack (2012a). Framework, Evolution and Economics of Packaging Waste Recycling: The Case of Germany. EIMPack project, Instituto Superior Técnico, Lisbon.  
 EIMPack (2012b). The Economics of Packaging Waste Recycling: The Case of France. EIMPack project, Instituto Superior Técnico, Lisbon.  
 EIMPack (2012c). The Economics of Packaging Waste Recycling: The Case of Romania. EIMPack project, Instituto Superior Técnico, Lisbon

waste once it pays for the FSLA (that is why the magnitude of this parcel is higher for this country). Government grants (subsidies to the investment) were not considered in Romania due to the fact that the waste management operations are mainly performed by private companies. One should note that in this country most of the packaging waste collected comes from the industrial flow which is significantly less complex (and costly) than the household packaging waste flow (industrial packaging waste is usually much better separated at the source and the frequency of collection is optimized). Figure 4 illustrates the balance between the unit costs and benefits (regarding aggregated tons, i.e. all materials) of selective collection and sorting activities performed by waste management operators.

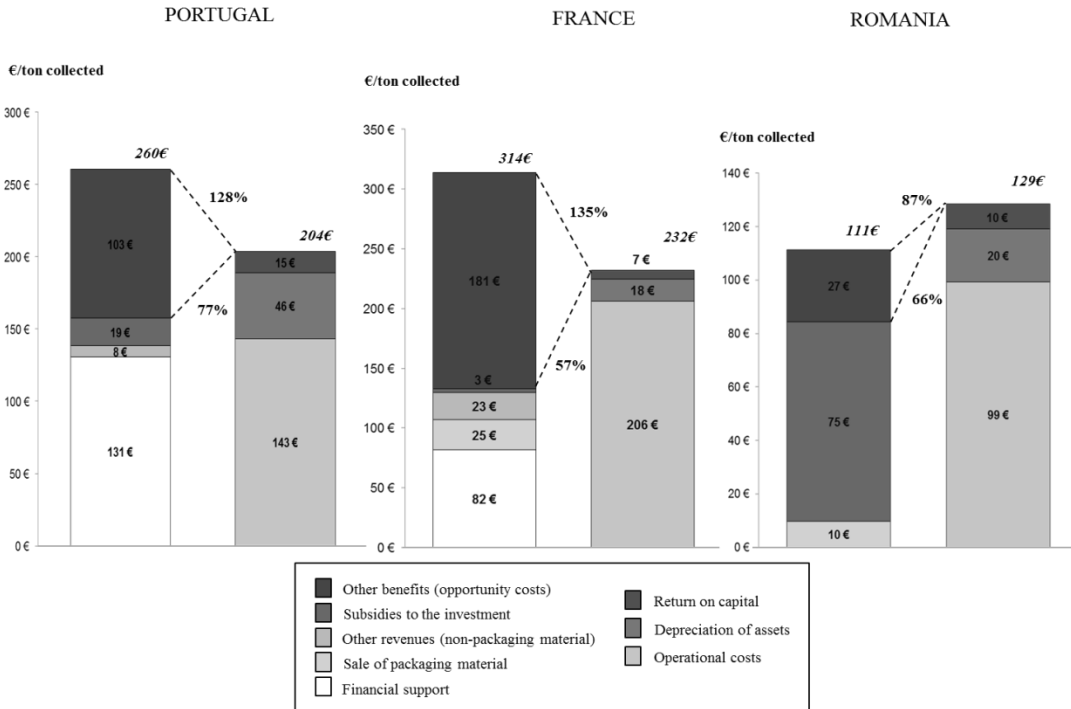


Figure 3 – Cost coverage considering aggregated tons.

Any assertions regarding the adequacy of the financial transfers carried out by the Green Dot companies depend on the perspective adopted. If one accepts that the savings attained by diverting waste from landfills (and incineration, etc.) should be accounted for as a benefit of recycling, then the financial support by the industry could be reduced (except in Romania). On the other hand, if the EPR principle was to be strictly followed, perhaps the transfers should increase. However, there is no indication about the cost-efficiency of waste management operators. In fact, it could be the case that operators are “dislocating” mixed waste management costs, expecting more funding from the industry. Furthermore, in most cases it is difficult to ascertain if operators are declaring “costs” or “prices” regarding

selective collection and sorting activities. The costs of packaging waste management (preparation for recycling) are shown in figure 5. One should bear in mind that glass is usually not sorted and has a high density (thus, sorting costs are mainly divided by the quantity of paper/cardboard and plastic packaging waste collected).

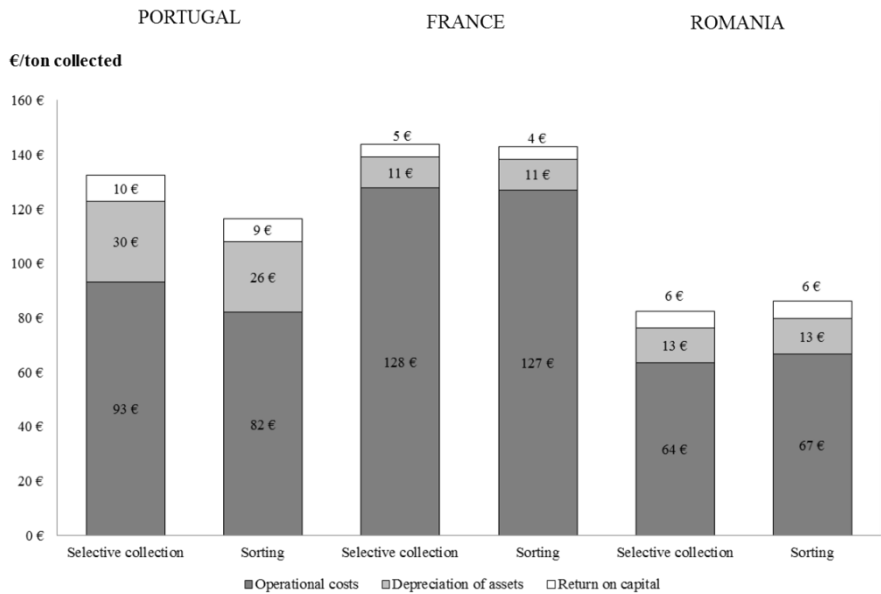


Figure 4 – Unit cost of selective collection and sorting per tons collected.

The unit costs of selective collection per type of household flow for Portugal and France are shown in figure 6. Plastic and metal household packaging waste is much more costly in general. For Romania it was possible to compute the operational costs for each type of packaging waste material (see figure 7).

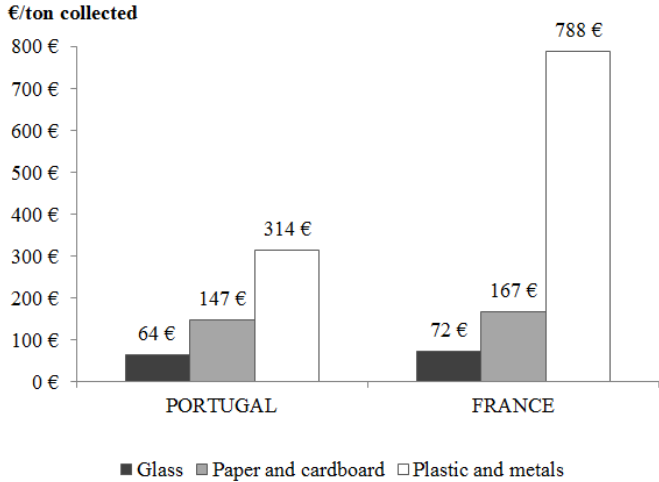


Figure 5 – Costs of selective collection per flow in Portugal and France.

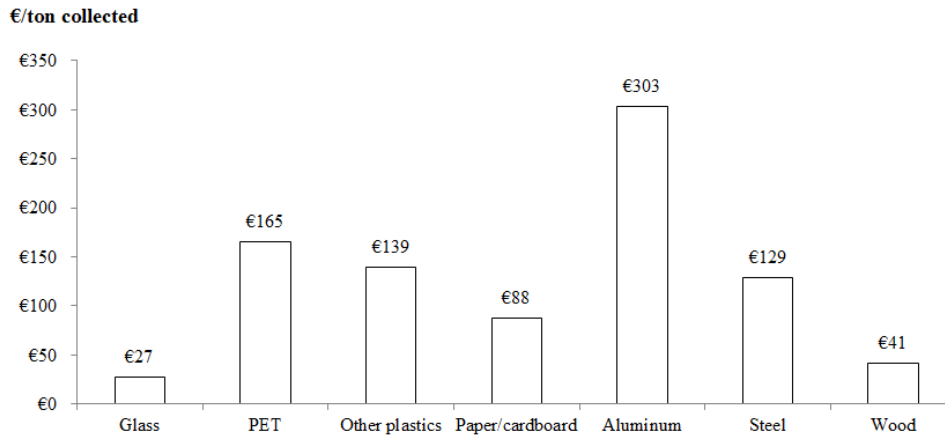


Figure 6 – Operational cost (collection and sorting) per packaging waste material in Romania.

In international comparisons, it is important to take into account the purchasing power parity (PPP) of each country. Hence, we also computed the costs and benefits of recycling with the adjusted values using World Bank indicators for 2010. These coefficients transform local currencies in international dollars taking into account the purchasing power of each country (thus correcting for some structural differences and rendering fairer results).

As one can see in figure 8, the PPP adjustment indicates that actually costs (and perhaps, inefficiency) are higher in Romania and lower in France. Conversely, benefits (and the financial support from the industry) seem to be higher in Portugal.

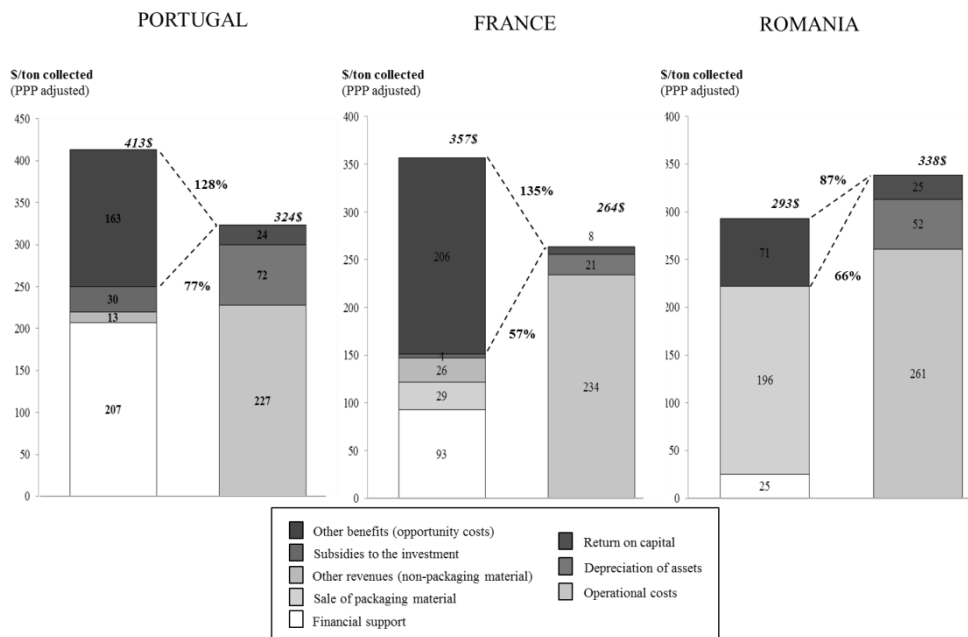


Figure 7 – Cost coverage considering (PPP-adjusted) international dollars per ton.

For comparison reasons, we also mention the collection costs in Germany as reported in tables 20 and 21. On average, the cost of kerbside collection of dry recyclables is around 265 €/ton; sorting should be around 150 €/ton. Apparently, in this country, the introduction of competition on the market was beneficial since waste management costs have decreased.<sup>27</sup>

Table 17 – Cost of collection and transportation of waste in Germany<sup>28</sup>

<b>Waste collection costs</b>	
<b>Residual household waste (€/ton)</b>	
Minimal value	70
Maximum value	130
Average	100
<b>Dry recyclables kerbside collection system (€/ton)</b>	
Minimal value	200
Maximum value	300
Average	265
<b>Drop-off centers (€/inh.year)</b>	
Cost	4,8

Since 2004, when DSD started to put waste collection services out to tender, the collection costs decreased about 30% (Bundeskartellamt, 2011). Table 21 presents the lightweight packaging waste (plastic and metal flow) management operation costs. One should note that this cost reduction can also be associated with the innovation and the development of the recycling industry and technology.

Table 18 – Costs of lightweight packaging waste management operations<sup>29</sup>

	<b>1996</b>	<b>2007</b>
	<b>(€/ton)</b>	<b>(€/ton)</b>
<b>Collection</b>	360 <sup>a</sup>	256 <sup>b</sup>
<b>Sorting</b>		150
<b>Treatment and Recycling</b>	610 – 820	100
<b>Subtotal</b>	970 – 1.180	506

<sup>a</sup> Value based on the LWP collection (including plastics).

<sup>27</sup> However, as many factors influence these costs (Chen, 1010) a more detailed analysis should be carried out to confirm this stance.

<sup>28</sup> BMWI (2009). Ökonomische und ökologische Bewertung der getrennten Sammlung von verwertbaren Abfällen aus privaten Haushalten sowie vergleichbaren Anfallstellen. Bundesministerium für Wirtschaft und Technologie, Berlin

<sup>29</sup> MU (2011). Evaluierung der Verpackungsverordnung. Umweltforschungsplan des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit, Berlin

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<sup>b</sup> Average value for LWP collection (including plastics).

In summary, both the magnitude of costs and the cost coverage of packaging waste management services differ widely among countries. For countries with competition on the market this information is not available.

## CONCLUSION

The for-profit or non-profit nature of the entities that take on the responsibility of recovering packaging waste (on behalf of the industry) is a crucial difference with implications on the overall functioning of the recycling systems. Competition seems to enhance cost efficiency. However, the lack of transparency is a negative externality of setting up a competitive environment among these entities or producer compliance schemes. In simple terms, our major research question was: “who is paying for the added costs of recycling”? For the case of Germany, the answer to this question is quite clear. The industry endures all the costs (selective collection, transport, sorting and storing) and collects all the benefits (selling of recyclables). Arguably, in the UK, the same happens because guarantors and recyclers (who sell the PRNs) have to purchase the packaging waste from waste management operators (demand increases the value of packaging waste). The problem is that one is not able to estimate the actual cost of selective collection and sorting due to competition (and “trade secret”). In fact, although the EPR principle is respected with these strategies, it would still be interesting to determine if this type of policy maximizes public welfare (i.e. minimizes the overall cost of recycling).

Covering several countries, this paper is not concerned with the details and specificities that should be considered if the objective was to criticize each system individually. Comparing different frameworks and approaches is crucial for the EU policy makers and also other countries that may be considering their options regarding the management of packaging waste in an environmentally (and financially) sound manner. Furthermore, by applying the same approach to the French, Portuguese and Romanian recycling schemes and plotting the results together, we are able to draw some wide-ranging implications.

Adopting an “economic perspective”, Portugal and France have a (packaging waste management) cost coverage of 128% and 135%, respectively. However, excluding the opportunity costs of avoiding the disposal (or other treatment) operations and the subsidies to the investment (public grants), we conclude that, in 2010, only 68% and 56% of the costs are

being supported by the industry in Portugal and France (respectively). From this perspective, the financial sustainability of the services would require an increase of respectively 50% and 125% of the FSLA in Portugal and France. In Romania the costs are (in both approaches) higher than the benefits. In this country, 93% of the packaging waste managed by the ERA recycling system comes from the industrial/commercial flow, being collected and processed directly by the industry.

Local authorities must be efficient in order to reduce the household packaging waste management costs. Arguably, both the SPV and Eco-Emballages financial models used in 2010 were set up to encourage the efficiency of the local authorities. The FSLA supported by SPV depends only in the performance of the local authority expressed in kg per inhabitant per year of packaging waste taken back. In France, the FSLA was calculated according to the Barème D (transfers increased with the selective collection performance). Most recently, the Barème E was developed entailing several different types of financial supports with the objective of promoting the overall efficiency of the systems and the disclosure of information.<sup>30</sup> This model, concerning the period between 2011 and 2016, was introduced to achieve the new goals (e.g. 75% of recycling and coverage of 80% of local authorities' efficient costs). The German and the UK financial models are based on the market competition and on the market prices of the packaging waste materials.

One crucial issue for all recycling systems has to do with free-riders (producers that introduce packaged goods into the market without contributing financially for packaging waste recovery operations). On one hand, the local authorities and the compliance schemes are supporting the waste management operations with no contribution from those producers (which distorts the market). On the other hand, the packaging waste is recovered through the systems, contributing for the recycling and recovery targets, resulting in unrealistic rates. In Germany, for instance, the proportion of packaging waste considered to be free-riding is around 23% (Koesegi, 2011) and the recycling rates, in some packaging waste materials exceeds 100%. This problem could be much worst in Romania where the proportion of packaging waste declared (in relation to total municipal waste) is unexpectedly low.

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<sup>30</sup> For instance: selective collection support, citizen awareness support, support for the sustainable development of the performance of the selective collection service, support for the performance of recycling, and support for other types of recovery.



Finally, the citizens' awareness of the environmental problems should always be encouraged by public authorities. The citizens' participation in the life-cycle of packaging waste is important for the efficiency and effectiveness of recycling, especially in Romania where the selective collection is quite recent (and coverage is still very low). All the stakeholders involved in the recycling process are important to its success and economic sustainability.

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