

1st International EIMPack Congress

Recycling of Packaging Waste: Considering all the Costs and all the Benefits

29, 30 November 2012



The *EIMPack* Project

The economic impact of the packaging and packaging waste Directive

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Sponsor

European Investment Bank, The EIB University Research Sponsorship Programme (EIBURS)

Line of research

The Economic Impact of Law: An Economic Assessment of the Impact of the Packaging and Packaging Waste Directive

Timeline

February 2011 to February 2014 (3 years)

Host Institution

Instituto Superior Técnico – Technical University of Lisbon (IST/UTL)

Research Unit

Center for Management Studies of IST

Principal Investigator

Rui Cunha Marques

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Objectives

Directive 94/62/EC

Provide a high level of environmental protection while ensuring the functioning of the internal market.

→ *increase in recycling and recovery rates...*



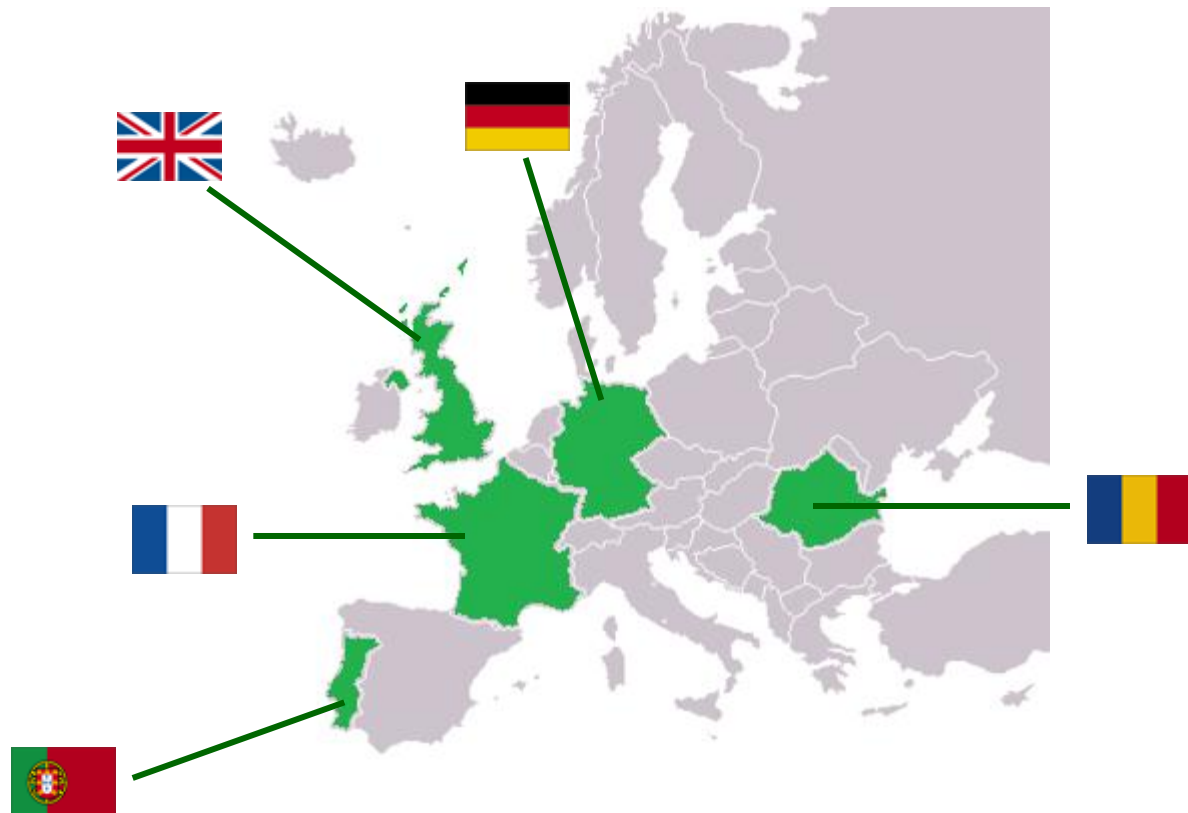
Ex-post evaluation

1. How have the distribution of costs been managed among the multiple stakeholders?
2. What is the Economic Rate of Return of the enhanced environmental protection?



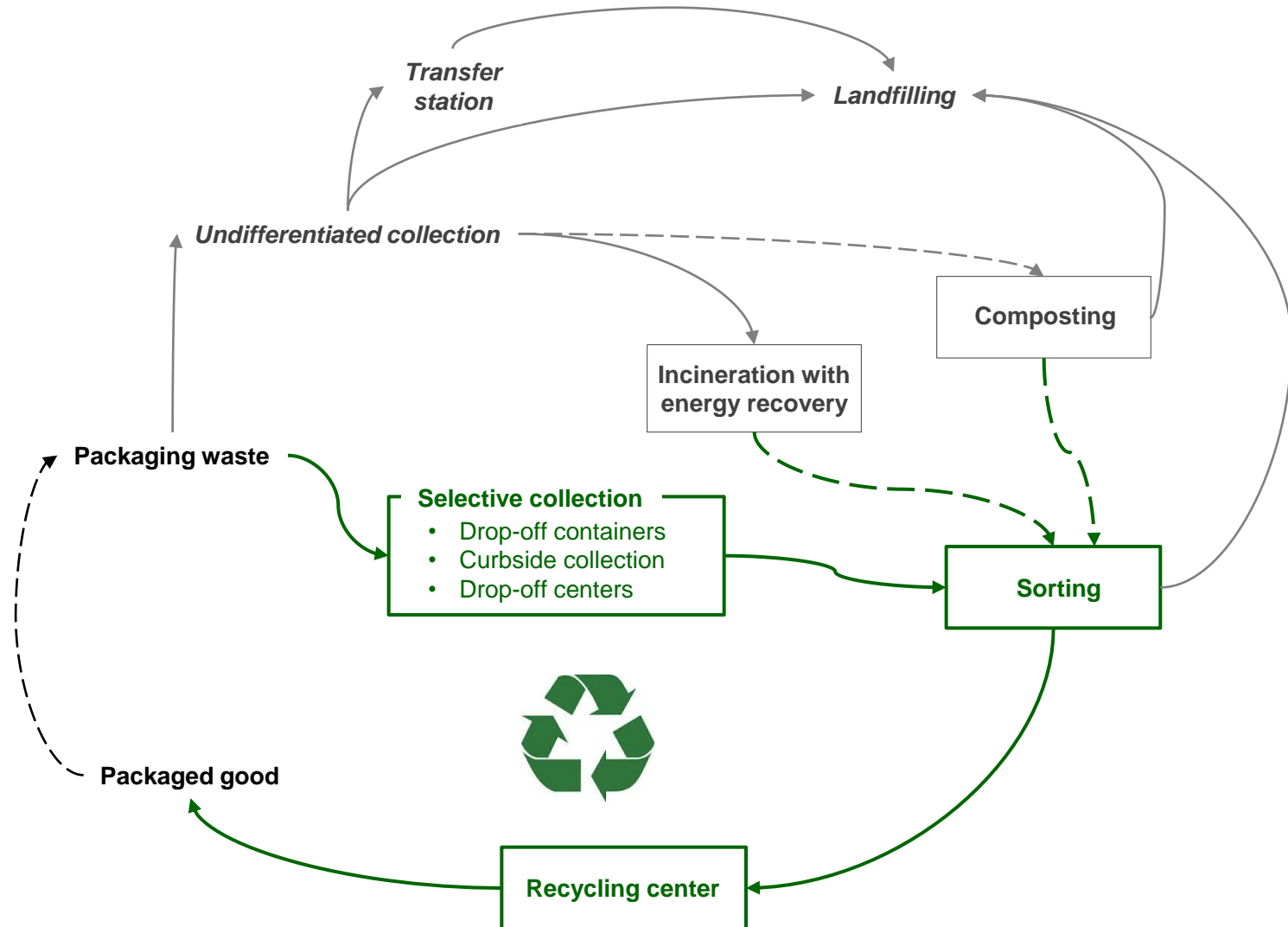
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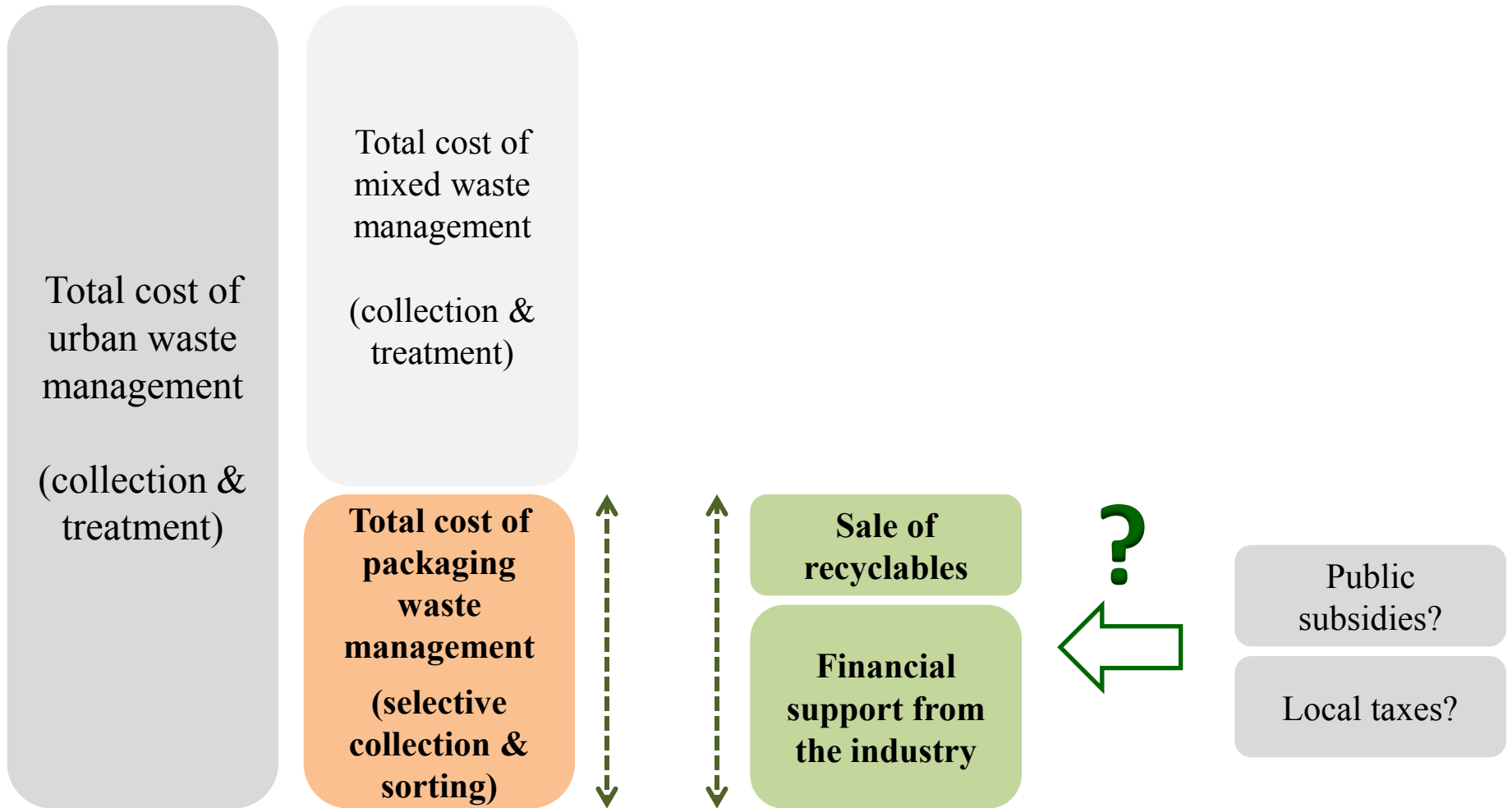
Case studies



- ❖ There are undeniable advantages in recycling some types of packaging waste;
- ❖ Nevertheless, recycling does not have only advantages and benefits;
- ❖ According to the PPW Directive “those involved in the production, use, import and distribution of packaging and packaged products” must accept the responsibility for packaging waste;
- ❖ We compare the costs incurred by the waste management operators with the financial support coming from the industry;

How is the extended producer responsibility principle being interpreted?





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

Directive	Deadline	Recovery targets	Overall	Glass	Recycling targets			
					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.

Packaging waste recycled in 2009. Source: Eurostat.

	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	<i>12,9</i>	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	<i>13,2</i>	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.

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Case-studies

France - Green dot fee 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

Based on Units +
Based on Weight



Cover 60 % of the “net
benchmark costs”

Financial Supports (2010)

Level	Performance (P) Kg/inh./year	Financial Support (S) in €/ton					
1	$P \leq N_b$	$S = S_b$					
2	$N_b < P \leq N_h$	$S = \frac{(N_b \times S_b) + (P - N_b) \times S_i}{P}$					
3	$N_h < P \leq N_p$	$S = \frac{(N_b \times S_b) + (N_h - N_b) \times S_i + (P - N_h) \times S_p}{P}$					
4	$P > N_p$	$S = \frac{(P - N_p + N_b) \times S_b + (N_h - N_b) \times S_i + (N_p - N_h) \times S_p}{P}$					
	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

S_p – plafond support;
 S_i – intermediary support;
 S_b – bottom support;
 N_b – lower level;
 N_h – high level;
 N_p – plafond Level.

Material	Option <i>Filières</i>	Option Federations	Option individual
	Price (€/ton)	Average (€/ton)	Average (€/ton)
Steel from selective collection	111,6	126,4	159,3
Steel from bottom ashes	41,5	49,3	69,1
Aluminium from selective collection	451	499,3	337,9
Aluminium from bottom ashes	552	635,8	<i>n.a.</i>
Plastics	196,3	189,6	<i>n.a.</i>
Paper/cardboard	72,3	75,6	51,4
Glass	22,42	<i>n.a.</i>	<i>n.a.</i>

Germany - Green dot fee 2010 (Duales System Deutschland GmbH)

Material	€/ton
Glass	74
Paper / cardboard	175
Tinplate	272
Aluminium, other metals	733
Plastic	1.296
Composites cartons with special acceptance and recycling guarantee	752
Other composites	1.014
Natural materials	102

Economic operators have to pay a fee for using the Green Dot trademark

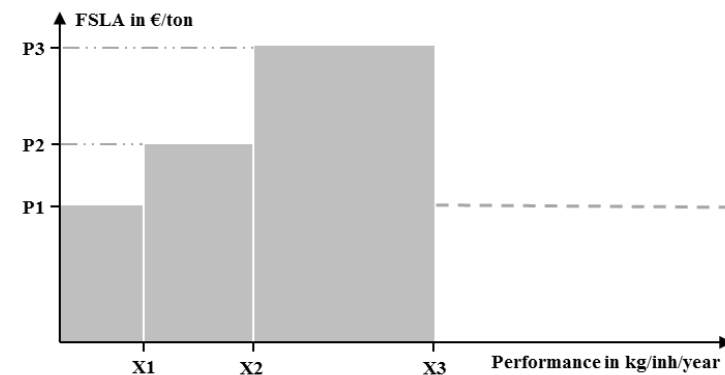
Material	€/ton
Glass	1,00
Paper / cardboard	3,00
Plastic	17,00
Composites	13,00
Tinplate	5,00
Aluminium	13,00

Portugal - Green dot fee 2010

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

Financial Supports (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
Aluminium	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



Romania - Green dot fee 2010

Packaging Material	Green Dot Fees (€/ton)
Glass	16,29
PET	21,47
Plastics	11,68
Cardboard paper	13,27
Steel	10,27
Aluminum	10,27
Wood	10,53

Financial Supports (2010)

Average price paid by recyclers (2010)

Packaging Material	Bonus payment (€/ton)
Glass	23,89
PET	32,40
Plastics	15,39
Cardboard paper	13,67
Steel	13,88
Aluminum	13,89
Wood	10,60

Packaging Waste Material	Average price €/ton
Glass	6,9
PET	333,5
Plastics	253,0
Paper and cardboard	126,5
Steel	218,5
Aluminium	977,5
Wood	29,9

The UK national targets

Year	Recovery (%)	Minimum 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

Average Packaging Recovery Note (PRN) prices in 2010

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

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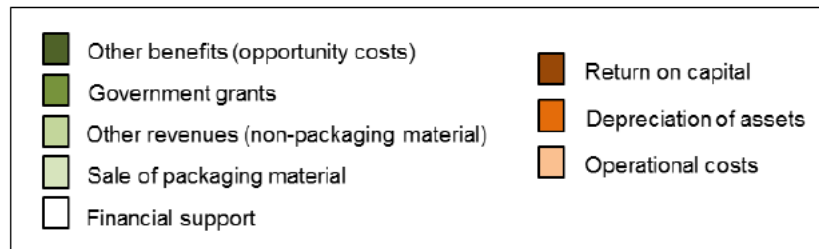
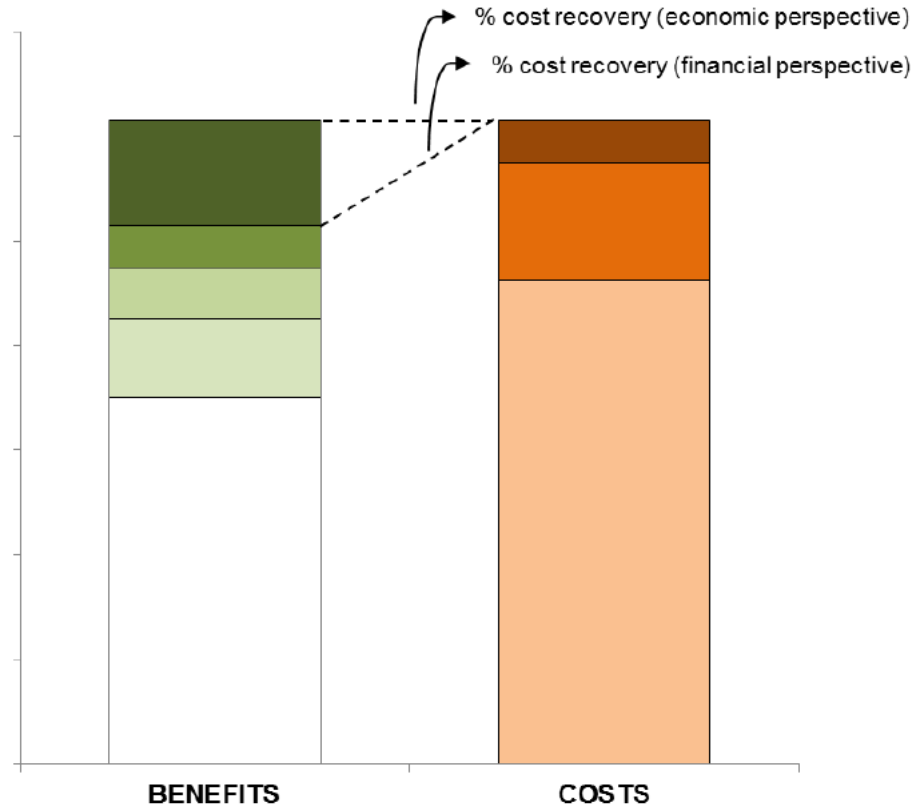
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Methodology

€/ton collected



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

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

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%

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

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

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 (see EIMPack 2011c and EIMPack 2012a,c)
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.

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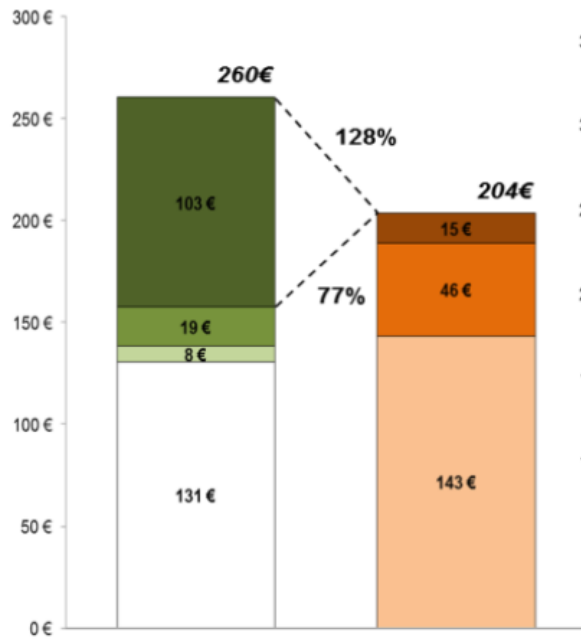
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Results

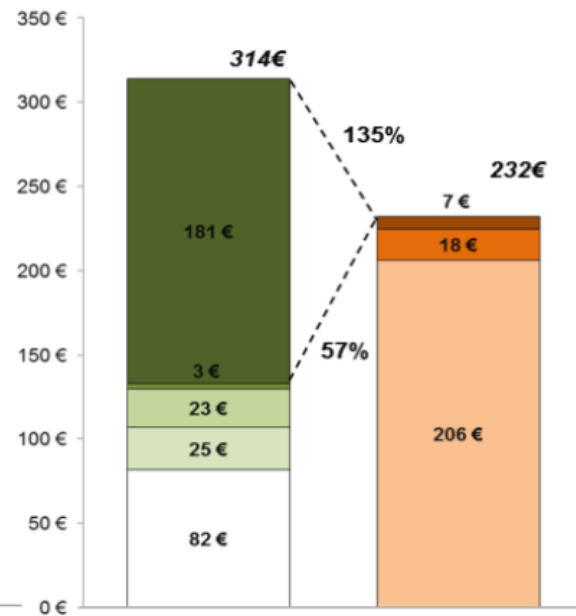
PORTUGAL

€/tonne collected



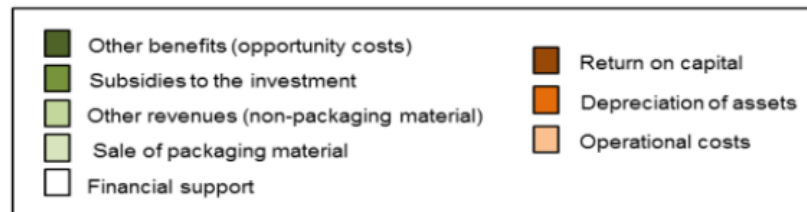
FRANCE

€/tonne collected



ROMANIA

€/tonne collected

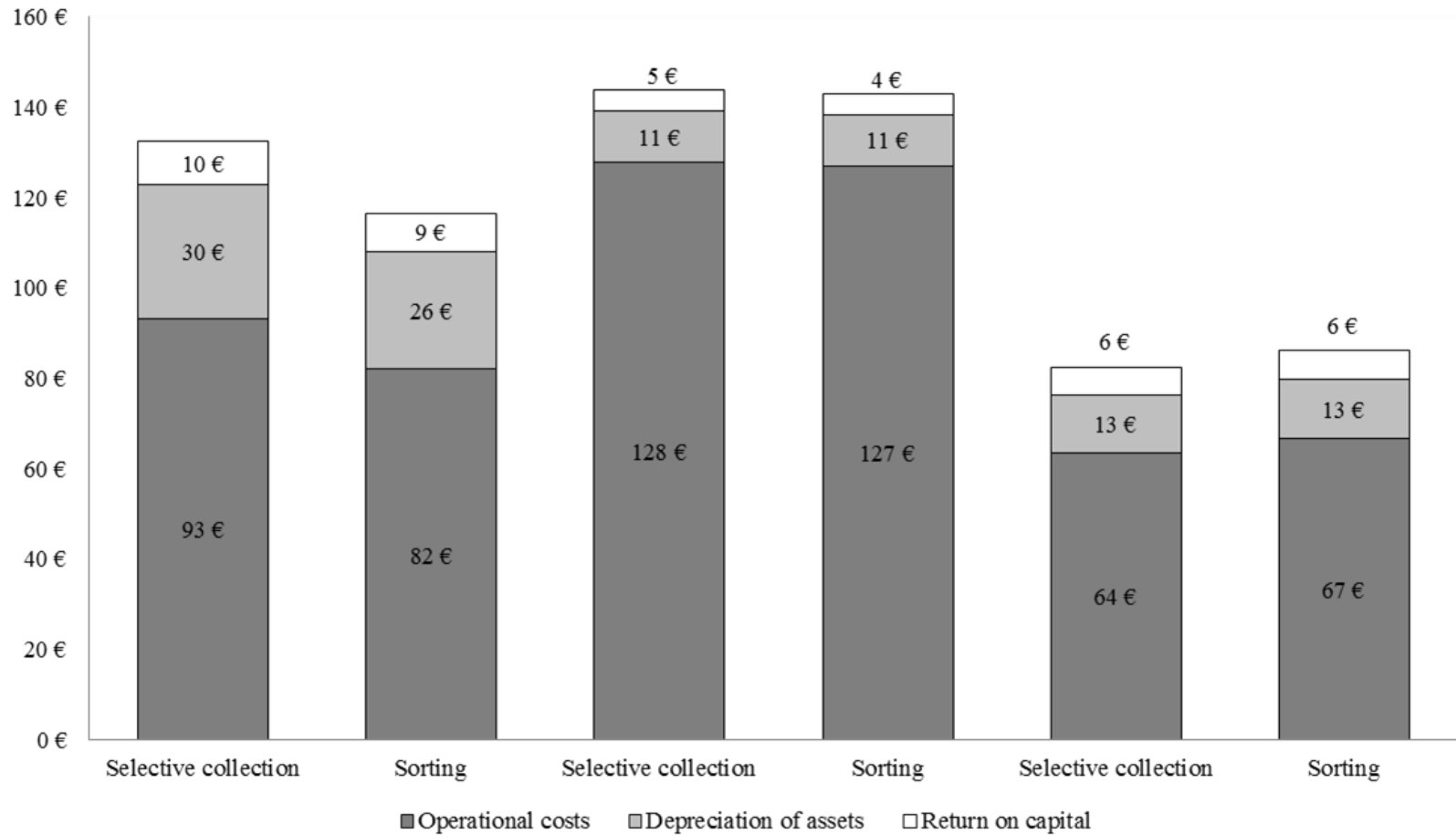


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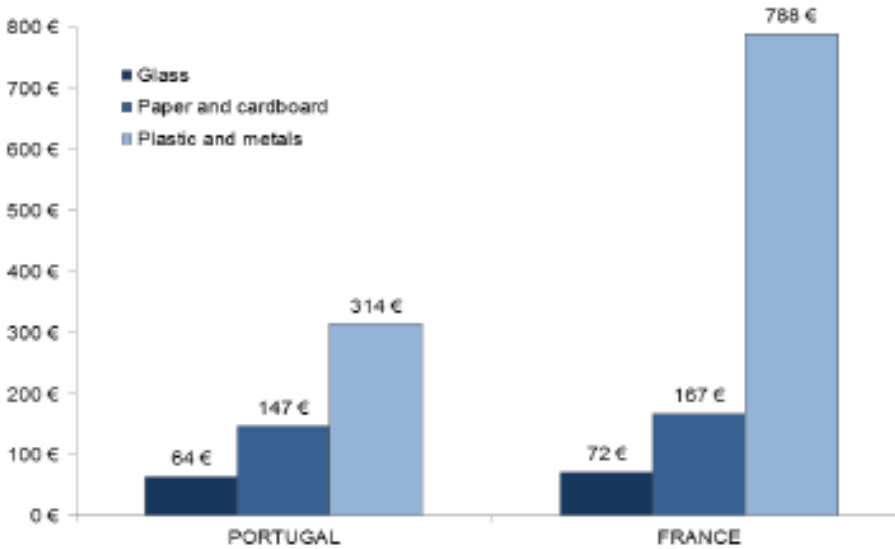
FRANCE

ROMANIA

€/ton collected



€/tonne collected



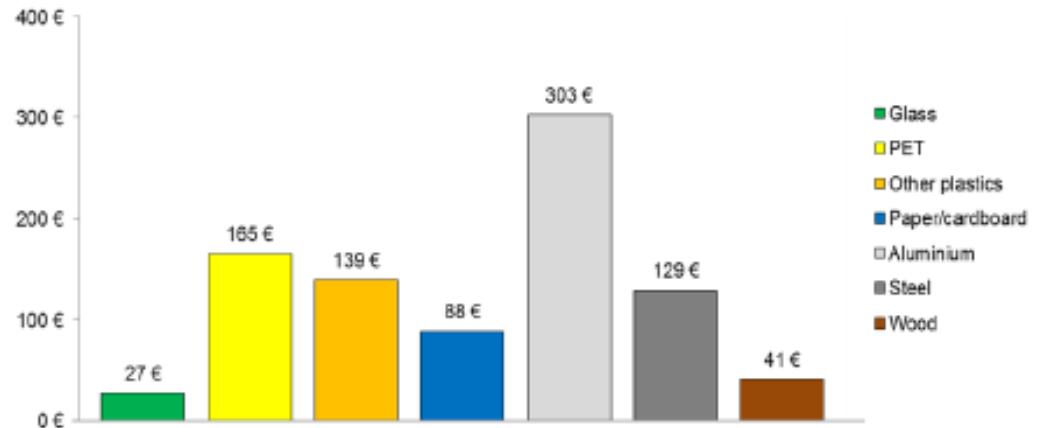
Costs of selective collection per flow



Operational costs (collection and sorting) per material in Romania

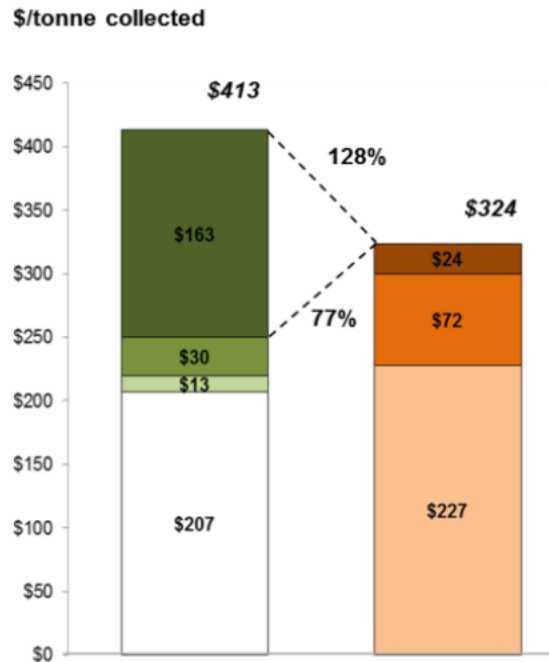


€/tonne collected

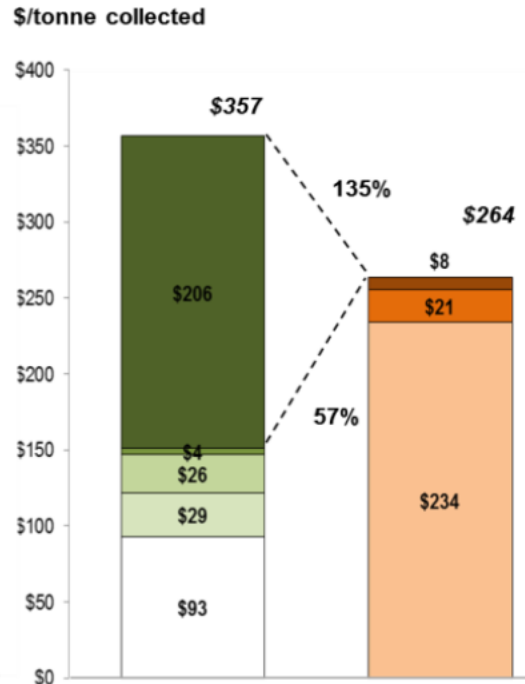


PPP adjusted results

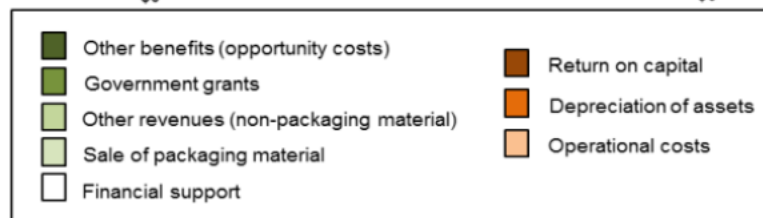
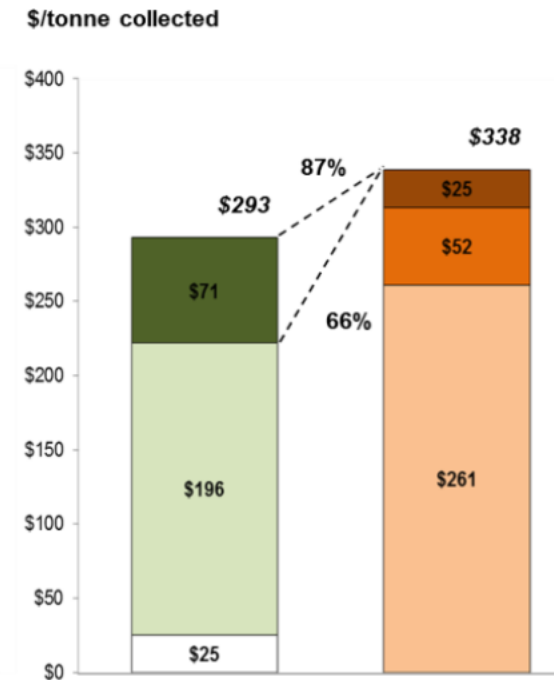
PORTUGAL



FRANCE



ROMANIA



- ❖ Adopting a strictly financial cost approach Vs. an economic approach is a relevant question at the EU level;
- ❖ The weight of the industry on recycling cost recovery widely diverges among the Case Studies;
- ❖ A “German type” of system ensures that the industry covers 100% of the recycling costs... but how much does it really costs? Difficult
- ❖ Are the costs reported by local authorities “efficient costs”?
- ❖ Considering incentives for efficiency, disclosure of information and citizen awareness.

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Additional studies

Kerbside sort collection system

11 LAs, covering 1.032.922 inh.
(about 2% of population)

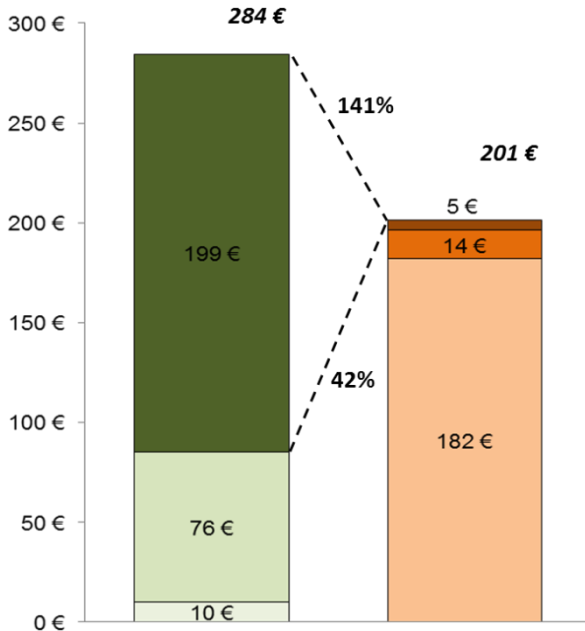
Two streams co-mingled collection system

12 LAs, covering 1.198.131 inh.
(about 2% of population)

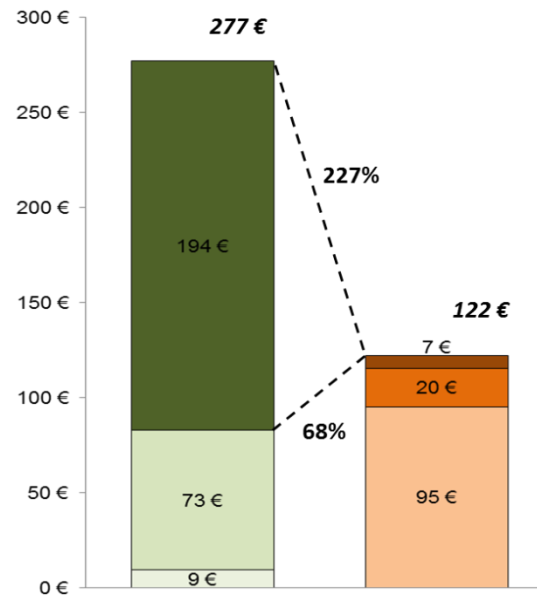
Single stream co-mingled collection system

7 LAs, covering 922.540 inh.
(about 2% of population)

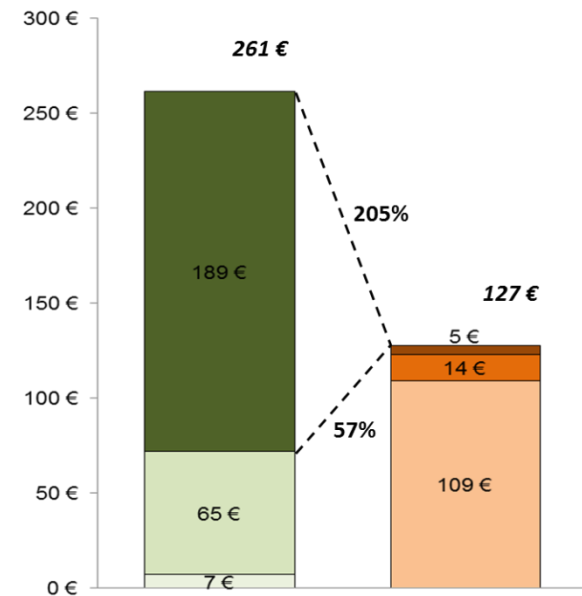
€/tonnes collected



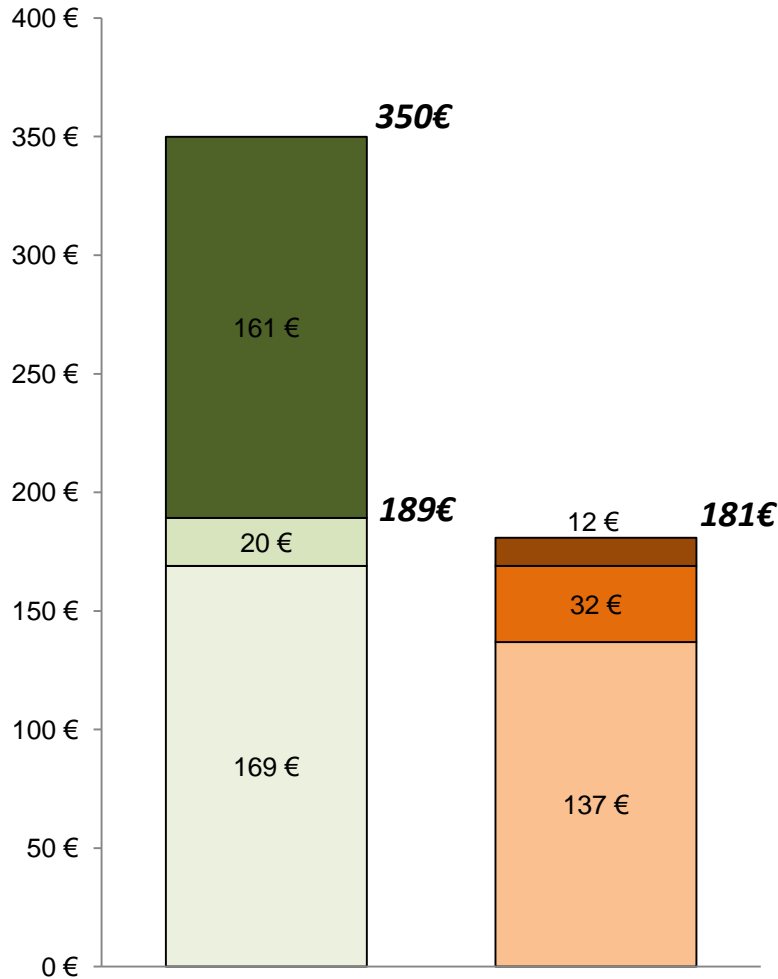
€/tonnes collected



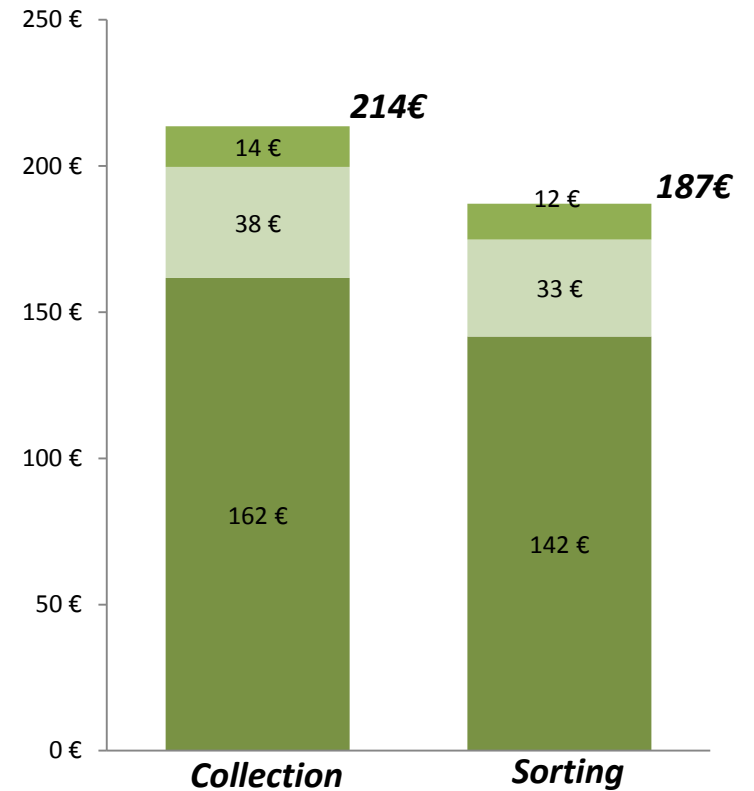
€/tonnes collected



- Other benefits (opportunity costs)
- Subsidies to the investment
- Sale of packaging material
- PRN value
- Return on capital
- Depreciation of assets
- Operational costs



Plastic bottles and flasks, Metals and Cardboard packaging for drinks (PMD)



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Outputs of the project

Presentations

- ❖ More than a dozen presentations in international congresses and meetings

Theses & dissertations

- ❖ Pedro Simões, Phd Thesis entitled "Measuring Performance of Urban Waste Services: Influence of Operational Environment, Regulation and Privatisation" - **Completed.**
- ❖ Ana Raminhos, MSc dissertation entitled "O Custo da Reciclagem de Embalagens" - **Completed.**
- ❖ Sandra Ferreira, Phd Thesis entitled "Determining the Willingness to Pay for Environmental Services" - Ongoing.

Scientific activity spreading actions

- ❖ EIMPack Workshop 1 -The financial flows in the recycling of packaging waste: The case of Portugal (4 November 2011)
- ❖ 1st International EIMPack Congress – Recycling of Packaging Waste: Considering all the Costs and all the Benefits (29 and 30 November 2012)

Scientific reports

- ❖ First Annual Report on the Progress of the Programme;
- ❖ Recycling of Packaging Waste – Literature Review;
- ❖ Comparing the Recycling Systems of Portugal, France, Germany, Romania and the UK;
- ❖ Case-specific reports from Belgium, France, Germany, Portugal, Romania & the United Kingdom: two reports each (Report 0 - Framework and Evolution of the Packaging Sector & Report 1 - Case Study);
- ❖ Life-cycle Assessment – Literature Review (shortly available).

Papers in international scientific periodicals

Marques, RC., Cruz, NF., Carvalho, P. (2012). Assessing and Exploring (in)efficiency in Portuguese Recycling Systems Using Non-parametric Methods. *Resources Conservation & Recycling* 67, 34-43.

Cruz, NF., Marques, RC., Simões, P. (2012). Economic Cost Recovery in the Recycling of Packaging Waste: The Case of Portugal. *Journal of Cleaner Production* 37, 8-18.

Cruz, NF., Marques, RC. (2011). O Sistema da Reciclagem em Portugal. (Submitted, in revision).

Cruz, NF., Ferreira, S., Cabral, M., Simões, P., Marques, RC. (2012). Comparing the Financial Flows in the Recycling of Packaging Waste in Europe. (Submitted, in revision).

Cabral, M., Ferreira, S., Simões, P., Cruz, NF., Marques, RC. (2012). Financial Flows in the Recycling of Packaging Waste: The Case of France. (Submitted, in revision).

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Recycling of Packaging Waste: Considering All the Costs and All the Benefits



During the last two decades, the waste sector in the European Union (EU) has been experiencing significant changes. Most of the developments regarding waste management operations were rule-driven at the European level. Regarding the specific case of “waste from consumer goods”, the Packaging and Packaging Waste (PPW) Directive stands out among the many rules and strategies. This EU law imposed challenging targets for the recycling rates of packaging waste to be attained by the various member states.

Although limited for the countries that already had national policies for packaging waste recycling/recovery, the impacts of the PPW Directive were significant and of different types. First, there were institutional impacts arising from the structuring of the “recycling schemes”. Entities from the public and the private sectors had to develop and coordinate their efforts in order to create the proper legal framework and monitoring systems. The waste market structure in each member state was necessarily impacted by this Directive since new activities had to be carried out. Second, there were financial impacts arising from the “extra costs” that were incurred by waste management operators (e.g. due to selective collection and sorting). The Extended Producer Responsibility (EPR) principle,

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Research Outputs

NEW: The website for the [1st International EIMPack Congress](#) is now online! Check it [here](#) and submit your extended abstract or paper.

• Presentations

- [Presentation 1 \(EIBURS annual meeting 2011\)](#)
- [Presentation 2 \(7th International Technical Conference on Waste, APESB, ISWA, Lipor, ISEP 2011\)](#)
- [Presentation 3 \(EIMPack Workshop 2011\)](#)
- [Presentation 4 \(EIBURS annual meeting 2012\)](#)
- [Presentation 5 \(Pro Europe meeting 2012\)](#)
- [Presentation 6 \(Waste Sector in Romania 2012\)](#)
- [Presentation 7 \(18th APDR Congress 2012\)](#)
- [Presentation 8 \(52nd ERSA Congress 2012\)](#)
- [Presentation 9 \(52nd ERSA Congress 2012\)](#)
- [Presentation 10 \(DEA 2012 - 10th International Conference on Data Envelopment Analysis\)](#)
- [Presentation 11 \(ISWA World Solid Waste Congress 2012\)](#)
- [Presentation 12 \(ISWA World Solid Waste Congress 2012\)](#)

• Working Papers

- Marques, R.C., Cruz, N.F., Carvalho, P. (2012). Assessing and exploring (in)efficiency in Portuguese recycling systems using non-parametric methods. *Resources Conservation & Recycling* 67, 34-43.
- Cruz, N.F., Marques, R.C., Simões, P. (2012). Economic Cost Recovery in the Recycling of Packaging Waste: The Case of Portugal. *Journal of Cleaner Production* 37, 8-18.

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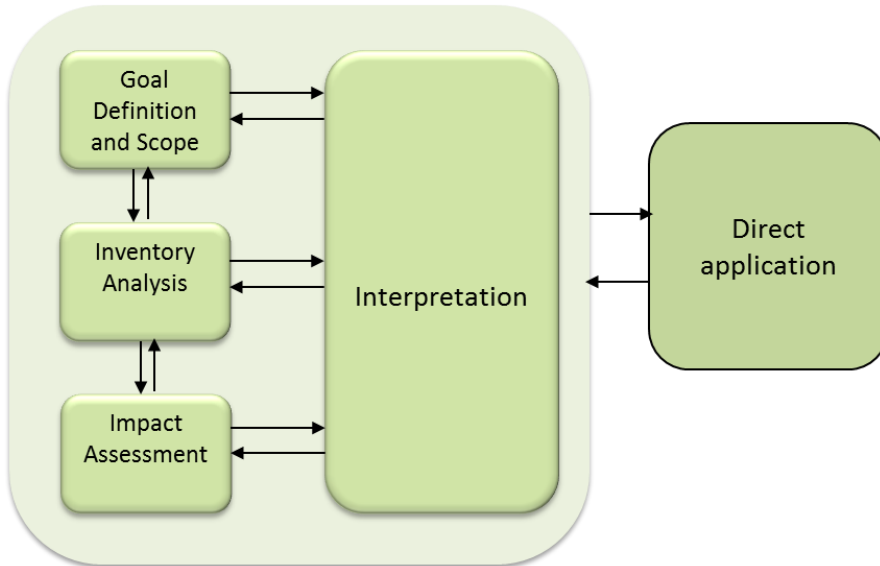


Next steps...



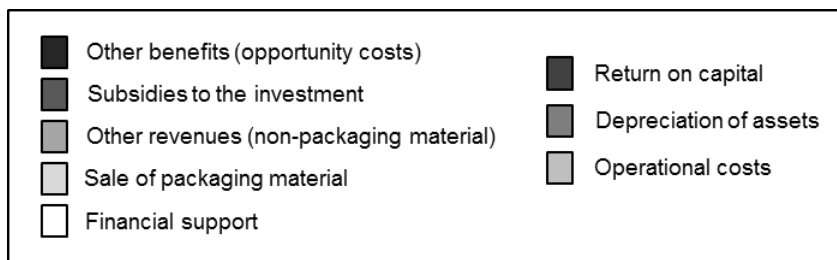
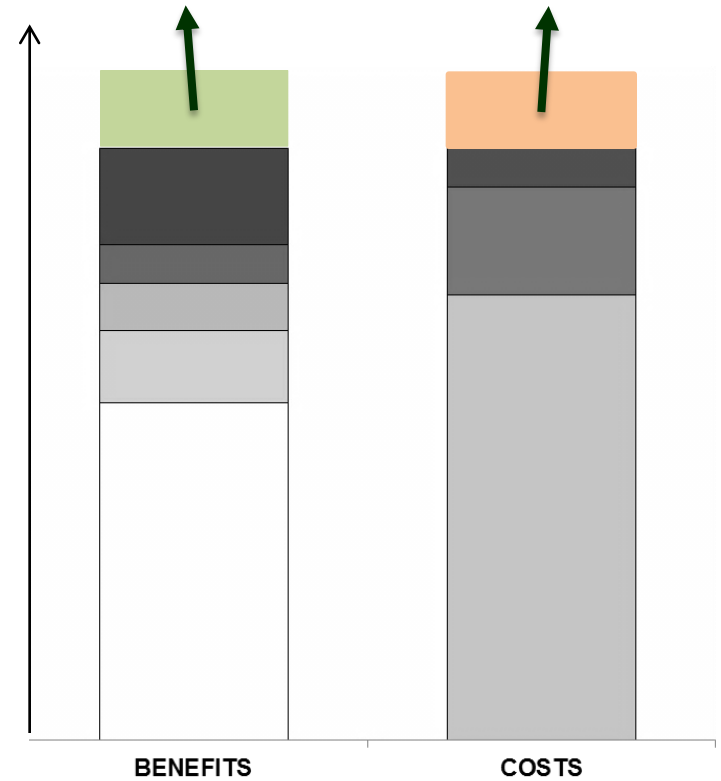
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Life Cycle Assessment



External benefits

External costs



Thank you!

Questions?

Please visit us at: <http://eimpack.ist.utl.pt/>

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