Examining the Cost of Introducing a Deposit Refund System in Spain: Technical Appendices

Report for Retorna

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A.1.0 Financial Analysis Model

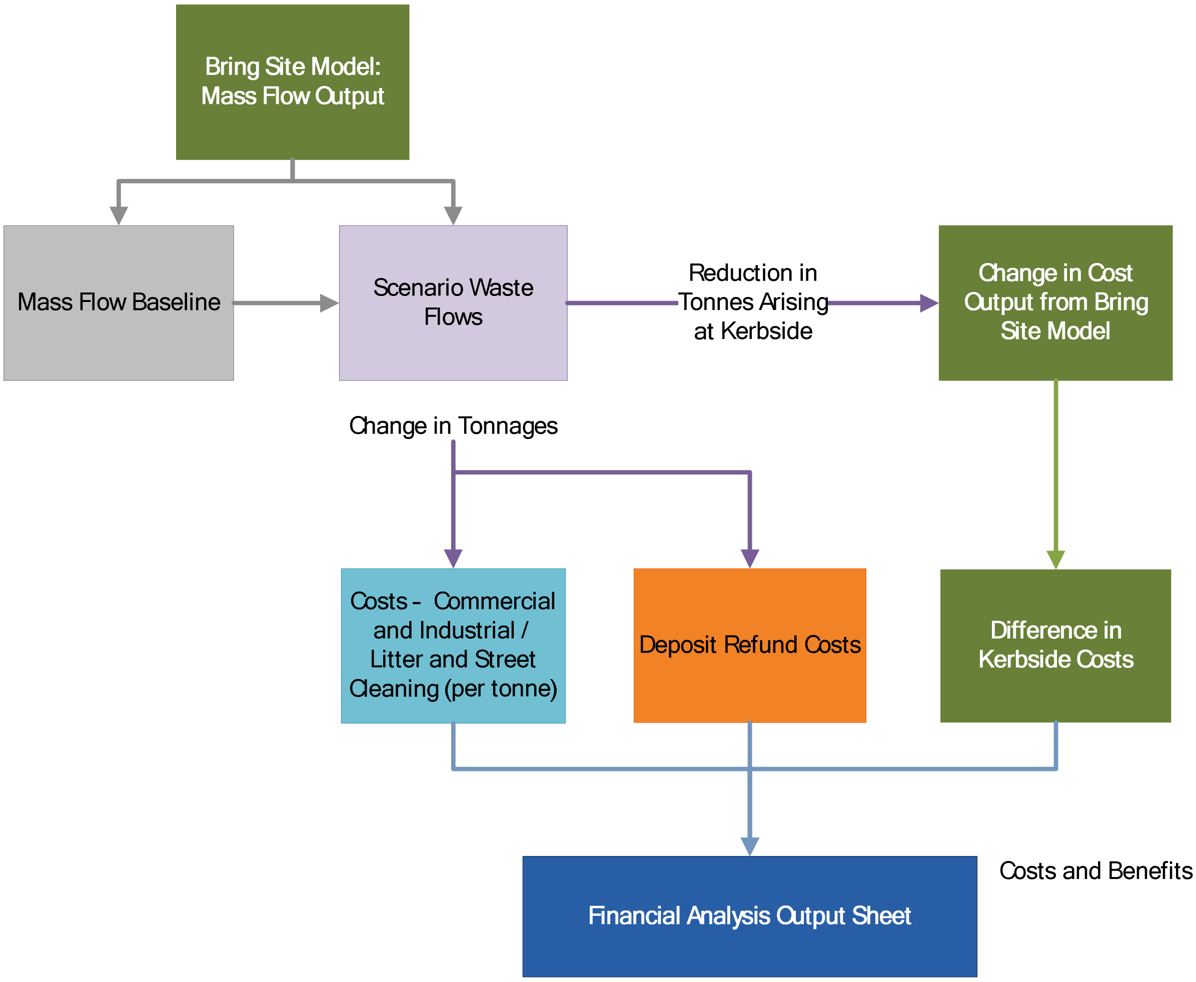
The financial analysis model has been developed by Eunomia as a bespoke model.

The overall structure of the model is given in Figure A-1.The key elements are:

1) A waste baseline for each of the key materials, which will include modelling of kerbside collection of household waste (through bring sites);
2) Scenario waste flow modelling;
3) Deposit refund system (DRS) modelling;
4) Final results calculations.

The remainder of this section first provides details on the materials that we have included in scope for the deposit refund system, as these will form the focus of the mass flow modelling. It then examines the waste mass flow assumptions used in order to model the baseline, followed by the key changes that are subsequently made to the waste mass flows as a result of introducing a deposit refund model in Spain.

Figure A-1: Cost Benefit Analysis Model Schematic Spain



A.1.1 Materials to be Included in Deposit Refund System

The materials considered in scope for the DRS were the following one-way (non-refillable) beverage containers:

1) Plastic bottles predominantly made from PET (Polyethylene Terepthalate) and HDPE (high-density polyethylene) e.g. carbonated soft drinks, mineral water, squash bottles, but excluding milk bottles.
2) Metal cans, both steel and aluminium e.g. fizzy soft drinks, beer cans, energy drinks etc.
3) Glass beverage containers e.g. beer bottles, soft drink bottles, but excluding wine and spirits bottles.
4) Beverage cartons e.g. non-fizzy soft drinks, including brands such as Tetrapak©.

Although there is, strictly speaking, no reason why in theory other containers or packaging could not be collected in these systems, the model has been designed around beverage containers for the following key reasons:

- Beverage containers are more likely than other types of food-based containers to be consumed away from home and thus end up as litter;[1]
- There are a significant number of beverage containers which could be tackled by a single collection system design (more than 18 billion were placed on the market in Spain last year);
- More investment in technology would be required in order to enable recognition in reverse vending machines (RVMs)/counting centres for other types and, importantly, shapes of containers/packaging;
- It enables industry-specific modelling, reducing the number of stakeholders and facilitating easier management of the system; and
- Hygiene issues, in particular with regard to plastic milk bottles and other food-based containers, have been given as a reason for not including those containers in existing deposit refund systems.[2]

Wine and spirit bottles are also excluded as these are typically consumed over a longer time scale, are less likely to be consumed 'on the go' and are thus less likely to contribute to litter.

The modelled system targets non-refillable containers, because a deposit refund system would encourage the capture of non-refillables which are purchased away from home as well as those consumed in the household. Targeting non-refillables

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[1] http://www.bottlebill.org/about/benefits/curbside.htm

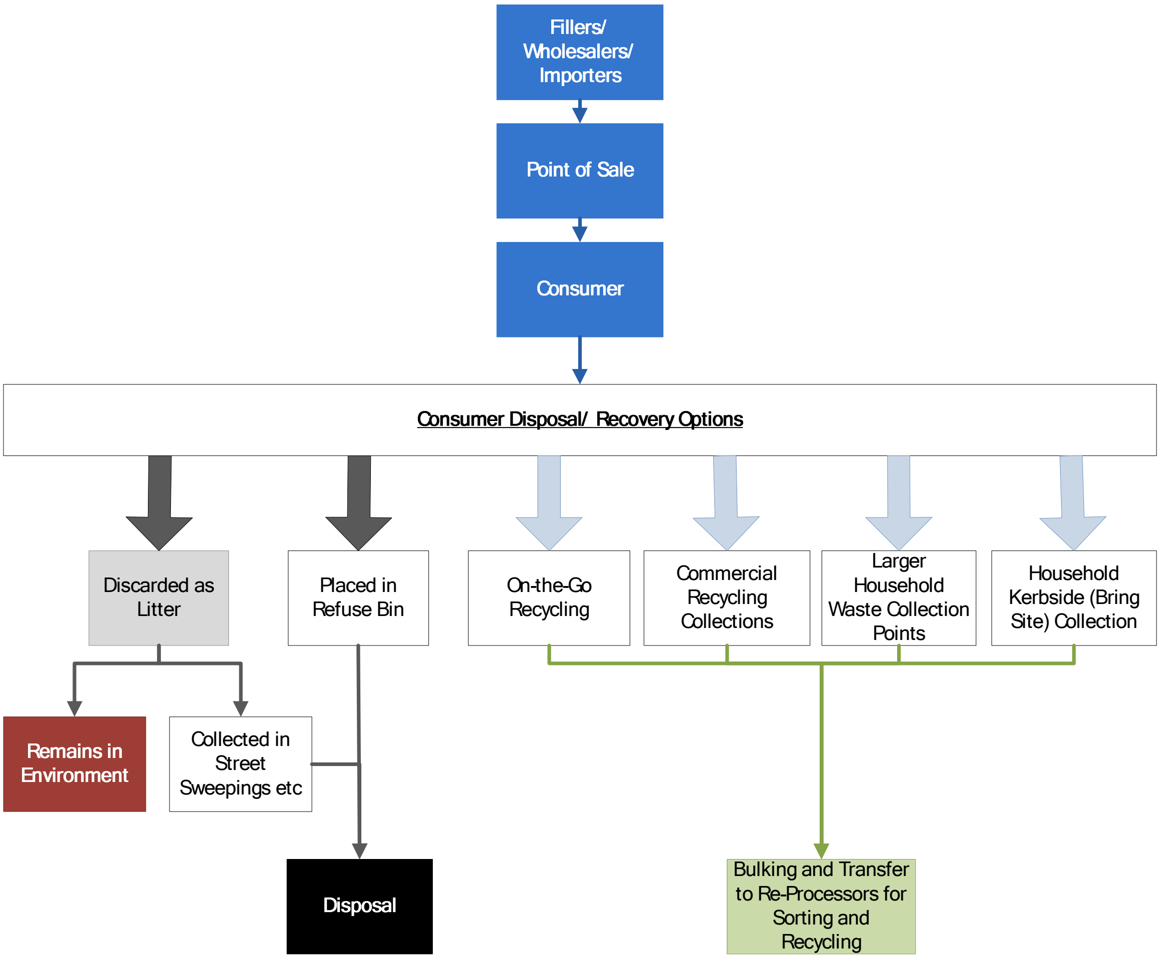
[2] ERM (2008) *Review of Packaging Deposits System for the UK*, Final Report produced for Defra, December 2008.

exploits the potential for increased recycling rates (and the associated improved use of resources and decreased primary resource extraction), a reduction in litter levels and an increase in the quality of material that is collected for recycling through the deposit mechanism.

A.1.2 Baseline

The first step in building the cost benefit analysis model was to consider the material flows in Spain, where the waste arises and how much of the waste is sent for recycling compared to how much ends up requiring disposal. Figure A-2 indicates the possible material flows in our container universe (before the DRS).

Figure A-2: Possible Container Material Flows (Pre-DRS)



For the purposes of the modelling assumptions, the data used is as up-to-date as possible, with modelling based on 2010 figures where possible. In order to ensure the impact of the introduction of the DRS is as directly comparable as possible to the baseline, both are modelled on the same year (i.e. 2010). This avoids having to make assumptions regarding inflation and the uncertainty over future changes to factors such as disposal costs. Nonetheless, sensitivity analysis is also undertaken around factors such as disposal costs in order to explore the financial impacts of the possible introduction/increase in landfill tax across Spain.

A.1.2.1 Household Bring Site Collection Modelling

This section describes how the baseline mass flows have been derived for the household bring site collection model.

<u>Population</u>

The household waste collection modelling is based on waste arisings generated per person in Spain and on the difference in collection logistics for different population distributions, e.g. urban, semi-urban or rural. Therefore the total population in each autonomous community and the percentage split of the three population classifications are shown in Table A-1. The summary statistics on which the modelling is based, i.e. the total population in each of urban, semi-urban and rural areas, is shown in Table A-2.

Table A-1: Population and Classification Data for 19 Autonomous Communities in Spain

Autonomous Community	Population	Households	Urban	Semi-Urban	Rural
Andalucia	8,202,220	2,417,179	51%	38%	10%
Aragon	1,326,918	443,243	61%	21%	17%
Asturias	1,080,138	389,402	59%	35%	7%
Balearic Islands	1,072,844	305,478	42%	53%	5%
Basque Country	2,157,112	741,408	48%	43%	9%
Canary Islands	2,075,968	552,497	53%	44%	3%
Cantabria	582,138	182,656	42%	37%	21%
Castile Leon	2,557,330	889,275	54%	26%	20%
Castile-La Mancha	2,043,100	610,272	32%	41%	28%
Catalonia	7,364,078	2,315,856	56%	36%	8%
Ceuta	77,389	19,399	100%	0%	0%
Extremadura	1,097,744	366,926	29%	40%	30%
Galicia	2,784,169	900,605	36%	47%	17%
La Rioja	317,501	101,439	52%	31%	17%
Madrid	6,271,638	1,873,792	85%	13%	2%
Melilla	71,448	17,926	100%	0%	0%

Autonomous Community	Population	Households	Urban	Semi-Urban	Rural
Murcia	1,426,109	378,252	56%	43%	1%
Navarre	620,377	188,772	35%	39%	26%
Valencian Community	5,029,601	1,492,792	47%	46%	8%
Total	46,157,822	14,187,169	54%	35%	10%

Table A-2: Summary Statistics for Population and Number of Households in Spain

	Urban	Semi-Urban	Rural	Total
Total Population	24,997,781	16,345,647	4,814,394	46,157,822
Total Households	7,662,221	5,011,057	1,513,891	14,187,169

Mass Flow Modelling

The average waste arisings in Spain is assumed to be 1.49 kg per person per day, based on a number of sources including EuroStat which reports 547 kg per person per year in 2009, and Gallardo who reports 1.26 kg per person per year going through the bring site system in urban areas.[3, 4] Using waste statistics for each autonomous community, an average was calculated for urban, semi-urban and rural inhabitants, which is shown in Table A-3. These statistics are assumed to include all municipal waste arisings, including street sweepings, litter bins, larger household collection points, and some commercial waste. We therefore reduced the total arisings by 25% in order to balance the mass flows from the kerbside bring site collections against those from other sources; an average of 1.12 kg per person per day is therefore assumed to be collected through this waste collection system.

[3] Eurostat (2009) Country Profiles, http://epp.eurostat.ec.europa.eu/guip/mapAction.do?mapMode=dynamic&indicator=tsien120#tsien120

[4] Gallardo, A., Bovea, M. D., Colomer, F. J., Prades, M. and Carlos, M. (2010) Comparison of Different Collection Systems for Sorted Household Waste in Spain, *Waste Management*, Vol.30, 2430-2439.

Table A-3: Total Waste Arising (in kg) per Person per Day

	Urban	Semi-Urban	Rural	Average
Average Total Waste (kg/person/day)	1.52	1.49	1.38	1.49
Average Waste Collected through Bring Sites (kg/person/day)	1.14	1.12	1.04	1.12

The composition of waste in any country is difficult to estimate. Gallardo (2010) estimated the waste composition in Spain by analysing data from 45 councils with populations of more than 50,000 inhabitants, representing about 8.5 million inhabitants in total. The results of this analysis are summarised in the second column of Table A-4; as a comparison, the UK household waste composition is shown in the third column; note that the two appear to be very similar.

The basic composition is not detailed enough to include the packaging material specific to a DRS, and therefore adjustments are necessary to separate out this component of the waste stream. The assumptions made to adjust the composition were:

- The total arisings per person in Table A-3 for the total populations in Table A-2 gives rise to total waste arisings of 25,175,219 tonnes per annum.
- Applying the Gallardo composition in column two of Table A-4 gives the tonnes per annum of each material type that might be considered 'potential' deposit material.
- The next step was to determine how much of each potential DRS material type was actually beverage containers as opposed to other types of packaging waste.
- Canadean® (beverage industry information specialists) data was used to determine the tonnage of deposit-bearing material that is placed on the market (average weight data used to calculate tonnages from Canadean unit data is given in Table A-5). Note that an additional 2 to 5 g was added for the lid of the container, depending on the material).[5]
- The total tonnes of drinks containers placed on the market in Spain, shown in Table A-6, was then used to determine the 'beverage container' fraction of each 'potential' deposit material - thereby separating the DRS materials out in the overall composition. This final adjusted composition is shown in the last column of Table A-4.

[5] Canadean (2010) *Global Packaging Service 2010 Cycle: Germany and Spain.*

Table A-4: Composition of Household Waste Arising in Spain

Material	Composition[6]	Adjusted Composition*
Glass – Other	7%	4.0%
Glass - Drinks excl Wine*		2.9%
Liquid Packaging Board (LPB)– Other	1%	1.1%
LPB – Drinks		0.2%
Metal – Other	4%	3.0%
Metal - Al Cans*		0.1%
Metal - Fe Cans*		0.5%
Organic	42%	41.9%
Plastic - PET Bottles*		0.6%
Plastic – Other	10%	9.6%
Paper and Card	20%	19.7%
Rubber	1%	0.5%
Sand, Stone, Soil	3%	3.4%
Textiles	2%	2.2%
Wood	1%	0.6%
Misc.	9%	9.0%
Rejects	1%	0.6%
Total	**100%**	**100%**
Notes *Here the composition is broken down to identify the percentage of beverage containers in household waste arisings according to material type		

[6] Gallardo, A., Bovea, M. D., Colomer, F. J., Prades, M. and Carlos, M. (2010) *Comparison of Different Collection Systems for Sorted Household Waste in Spain,* Waste Management, Vol. 30, 2430-2439.

The resulting adjusted composition was used in the modelling to determine material-specific mass flows. Compositional analyses are not always agreed upon; for example Ecoembes figures show that liquid packaging board (LPB) is only 0.6% of total waste, while according to SIG-Combibloc (packaging solutions specialist) glass accounts only for 1.3% and plastic 2.78% of the total waste stream.[7] However, such low values would result in significantly less packaging in the waste stream than drinks containers placed on the market; therefore we have used the calculations and values described above to determine the mass flows.

Table A-5: Average Weight of Drink Containers in DRS (Empty)

Materia l	Drink	Volume* (cl)	Weight used for Spanish Data (g)
Glass	Soft Drink	20	151
	Beer	25	151
	Beer	33	222
	Beer	100	461
LPB	Soft Drink	20	13
	Soft Drink	33	18
	Soft Drink	100	41
	Soft Drink	150	57
Metal	Soft Drink	25	22
	Beer, Soft Drink	33	25
Plastic	Water	33	12
	Soft Drink	50	16
	Soft Drink	100	33
	Soft Drink, Water	150	29
	Soft Drink, Water	200	39
	Water	500	115
Note: * For brevity we only include volumes where over 100M units are sold per year.			

[7] http://www.sig.biz/site/en/index.html

Table A-6: Tonnes of Deposit-Bearing Materials Placed on the Market in Spain in 2009

Material	Deposit-Bearing Drinks Containers Placed on the Market (tonnes)[8]
Glass Bottles	726,953
PET Bottles	179,304
HDPE Bottles	3,501
Aluminium Cans	33,884
Steel Cans	135,535
LPB	50,980
Total	**1,130,157**

Recycling Rates

The current recycling rates, like the composition, vary depending on the source of information. Three examples are shown in Table A-7, with the values used in the modelling given in the shaded grey cells. It is important to note that these values are not the final recycling rates often reported by Ecoembes, etc., which includes the recovery of recyclable materials from residual waste treatment. The recycling rates shown in this table are only for separately collected materials that go through the kerbside bring system in Spain, this being the system that we are interested in modelling.

The recycling rates for the DRS are based on the baseline recycling rate for Spain. We assume that, in introducing the DRS, 92.5% of DRS containers currently in the household bring site waste stream will be returned into the DRS (resulting in an overall DRS return rate of 89% when combined with the other sources of waste considered in the mass flow modelling due to a lower return rate of about 78% in the commercial and industrial sectors). The rationale for the likely return rates follows in Appendix A.3.1. The remaining 7.5% of household DRS containers will remain in the kerbside system. The recycling rate for those deposit bearing containers that are still collected in the kerbside system is calculated by taking the 7.5% of containers not returned in the DRS, and multiplying this by the baseline recycling rate. E.g. For glass, 51% of the 7.5% not returned in the DRS is recycled, which equates to a total of 3.9% of deposit-bearing glass being recycled in kerbside bring system, leaving 3.6% in the kerbside residual waste stream.

[8] Canadean (2010) *Global Packaging Service 2010 Cycle: Germany and Spain.*

Table A-7: Recycling Rates for Potential DRS Materials (values used in the model are shaded in grey).

	Example Current Recycling Rates			DRS Recycling Rates	
Material	Based on Gallardo *et al.* (2010)[9]	Separately Collected Materials[10]	Overall Recycling Figures[11]	Baseline Kerbside-Collected Containers Now Returned in DRS	DRS Containers Recycled at Kerbside
Glass	44%	**51%**	36%	92.2%	4.0%
LPB	**18%**	-	30%	92.2%	1.4%
Metals (Overall)	8%	17%			
Metals (Al)	-	**6%**		92.2%	0.5% Al
Metals (Fe)	-	**19%**		92.2%	1.5% Fe
Plastic	10%	**23%**		92.2%	1.8%

[9] Gallardo, A., Bovea, M. D., Colomer, F. J., Prades, M. and Carlos, M. (2010) *Comparison of Different Collection Systems for Sorted Household Waste in Spain,* Waste Management, Vol. 30, 2430-2439.

[10] Fundació per a la Prevenció dels Residus i el Consum Responsible (2011) *Análisis de los Resultados de Recuperación de Residuos de Envases en 2008,* July 2011.

[11] Calculated based on both the official recycling statistics from INE (Instituto Nacional de Estadística) (2009), available at http://www.ine.es/jaxi/menu.do?type=pcaxis&path=/t26/e068/p01/a2009&file=pcaxis, and a number of autonomous community sources, including: Junta de Andalucía (1999) *Plan Director Territorial de Gestión de Residuos Urbanos de Andalucía*, http://www.juntadeandalucia.es/medioambiente/web/aplicaciones/Normativa/ficheros/d218_99.rtf; COGERSA (2008), Informe anual Cogersa 2008, http://www.cogersa.es/metaspace/file/24959.pdf; Junta de Castilla y León (2005), *Plan Regional de Ámbito Sectorial de Residuos Urbanos y Residuos de Envases de Castilla y León 2004-2010*, http://www.jcyl.es/web/jcyl/binarios/368/922/Decreto_18_2005.pdf; Junta de Castilla-La Mancha (2009), *Plan de Gestión de Residuos Urbanos 2009-2019,* http://pagina.jccm.es/medioambiente/planes_programas/plan%20de%20ru%20de%20castilla%20la%20mancha_v2.pdf; Xunta de Galicia (2010), *Plan De Xestión de Residuos Urbanos de Galicia (PXRUG) 2010-2020*, http://cmati.xunta.es/portal/webdav/site/cptopv/shared/es/pdfs/SXCAA/PXRUG/1.Plan_de_xestion.pdf.

A.1.2.2 Litter Bins, Street Sweepings and Litter Remaining in the Environment

As discussed above, waste flow data in Spain is not always split out into the various mass flows that would ideally be required when modelling the beverage container population. Indeed, household waste arisings figures typically also include some commercial waste, and litter and street sweepings arisings are often combined with refuse or recycling at bring sites rather than being reported as separate waste streams.

In order to determine an estimate of the mass flows from litter bins and street sweepings, we used kg per inhabitant per annum data from the Barcelona area from 2009/10.[12] Recognising this is probably a high-end estimate of total litter and street sweeping arisings across Spain, due in part to the large tourist population as well as the need for beach cleaning in the area, and that Barcelona is a high density urban region, we scaled the values down by 70%. Hence a mass flow for litter bin and street sweepings was consequently derived which represents 2.2% of the total waste arisings per inhabitant. Note that this broadly corresponds to litter in the UK which is measured in some detail and which has been reported to represent 3% of municipal waste.[13] The following litter composition was assumed, using typical waste compositions from Scotland and general assumptions, in order to determine the tonnages of beverage containers collected through this waste stream:

- 11.4% glass packaging;
- 8% plastic bottles (with 80% of plastic bottles subsequently assumed to be PET or HDPE);
- 5.1% metal cans (with 90% of these assumed to be beverage cans); and
- 9.8% cardboard (with 10% of these assumed to be beverage cartons).[14]

We also assume that 1% of the total containers placed on the market end up being left in the environment i.e. is not collected via street sweeping (equates to 180 million containers per annum).

Estimates of the tonnages of beverage containers from litter and street sweepings are presented in Table A-8.

A.1.2.3 Larger Household Collection Points (Puntos Limpios)

There are currently a number of larger household collection points or 'puntos limpios' across Spain (sometimes referred to as ecoparques or deixalleries) where residents

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[12] Personal communication with Carlos Vázquez, Head of the Waste Management Department of Barcelona, 25th November 2011.

[13] North London Waste Authority (2007) Recycle on the Go Consultation

[14] Based on a typical litter composition (wt%) taken from the following study: AEA and Wasteworks (2010) *The Composition of Municipal Solid Waste in Scotland*, Report for Zero Waste Scotland and Natural Scotland, April 2010.

can take waste for recycling, including waste streams which are not typically collected in bring sites, such as waste electrical and electronic equipment, textiles and cooking oil. The tonnages of beverage containers separately collected for recycling at puntos limpios is based on data from the metropolitan areas of Barcelona, converted to kg per inhabitant per annum, scaled up to the whole of Spain.[15] The estimated tonnages of beverage containers from puntos limpios are presented in Table A-8.

A.1.2.4 Total Products Placed on the Market / Total Waste Arisings / Commercial and Industrial Wastes

The definition of commercial and industrial wastes in this study includes all waste from non-household sources. This includes beverage containers deposited in refuse or recycling schemes from commercial or industrial enterprises. It should be noted that the existing Law 11/1997 and the Order of April 27th 2008 apply only to household packaging, with commercial and industrial packaging only voluntarily subject to a DRS. However, given the current difficulty in differentiating between household and commercial packaging arisings, containers from commercial and industrial sources form part of the mass flow baseline in this study.

In order to estimate the quantity of beverage containers collected from non-household sources, our simple approach estimates that:

Containers from Commercial and Industrial Sources	=	Total Containers Placed on Market minus Containers Captured in other Waste Streams for Recycling and Treatment and/or Disposal

The figure for 'Total Containers Placed on Market' is calculated from known estimates for the total number of containers placed on the market and the average weight of a container. Canadean® (beverage industry information specialists) supplied us with data pertaining to the quantities of different beverages, by container type, placed on the Spanish market from 2003 to 2010, and projected forward to 2015.

The weights of beverage containers were determined according to material type and container size. This data allowed us to calculate the total weight of containers placed on the Spanish market every year. By subtracting the tonnages of beverage container waste collected from households, puntos limpios and litter for recycling and disposal from the total weight of containers placed on the Spanish market, the resultant figure indicates the relatively small tonnage of beverage containers that would be collected from commercial and industrial sources, with an estimated 10% of this figure assumed to be recycled, and the remainder assumed to be collected in the refuse stream. The overall number and tonnages of containers placed on the market and the amount of containers found in the environment are given in Table A-8.

[15] http://www.deixalleries.com/interes8.php?ANO=2010

A.1.2.5 Summary Baseline Figures

Table A-8 shows the mass flow baseline upon which subsequent calculations were undertaken to establish the financial costs associated with the introduction of a deposit system. Due to the high-level nature of this study, a full analysis of the ranges and uncertainties in the modelling could not be accomplished. However, we believe the estimates provided in Table A-8 to be reasonable, being, as they are, based on reasoned argument, and rationalised to the greatest extent possible.

A.1.3 Introduction of a DRS

This section describes the central scenario that has been modelled for the introduction of a deposit refund system in Spain. In this scenario the household bring site system for containers continues to operate in parallel to the deposit refund system, but we assume that householders no longer place the majority of their deposit-bearing beverage containers in the kerbside system, instead deciding to put these containers into the DRS and claim back their deposits.

As discussed in Appendix A.1.2.1, the DRS scenario results in changes in mass flow compared to the baseline. To determine the magnitude of the change, we estimated the likely situation following implementation of the DRS, and then calculated the difference compared to the baseline.

In both cases the mass flows were adjusted so that the overall return rate for the DRS was set at reasonable levels. The rationale for the likely return rates follows in Appendix A.3.1.

Reflecting experience from other countries with a DRS, we modelled a switch in the percentage of metal beverage cans that are sold in steel compared to aluminium cans. The current ratio of steel to aluminium cans in Spain is around 80% steel, 20% aluminium cans.[16] Spain has a strong history of steel packaging manufacture, and is thus slightly unusual in its current split of steel to aluminium in the beverage container industry.[17] However, in introducing a DRS into a steel-dominated market, less of the system costs would be covered by the scrap value than if the cans were, for example, predominantly made of aluminium. In most existing DRSs, by varying the fee that producers pay according to the value of the material, producers are effectively encouraged to switch to higher value materials in order to suppress the costs of the DRS, resulting in almost 100% of beverage cans being made of aluminium rather than steel. System operators, producers and retailers in Spain would therefore probably start looking at options like changing their material mix in order to reduce the overall costs of the system. Following the introduction of the DRS, we thus modelled what we consider to be a relatively conservative ratio of beverage cans placed on the market at 80% aluminium, 20% steel.

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[16] Anonymous European Industrial Source (2011)

[17] http://www.roeslein.com/laselva-spain.html, http://www.arcelormittalpackaging.com/pdf/Publi%20Canmaker.pdf, http://www.apeal.org/uploads/Library/Environmental%20Brochure.pdf

The calculation of the change in mass flows through the household bring site system was described in Appendix A.1.2.1. For the remaining waste streams, it is assumed that the same percentage reduction is applied to the number of containers collected in each waste management route (other than at the kerbside) in order to achieve an overall return rate in the deposit refund system of 90%.

In reality, it might be that there is a larger reduction in the number of containers collected through particular waste management routes as opposed to others. For instance, it would be easier for an individual to pick containers out of litter bins or the environment than from bring banks or commercial waste routes. Hence it might be expected that fewer beverage containers would be found in litter bins and the environment than in bring banks or commercial waste routes. However, given the lack of evidence to support this theory, we have modelled the same reduction in beverage containers for each management route.

Table A-9 shows the modelled change in waste mass flows as a result of the implementation of a DRS in Spain and Table A-10 indicates the mass flows which result from the implementation of the DRS and the number of containers that are collected through the DRS system.

Table A-8: Mass Flow Baseline for Financial Modelling

Products	No. of Deposit-Bearing Containers (millions) Placed on Market	Tonnages (thousand tonnes)								
		Placed on Market	Hhld Kerbside		Puntos Limpios – Recycling Only	Commercial		Litter		
			Recycling	Refuse		Recycling	Refuse	Recycling	Refuse	Environment
Glass Bottles	3,433	715	280	264	1.01	10	93	10	50	7
PET/HDPE Bottles	5,719	180	31	105	0.21	1	7	6	28	2
Cans (Fe.)	5,405	131	19	82	0.05	1	7	3	17	1
Cans (Al.)	1,351	33	1	24	0.05	0	3	1	3	0
Cartons	2,183	51	7	31	0.06	1	7	1	4	1
Total	**18,091**	**1,111**	**339**	**507**	**1.36**	**13**	**117**	**20**	**102**	**11**

Table A-9: Change in Mass Flow Tonnages Resulting From Introduction of DRS

Products	Change in Tonnages (thousand tonnes)									
	Total Arisings	hhld Kerbside		Puntos Limpios – Recycling Only	Commercial		Litter			via DRS
		Recycling	Refuse		Recycling	Refuse	via DRS	Refuse	Env.	
Glass Bottles	0	-260	-245	-1	-8	-73	-8	-39	-6	639
PET/HDPE Bottles	0	-29	-98	0	-1	-5	-4	-22	-1	161
Cans (Fe.)	-98	-19	-81	0	-1	-7	-3	-16	-1	29
Cans (Al.)	98	-1	-17	0	0	0	0	0	0	117
Cartons	0	-6	-29	0	-1	-5	-1	-3	0	46
Total	**0**	**-315**	**-470**	**-1**	**-10**	**-91**	**-16**	**-80**	**-9**	**992**

Table A-10: Mass Flows Resulting From Introduction of DRS

Products	Total Tonnages (thousand tonnes)										No. of Deposit-Bearing Containers (millions) collected via DRS
	Total Arisings	hhld Kerbside		Puntos Limpios – Recycling Only	Commercial		Litter			via DRS	
		Recycling	Refuse		Recycling	Refuse	via DRS	Refuse	Env.		
Glass Bottles	715	20	19	0.221	2	20	2	11	2	639	3,066
PET/HDPE Bottles	180	2	7	0.045	0	2	1	6	0	161	5,108
Cans (Fe.)	33	0	1	0.003	0	0	0	1	0	29	1,209
Cans (Al.)	131	0	7	0.043	0	3	1	3	0	117	4,837
Cartons	51	0	2	0.012	0	1	0	1	0	46	1,944
Total	1,111	23	37	0.325	3	27	4	22	2	992	**16,166**

A.2.0 The Existing Household Bring Site System

This section describes the key assumptions used in modelling the existing household bring site system across Spain.

A.2.1 Collection Modelling

Unless otherwise specified, all assumptions are based on the Ecoembes report.[18] The main differences between the assumptions used in the Ecoembes report and those used in our collection modelling are:

- The mass flow modelling done above is not addressed in the Ecoembes report.
- It is assumed that the collection bins are 66% full when they are collected, but the collection frequency is not discussed.
- Vehicle costs are annualised over 8 years in our modelling rather than 9.
- Contracted hours for staff are increased to 1,800 per year for all staff in our modelling compared to the 1,554 to 1,806 hours per year used for the different autonomous communities in the Ecoembes report. The working hours per day, on the other hand, was modelled at 7 hours, rather than the 7.5 in the Ecoembes report, to include a contingency for rest, breakdowns, queuing in traffic, etc.
- An absentee rate of 10% is used rather than 5%.
- Industrial profit is assumed to be 10% rather than 5%.

A.2.1.1 Collection Bin Assumptions

Four methods of collection were modelled using different collection bin types:

1. Igloo;
2. Rear loading container;
3. Side loading container; and
4. Underground containers.

The provision of these four systems across Spain is shown in Table A-11. We assume the same provision split for each of urban, semi-urban and rural.

[18] Ecoembes (2007) *Estudio para la Determinacion de la Formula de Pago de Aplicacion a la Recogida Selectiva de Envases Ligeros*, September 2007

Table A-11: Provision of Four Predominant Bring-Style Collection Systems in Spain

System	% Provision of Collection Bin Systems[19]
Igloo	35.31%
Rear Loading	21.28%
Side Loading	33.61%
Underground and Other	9.80%

The volume of the four collection bin types is shown in Table A-12. The geographical distribution of the collection bins in litres per person is assumed to vary by bin type and population classification. Given that people in rural areas are more dispersed, a larger volume per person must be provided in order to maintain a reasonable travel time to the collection bin. In urban areas people in closer proximity to one another and therefore a smaller volume can be provided that is still close to where people live.

Table A-12: Collection Bin Specifications and Distribution

		Geographical Distribution of Collection Bins (litres per person)		
Collection Bin Type	Volume (m^3)	Rural	Semi-Urban	Urban
Igloo	2.5	9.09	6.25	5.00
Rear Loading	1.0	10.00	8.33	7.69
Side Loading	2.4	9.60	8.00	6.86
Underground	4.0	10.00	8.00	6.67

The assumed density of the materials in the containers is shown in Table A-13. The lightweight packaging and residual waste density is based on the Ecoembes report, while the density of glass is based on modelling done in the UK.[20]

[19] Ibáñez, E. (2011) *Gestión de Envases. Sistema Integrado de Gestión.* Workshop Zero Waste, Barcelona February 10th 2011, Slide 19, available at http://www.sostenipra.cat/Zero_waste_Workshop/41.pdf

Table A-13: Density of Materials in Collection Bin

	Glass	Lightweight Packaging	Residual
Density (kg m^3)	250	25	125

The capital cost of the collection bins and the assumed rate of replacement and maintenance costs are shown in Table A-14. The collection bin capital cost (including delivery) is annualised over the lifetime of the bin at a 5% interest rate. Total annual costs for the collection bins, including annualised capital, washing, replenishment and maintenance is shown in Table A-15.

Table A-14: Collection Bin Cost Assumptions

Collection Bin	Capital Cost	Delivery Cost	Maintenance and Replacement (% of Capital)
Igloo	€ 445.40	€ 26	11%
Rear Loading	€ 199.92	€ 15	11%
Side Loading	€ 692.60	€ 70	11%
Underground	€ 5,555	€ 0	2%

Table A-15: Annual Collection Bin Costs

Collection Bin	Classification	Lifetime of Bin	Number of Washes per Year	Cost per Wash	Total Annual Cost per Bin
Igloo	Rural	9	4	€ 15.79	€ 174.82
	Semi-Urban	8.5	6.5	€ 14.66	€ 209.89
	Urban	8	7	€ 13.53	€ 212.62
Rear	Rural	8	4	€ 5.64	€ 75.48

[20] Resource Futures (2009) *Bulk Density Study: Phase 2*, Report for WRAP, April 2009.

Collection Bin	Classification	Lifetime of Bin	Number of Washes per Year	Cost per Wash	Total Annual Cost per Bin
Loading	Semi-Urban	7.5	6.5	€ 5.07	€ 87.57
	Urban	7.5	8	€ 4.51	€ 90.69
Side Loading	Rural	10	4	€ 9.02	€ 201.96
	Semi-Urban	10	7	€ 9.02	€ 229.02
	Urban	10	8	€ 7.89	€ 229.00
Underground	Rural	30	4	€ 15.79	€ 535.62
	Semi-Urban	30	6.5	€ 14.66	€ 567.75
	Urban	30	7	€ 13.53	€ 567.17

A.2.1.2 Vehicle Assumptions

The vehicle specifications are shown in Table A-16. The weight and volume of the vehicles are typical of those used for waste collection in Spain, and the compaction rates are given relative to the material densities shown in Table A-13. The compaction rate of lightweight packaging is based on the Ecoembes report; glass is assumed not to compact (i.e. it has the same density in the container as in the vehicle), and residual waste is assumed to compact by a factor of four so as to not exceed the weight restrictions of the vehicles on the road.

Table A-16: Vehicle Specifications

			Compaction		
	GVW (tonnes)	Capacity (m^3)	Lightweight Packaging	Glass	Residual Waste
Igloo Vehicle	26	20	6.83	1	4
Rear-Loading Vehicle	26	22	6.91	1	4
Side-Loading Vehicle	26	25	6.21	1	4
Underground Container Vehicle	26	20	6.83	1	4

In the Ecoembes report, vehicle capital cost is annualised over 9 years at a 5% interest rate. In Spain, it might be considered more common to annualise vehicle costs over 8 years, particularly where vehicles are driving onto landfill, so in the current model we annualise over 8 years at a 5% interest rate. Other vehicle costs include maintenance, which is assumed to be a percentage of the total capital cost of the vehicle each year, and taxes and insurance, which are assumed to be a flat rate for each vehicle. Fuel costs are based on the assumption that an average vehicle uses 20,000 litres of fuel per year at a cost of € 1.30 per litre. Total vehicle costs are shown in Table A-17. Vehicles are assumed to operate over 298 days per year, as stated in the Ecoembes report, i.e. 365 minus 52 Sundays minus 15 public holidays.

Table A-17: Vehicle Costs

	Total Capital Cost	Annual Maintenance Cost (% of Capital)	Annual Insurance and Taxes	Fuel Costs	Total Annual Cost of Vehicle
Igloo Vehicle	€ 120,899.33	10.83%	€ 2,706.37	€ 26,000.00	€ 60,506
Rear-Loading Vehicle	€ 131,031.78	10.83%	€ 2,706.37	€ 26,000.00	€ 63,171
Side-Loading Vehicle	€ 171,826.34	8.97%	€ 2,706.37	€ 26,000.00	€ 70,704
Underground Container Vehicle	€ 131,031.78	10.83%	€ 2,706.37	€ 26,000.00	€ 63,171

A.2.1.3 Staff Assumptions

The Ecoembes report assumes that all vehicle staff are contracted between 1,554 and 1,806 hours per year for the different autonomous communities. Taking the average, weighted by population according to the percentage of Spain that is urban, semi-urban or rural, the contracted hours per year are shown in Table A-18. These are thought to be quite low; assuming 8 hour shifts (including a 30 min break) and a 5 day working week, this means that collection crews would only be working for 41.6 weeks per year. A more realistic value of 1,800 hours per year (45 weeks of 5 day, 8 hour shifts) was thus used as the basis for the staff costs in the bring site modelling. Based on our detailed knowledge of collection logistics and the need to also factor in time for short breaks (rest and recuperation) and any vehicle breakdowns, queuing etc, we then assumed that, although vehicle staff are contracted to collect waste for 7.5 hours per shift, their 'productive hours' (i.e. the time spent collecting and travelling to and from the depot and the tip) would actually only be 7 hours per shift.

Total staff costs are shown for drivers and loaders in Table A-19 and Table A-20 respectively. The salaries are averaged from the values for each autonomous community reported in the Ecoembes report. The Ecoembes report uses an absentee rate of only 5%, which is thought to be quite low; therefore a value of 10% is used in the current modelling to more accurately reflect illness cover. The formula used to calculate the annual staff cost is the same as in the Ecoembes report:

Total annual staff cost = ((salary + life insurance + uniform and equipment) * (1+age factor)) / (1-absenteeism).

Since staff are only assumed to work 240 days per year, while vehicles work 298 days per year, the staff costs are scaled up to determine total staff costs per vehicle, which therefore includes the extra staff that would be required to cover all the shifts and all holiday cover required to run the vehicles for 298 days per year.

Table A-18: Contracted Hours per annum for Vehicle Staff

	Drivers and Loaders
Urban	1,666
Semi-Urban	1,665
Rural	1,675

Table A-19: Driver Costs

	Average Salary	Age Factor	Absenteeism	Life Insurance	Uniform and Equipment	Annual Cost	Staff Cost per Vehicle
Urban	€29,306	5%	10%	€ 40.00	€ 300.00	€34,587	€42,945
Semi-Urban	€28,949	5%	10%	€ 40.00	€ 300.00	€34,171	€42,429
Rural	€28,661	5%	10%	€ 40.00	€ 300.00	€33,834	€42,011

Table A-20: Loader Costs

	Average Salary	Age Factor	Absenteeis m	Life Insurance	Uniform and Equipment	Annual Cost
Urban	€ 25,521	5%	10%	€ 40.00	€ 300.00	€ 30,171
Semi-Urban	€ 25,310	5%	10%	€ 40.00	€ 300.00	€ 29,925
Rural	€ 25,010	5%	10%	€ 40.00	€ 300.00	€ 29,574

A.2.1.4 Other Cost Assumptions

Other costs added to the total cost of collection include:

- Industrial profit; this is assumed to be 5% in the Ecoembes report, but we have assumed it to be 10% in our approach.
- General expenses; these are assumed to be 12.2%.
- Administration costs:
    - In Urban areas - 6.5%
    - In semi-urban and rural areas - 8%.

A.2.1.5 Timing Assumptions

Based on the geographical distribution of collection bins and the density assumptions discussed in Appendix A.2.1.1, we assume that the collection bins are filled according to the mass flows established in Appendix A.1.2.1. Once the bins are full to some 'critical' fill rate, then it is assumed they are emptied. The critical fill rates assumed and the calculated collection frequencies therefore required (lifts per week) are shown in Table A-21. The critical fill rates of 66% for lightweight packaging and 75% for residual waste are based on Ecoembes' assumptions, and the fill rates for glass are based on industry experience.

Table A-21: Critical Fill Rate Assumed for each Material, and the Resulting Collection Frequency per Week Based on the Baseline Mass Flows

		Collection Frequency per Week		
	Critical Fill	Urban	Semi-Urban	Rural
Lightweight Packaging	66%	2.32	1.95	1.40
Glass	35%	0.51	0.42	0.31
Residual	75%	5.16	4.45	3.41

The collection of the bins is based on the Ecoembes assumptions of how many collection bins can be collected per hour. These assumptions, along with other assumptions on the collection logistics are summarised in Table A-22.

Table A-22: Collection Logistics Assumptions

Collection Bin Type	Classification	Collection of Bins (No. per hour)	Time to and from Depot (hours)	Time from Round to Tip (hours)	Tipping Time (hours)	Sandwich Time (hours)
Side-loader	Rural	16.17	0.50	1.00	0.08	0.50
	Semi Urban	19.02	0.50	0.83	0.08	0.50
	Urban	23.13	0.50	0.67	0.17	0.50
Rear-loader	Rural	29.16	0.50	1.00	0.08	0.50
	Semi Urban	33.43	0.50	0.83	0.08	0.50
	Urban	47.83	0.50	0.67	0.17	0.50
Igloo	Rural	9.06	0.50	1.00	0.08	0.50
	Semi Urban	10.98	0.50	0.83	0.08	0.50
	Urban	12.51	0.50	0.67	0.17	0.50
Underground Container	Rural	7.60	0.50	1.00	0.08	0.50
	Semi Urban	7.60	0.50	0.83	0.08	0.50
	Urban	12.31	0.50	0.67	0.17	0.50

A.2.1.6 Material Incomes and Disposal

In Spain, the cost of the landfill gate fee and landfill tax varies by autonomous community. In general, there is no landfill tax, but a gate fee of around €30 is charged, while in Madrid the gate fee is €40. Catalonia is the only autonomous community with a landfill tax of €10 and a €50 gate fee.[21] The total 'lower disposal cost' scenario modelled for each autonomous community, based on the current costs of disposing of waste in landfill is shown in Table A-23, with the population weighted average calculated at €36.17 per tonne.

Current landfill disposal costs in Spain are relatively low compared to a number of other European countries. Given the need to meet the requirements of the Waste Framework Directive, including;

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[21] UCD Dublin (2010) *Economic Instruments – Charges and Taxes: Landfill Tax (EU)*, posted on 03.08.10, available at http://www.economicinstruments.com/index.php/solid-waste/article/280-

1) the need to enshrine the waste hierarchy in waste management policy and legislation; and

2) the need to comply with targets under Article 5 of the Landfill Directive,

it seems likely that the avoided cost of disposal will increase over the next few years in Spain.

A more appropriate figure for the avoided cost of disposal in future, therefore, might be the likely cost of alternative residual waste management in Spain. The cost of MBT and incineration facilities in Spain are typically around €60 to €80 per tonne, this being for existing plants, some of whose construction will have been supported by European funding, potentially keeping the costs at the lower end of what might otherwise be expected. In order to explore the financial impact of diverting waste away from existing collection systems and from disposal and into the DRS, we thus modelled two disposal cost scenarios – a lower disposal cost (at the current €36.17 per tonne for landfill) and a higher disposal cost (at €80 per tonne, i.e. at the lower end of the typical range of costs for modern MBT/ incineration plants).[22] The costs assumed for both scenarios are presented in Table A-23.

Table A-23: Landfill Disposal Cost Modelled

Autonomous Community	Lower Disposal Cost Scenario			Higher Disposal Cost Scenario
	Landfill Tax	Gate Fee	Total Disposal Cost per tonne	Total Disposal Cost per tonne
Andalucia	€ 0	€ 30	€ 30	€ 80
Aragon	€ 0	€ 30	€ 30	€ 80
Asturias	€ 0	€ 30	€ 30	€ 80
Balearic Islands	€ 0	€ 30	€ 30	€ 80
Basque Country	€ 0	€ 30	€ 30	€ 80
Canary Islands	€ 0	€ 30	€ 30	€ 80
Cantabria	€ 0	€ 30	€ 30	€ 80
Castile Leon	€ 0	€ 30	€ 30	€ 80
Castile-La Mancha	€ 0	€ 30	€ 30	€ 80

[22] It can be the case, of course, in situations of over-capacity (relative to demand) that prices fall below this. The surplus incineration capacity in Central and Northern Europe is leading to downward pressure on prices, with gate fees frequently as low as €45 per tonne in the marketplace.

Autonomous Community	Lower Disposal Cost Scenario			Higher Disposal Cost Scenario
	Landfill Tax	Gate Fee	Total Disposal Cost per tonne	Total Disposal Cost per tonne
Catalonia	€ 10	€ 50	€ 60	€ 80
Ceuta	€ 0	€ 30	€ 30	€ 80
Extremadura	€ 0	€ 30	€ 30	€ 80
Galicia	€ 0	€ 30	€ 30	€ 80
La Rioja	€ 0	€ 30	€ 30	€ 80
Madrid	€ 0	€ 40	€ 40	€ 80
Melilla	€ 0	€ 30	€ 30	€ 80
Murcia	€ 0	€ 30	€ 30	€ 80
Navarre	€ 0	€ 30	€ 30	€ 80
Valencian Community	€ 0	€ 30	€ 30	€ 80
Average weighted by the population in each community			**€ 36.17**	**€ 80**

The material incomes per tonne, shown in Table A-24, are the values that are obtained once the material has been processed through a sorting facility to separate out the various packaging material streams, and are net of the cost of onward transport to the reprocessing facility. The sorting cost is assumed to be €158 per tonne of material going into the sorting facility plus €232 per tonne of recyclate output from the facility (assuming that 65% of the input material is subsequently recycled). This results in an overall sorting cost of €309 per tonne of input material.[23]

[23] Based on figures from Asplarsem (sorting plants association) from 2006, see http://asplarsem.com/public/asplarsem.com/mod_listador_simple_a528/formulas-pago/Formula%20Seleccion%20Envases.pdf

Table A-24: Income and Sorting Costs per Tonne of Material Collected (note incomes are negative and costs are positive).

Material	Income per tonne[24]	Sorting Cost per tonne	Total Cost
Glass	-€ 17	-	-€ 17
PET	-€ 266	€ 309	€ 42
HDPE	-€ 262	€ 309	€ 47
Aluminium Cans	-€ 750	€ 309	-€ 441
Steel Cans	-€ 210	€ 309	€ 99
LPB	€ 0	€ 309	€ 309

A.3.0 The Deposit Refund System Model

The various stakeholders in an operating deposit refund system are:

- A government body authorising the system and associated finances, and setting recycling targets for the various materials;
- A central organisation owned and run (within the constraints set by the authorising body) by, for example, non-governmental organisations, industry bodies, producers, breweries and retailers;
- The manufacturers of containers, producers of beverages and industries that 'fill' the containers;
- Any retailer which sell beverages in Spain;
- All consumers which purchase beverages in Spain; and
- Businesses and organisations involved with the collection, sorting and reprocessing of waste containers.

Various stakeholders are involved in the material flows of beverages (pre and post-consumption), deposit payments, other finances and sales or container return data. An overview of the key elements, material and finance flows, in the Spanish deposit refund system model developed for this study is given in Figure A-3.

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[24] Based on figures from the Ecoembes public tender (2011), see http://www.ecoembes.com/es/gestion-del-envase/reciclaje-del-envase/resultados-de-adjudicaciones/envases-ligeros/Paginas/resultado-adjudicaciones-eell.aspx

The system developed for this study is based on similar principles (though the details reflect the Spanish structure of retailing) to the systems which exist in Denmark (Dansk Retursystem, Norway (Norsk Resirk), Sweden (Returpack), Finland (Palpa), and in a number of provinces within Canada (ENCORP Atlantic Ltd, ENCORP Pacific Inc). The operation of the system is described in the following points:

- As beverages are produced and sold to wholesalers, or directly to retailers, producers send sales data to a central system along with a payment matching the total value of the deposits on all items sold. The cost of the deposits is then paid back to the producers, by wholesalers or retailers, upon sale. The same happens as wholesalers sell items to retailers. Producers also pay an administration fee to cover the remaining costs of the system. This is adjusted periodically to reflect market prices of recyclate, amongst other factors;
- When the consumer purchases a beverage they pay the deposit to the retailer, so the retailers are also reimbursed the total value of deposits;
- As consumers return empty containers to stores (or any other take-back centre) the deposit is paid to them by the retailer. This puts the retailer out of pocket, so they send return data to the central system, which reimburses the retailer. Thus the circle of deposit payments is closed. As the return rate for containers is not 100% the central system will not need to reimburse the retailers the full amount of deposits, so money will remain with the organisation to fund its operation.
- In addition to the deposit, the central system pays a handling fee to the retailer for each returned container, the intention being to compensate the retailer for loss of space (storage requirements) and time (in processing the deposit and taking back the containers);;
- Returned empty containers are collected in a number of ways. Automated systems of collection use reverse vending machines (RVMs). Manual collection is also possible. In this instance the retailer accepts the container, over the counter, and stores it in bags or crates at the back of the store/outlet for transport;[25]
- Where the containers are collected via an RVM, the sorted and compacted material can be transported either directly to a recycler or via a logistics centre, with the material revenues being paid back into the central system. Material revenues will also be paid on those containers that are collected manually, though the containers will first have to be transported to a

[25] This differs to the typical systems employed in countries such as South Australia and Canada, where collections occur at a small number of redemption centres rather than at every retail outlet. We believe that in order to maximise return rates and to remove the need for consumers to travel individually make their way to redemption centres to return their containers, a denser network of collection points would be more appropriate for Spain, and would eliminate additional environmental impacts which might arise from making 'dedicated journeys' to redemption centres. Thus we have modeled the system based on a high number of collection points via both automated and manual methods of collection, similar to systems used in Norway and Denmark.

dedicated centre for counting, sorting and compacting, before it can be hauled on to a recycling facility. These logistics costs are met by the central system;

- The central system is the focal point for the flow of information regarding container sales and finance for the whole deposit refund system. A significant one-off cost will be required to initially set up the deposit refund system, including all the necessary administrative support, which we have modeled as being met by 'one-off' producer and retailer joining fees. There will also be on-going costs associated with administering the system which are covered as part of the producer administration fee paid on each unit that is placed on the market. The overall administration fee payable by the producers/ importers is calculated as the balance of income from material revenues and unclaimed deposits against the costs of collection, transport, processing, admin, marketing and handling fees. In other words, the administration fee guarantees the DRS is 'cost neutral' overall.

It is worth noting that the system modeled here differs to that which exists in Germany, where the organisation that manages the deposit refund scheme, the DPG, only has an 'over-seeing' role. The system in Germany is much less centralised, with retailers able to set up their own systems of collection and processing, and payments moving directly between the producer and retailer (predominantly through one of six third party clearing service providers) rather than going through a central system.[26] In order to maintain as simplistic an approach as possible to setting up a DRS in Spain, we chose to model the Spanish system based on the central model, seeking to learn from experiences that have been highlighted in the operation of the German system, and indeed, others.[27,28] However, that is not to say that a more decentralised approach would not work should the Spanish Government decide that this would be its preferred approach.

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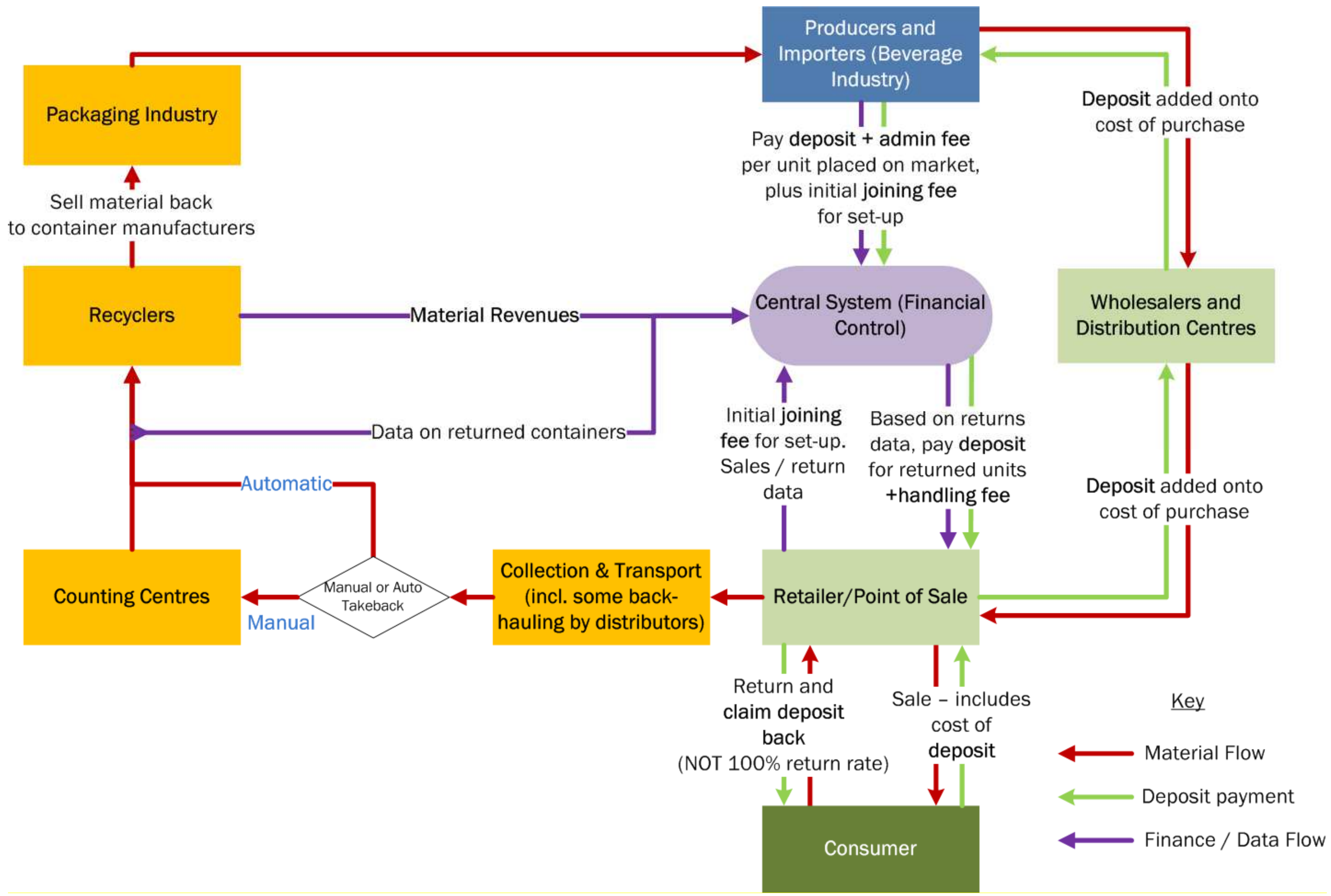
[26] Ernst & Young (2009) *Assessment of Results on the Reuse and Recycling of Packaging in Europe*, report produced for the French Agency for Environment and Energy Management (ADEME), March 2009.

[27] Perchards (2007) *Study on Factual Implementation of a Nationwide Take-back System in Germany After 1 May 2006*, Final Report, 14 February 2007.

[28] G. Bevington (2008) *A Deposit and Refund Scheme in Ireland*, Report commissioned by Repak Ltd., September 2008.

Figure A-3: Deposit Refund System Model



A.3.1 The Deposit and Return Rates

One of the crucial elements in the deposit model is the setting of the deposit itself. The value of the deposit for Spain was calculated based on deposits and return rates from other systems around the world. The return rate was plotted as a function of the deposit across existing schemes (see Figure A-4) in order to establish what return rate would be likely to be achieved based on a €0.20 deposit for the Spanish system.

The following best fit line was calculated for the data shown:

$$\text{Return Rate} = 0.0422Ln(x) + 0.9618$$

As illustrated in Figure A-4 an 85% to 95% return rate is currently achieved across a number of DRSs worldwide; if we assume that the principle motivation driving returns is an economic one, such return rates should therefore be achievable across Spain. We note, however, that other factors will also be involved in obtaining high return rates, including ensuring that there are sufficient return points for the DRS containers, and whether or not people in Spain are used to returning containers i.e. the 'habit of return'.[29,30] In respect of the former point, our modelling is designed with a significant number of return points in order to make returns as easy as possible. Regarding the latter, we would argue that there appears to be no evidence to suggest that a habit could not be established anew given the financial incentive of the DRS.[31] Indeed, in the recent CECU study it was found that 89.6% of the people consulted would collaborate with a DRS.[32]

The deposits were converted from the local currency of the DRS to Spanish Euros using OECD Actual Individual Consumption Purchasing Power Parities from 2009 to give a better estimate of the value of the deposit than simply using the current exchange rate.[33] Figure A-4 illustrates that, in setting a deposit of €0.20 per container, the return rate for the system would be 89%. Sensitivity analysis is presented in the main body of the report on the potential financial impacts of applying different deposit values and the resultant return rates that might be obtained from the system.

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[29] Perchards (2005) *Deposit Return Systems for Packaging Applying International Experience to the UK, Peer Review of a Study by Oakdene Hollins Ltd.*, Report to Defra 14 March 2005

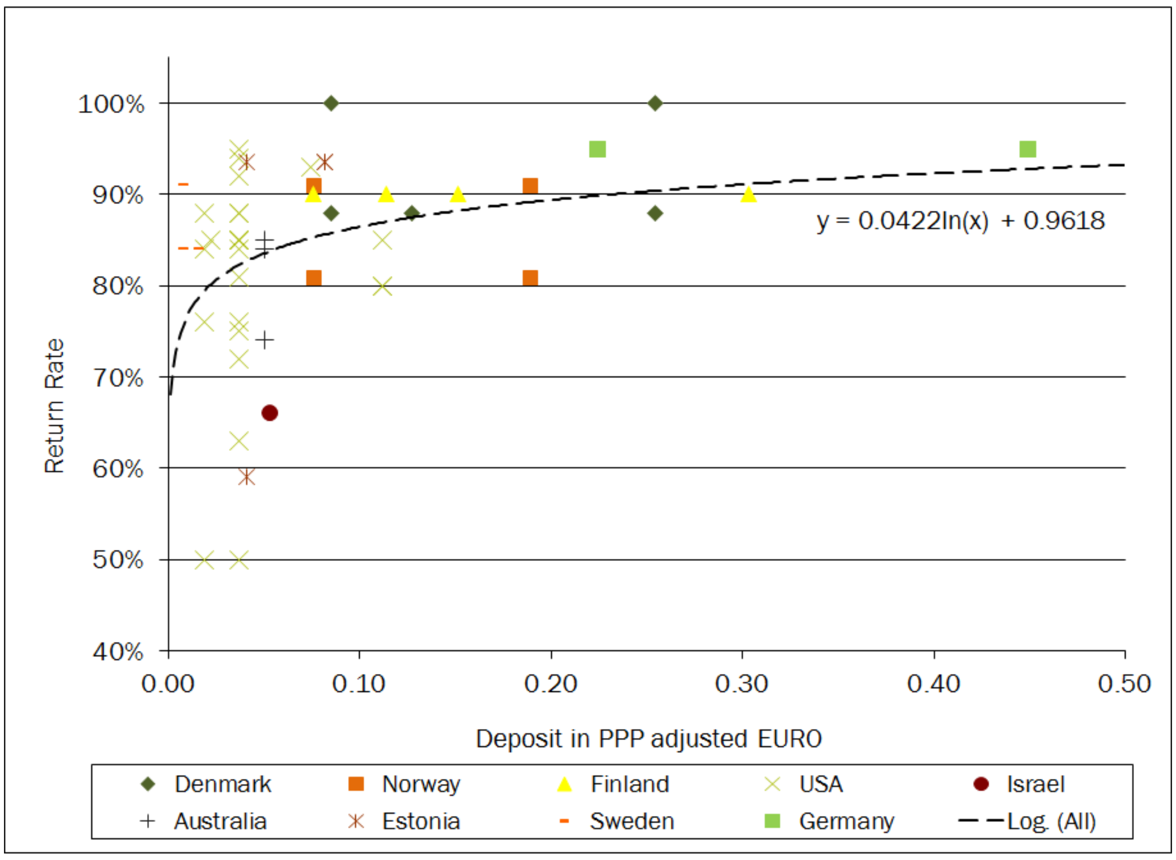
[30] Thomas Sterner (1999) Waste Management and Recycling, in T. Sterner (ed.) (1999) *The Market and the Environment: the Effectiveness of Market-based Policy Instruments for Environmental Reform*, Cheltenham: Edward Elgar

[31] Eunomia Research and Consulting (2010) *Have We Got the Bottle? Implementing a Deposit Refund System in the UK*, report for the Campaign to Protect Rural England, September 2010.

[32] CECU (2011) *Estudio Sobre la Acogida del Sistema SDDR en España. Investigación Cuantitativa.*

[33] OECD (2010) Purchasing Power Parities (PPP), Accessed May 2011, http://www.oecd.org/department/0,3355,en_2649_34357_1_1_1_1_1,00.html

Figure A-4: Return Rates as a Function of Deposits in PPP-Adjusted Spanish Euros



Source: Eunomia

A.3.2 Handling, Collection, Logistics, and Processing

The costs of handling the containers at retail outlets are borne by the retailers themselves, and the costs of transport and collection by the central system. This Section outlines the determination of these costs.

A *handling fee* is included in deposit refund systems to compensate the retail industry for the additional cost realised through having to handle returned beverage containers. In the current economic climate, many retailers would be opposed to an additional *uncompensated* cost on their business. In determining the handling fee, the key considerations centre on the collection of returned beverage containers i.e. where are the containers returned to, and how are they accepted by the retailer? Both these factors clearly affect the nature of the collection logistics required. It is therefore important to understand first the retail landscape prior to determining the system specification. This is described in the first of the sections below, along with the outline design of the container take back and collection system.

Interestingly in other systems the handling fee is not directly linked to the costs incurred by businesses.[34] However, for this study it was felt appropriate to base the initial handling fee on some rational considerations of the costs incurred. Moreover, calculating the handling fees in this way enables their more straightforward inclusion in the financial analysis.

A.3.2.1 Retail Landscape and System Design

Part of the 2009 European Commission communication on beverage packaging, deposit systems and free movement of goods highlights that whilst Member States are allowed to introduce a DRS if considered necessary for environmental reasons, the system needs to be designed in order to ensure a fair, open and transparent system.[35] The design needs to ensure that a sufficient number of return points for consumers exist to encourage participation in the system, the avoidance of 'island solutions' - a retailer-owned patchwork of different return systems which are not compatible and which often force additional costs on suppliers to adapt packaging to the requirements of the specific retailer, and a system which is open to all economic participators in the sector concerned.

In order to ensure in our modeling that a sufficient number of return points are subsequently available to consumers in the Spanish system, we have modeled the system as requiring a collection point at virtually all retail outlets that sell beverage containers. In order to try to give the retailer a choice as to how returned containers are subsequently collected, and to make the return easier for larger stores to which most containers would most likely be returned, we have also modeled each retail outlet as using either an automated system of collection (e.g. reverse vending machine) or a manual collection, where the retailer takes back the container over the counter and stores the containers in bags/crates at the back of the store/outlet for transport. A denser network of collection points is modelled in order to maximise return rates, to remove the need for consumers to travel individually to redemption centres to return containers, and to reduce litter caused by the disposal of containers whilst 'on the go'.

In order to be as comparable as possible with the recently published Sismega summary report, the types and total numbers of grocery store outlets in Spain that might accept returned containers were based predominantly on data from the same source i.e. data provided by Nielsen (a global market research company).[36] To this was added data on several key additional retailer types across Spain that might also sell beverage containers, but which were not considered as part of the Sismega study (namely food stores, gas stations/service areas/convenience stores and catering

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[34] Personal communications with TOMRA, May 2010

[35] EC (2009), *Communication from the Commission: Beverage Packaging, Deposit Systems and Free Movement of Goods*, May 2009

[36] 2010 data provided by Nielsen, covering all hypermarkets and supermarkets, traditional stores, restaurants and hotels, clubs, bars, pubs and cafes.

facilities in the workplace).[37,38,39] It is estimated that there are over 320,000 outlets currently operating in Spain that are likely to sell beverages (see Table A-25). The types of retail outlet considered were:

- Hypermarkets (> 2,500 m^2);
- Supermarkets (1,000 - 2,499 m^2);
- Supermarkets (400 – 999 m^2);
- Supermarkets (100 - 399 m^2);
- Supermarkets (< 100 m^2);
- Traditional shops;
- Food stores;
- Restaurants and hotels;
- Clubs, bars and pubs;
- Cafes;
- Other bars;
- Catering in workplace; and
- Gas stations/service areas/convenience stores.

[37] Fundación Hostelería de España (2010) *Los Sectores de la Hostelería en 2009.*

[38] La Caixa (2009) *Anuario Económico de España 2009,* available at http://www.anuarieco.lacaixa.comunicacions.com/java/X?cgi=caixa.anuari99.util.ChangeLanguage&lang=cat

[39] Alimarket (2010) *Informe anual Alimarket de Distribución 2010.*

Table A-25: Number of Retail Outlets in Spain that Sell Beverages

Type of Retailer	Number of Retail Outlets
Hypermarket (>2,500 m^2)	438
Supermarket (1,000 - 2,499 m^2)	2,996
Supermarket (400 - 999 m^2)	4,891
Supermarket (100 - 399 m^2)	8,890
Supermarket (< 100 m^2)	10,078
Traditional Store	26,494
Food Stores	29,844
Restaurants and Hotels	57,640
Clubs, Bars and Pubs	23,483
Cafes	137,302
Other Bars	9,152
Catering in the workplace	12,223
Gas Stations/Service Areas/Convenience Stores	5,893
Total	329,324

Table A-26 shows the proportion of each retail category that is likely to pay a joining fee and form part of the deposit scheme, and that would be able to accept the return of all containers. A significant amount of the beverages sold in Horeca are in refillable rather than non-refillable containers. In reality, the Spanish system may consider Horeca outside scope, depending on the proportion of the beverages that they sell in refillable compared to non-refillable containers. However, given the current trend towards an increasing amount of beverages being sold in non-refillables across Spain, the assumption that a proportion of these retailers would be in the DRS is perhaps a more sensible and conservative approach.[40] The proportion of Horeca assumed to be in the DRS was thus calculated based on the amount of beverages sold across each retail type in non-refillable rather than refillable containers.

[40] It is perhaps worth noting that in, for example, Norway, most Horeca are included in the DRS, whereas in Germany, the majority are not.

Table A-26: Percentage of each Retail Type Joining the Deposit System and Requiring a Collection of Containers

Type of Retailer	Retailers in System	Rationale
Hypermarket (>2,500 m^2)	100%	Relatively large sales / return volumes at each retailer type, so all assumed to join DRS, as per Sismega summary report.
Supermarket (1,000 - 2,499 m^2)		
Supermarket (400 - 999 m^2)		
Supermarket (100 - 399 m^2)		
Supermarket (< 100 m^2)		
Traditional Store		
Food Stores		
Restaurants and Hotels	25%	It is assumed that only a quarter of hotels, restaurants, clubs, pubs and bars will receive enough returned non-refillable containers to warrant a collection. Majority of containers assumed to be refillables.
Clubs, Bars and Pubs		
Other Bars		
Cafes	50%	Assume that half of cafes will sell enough beverages from non-refillable containers to warrant a collection rather than employees returning containers to local convenience stores themselves.
Catering in the Workplace	10%	Assume only 10% will sell or receive enough non-refillable containers to warrant being part of the DRS.
Gas Stations/Service Areas/Convenience Stores	100%	Assume all gas stations/service areas will receive enough returned containers/sell enough non-refillable beverages to warrant a collection.
Kiosks	0%	All kiosks will be too small to join the system, and therefore it is assumed that employees from kiosks will take any containers that are returned to them to local supermarkets.

It should be noted that, in this model, it is assumed that retailers are only obliged to take back the container types that they sell. Where a small retailer stocks all material types and is manually taking back containers, rather than stocking separate boxes for returned glass, when in small volumes the glass would probably be placed in the bag with commingled plastics and cans – this is the current procedure in Germany and Denmark.[41]

We have assumed that all small kiosks would opt not to participate in the system, and would instead take returned containers to the nearest convenience store or supermarket– this is common practice in other countries, and may be supported by a policy for granting (particularly) small businesses exemptions from the requirement to take-back any containers other than those sold by the particular business. As noted in the recent communication from the Commission on deposit systems, consideration should be given to small businesses as follows:[42]

> *"Exemptions for small businesses - Member States may reduce some of the operational obligations concerning deposit systems for participating small businesses, based e.g. on de minimis considerations. To give an example: Small kiosks may not have the storage space necessary for meeting their take-back obligations. Therefore, it might be considered reasonable to grant them certain exemptions. However, it is advisable to assess whether any such exemption would not affect the overall quality and functioning of the deposit and return system as such, or would lead to discriminatory application of its conditions."*

Information on market distribution for the main beverage sectors was taken from relevant sector reports.[43] Assuming that refillables are sold through Horeca rather than through grocery stores, the figures were then adjusted to remove refillables from the market share calculations, The material composition of the containers sold in each sector was then estimated based on the Canadean data, which breaks down sales into beverage type (beer, soft drinks, juices, water), container type (bottle, can, keg etc) and container material (glass, PET, HDPE, other plastics, cans, cartons). From this data, the proportion of glass bottles, plastic bottles, cans and cartons returned to each type of retail outlet was calculated, the key assumption being that the majority of containers will be returned to the same type of retail establishment as they were sold. Finally, an adjustment was made to the proportions to account for those instances where not all retailers were assumed to be part of the DRS, and hence would need to go to other stores to return those containers that are returned to them by the consumer. In this instance, we assumed that these containers would be returned to stores with automated (RVM) collections rather than manual collections. The final proportions of each container material type assumed to be returned to each retailer are presented in Table A-27.

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[41] Personal communication with TOMRA.

[42] EC (2009) *Communication from the Commission: Beverage Packaging, Deposit Systems and Free Movement of Goods*, May 2009

[43] Mercasa (2011) *La Alimentación en España 2010,* available at http://www.munimerca.es/mercasa/alimentacion_2010/3_info_sectores.html

Table A-27: Proportions of each Material Type Collected by each Retailer Type (%)

	Glass	PET/HDPE	Cans	Cartons
Hypermarket (>2,500 m^2)	24.34%	21.89%	24.80%	13.96%
Supermarket (1,000 - 2,499 m^2)	29.70%	28.56%	28.62%	30.98%
Supermarket (400 - 999 m^2)	20.08%	19.61%	19.61%	22.03%
Supermarket (100 - 399 m^2)	13.72%	13.70%	13.65%	16.11%
Supermarket (< 100 m^2)	2.91%	2.70%	2.72%	2.70%
Traditional Store	1.51%	2.55%	1.41%	0.16%
Food Stores	3.27%	4.88%	3.02%	2.56%
Restaurants and Hotels	0.17%	0.25%	0.28%	0.52%
Clubs, Bars and Pubs	2.01%	2.87%	3.23%	6.13%
Cafes	0.07%	0.10%	0.11%	0.20%
Other Bars	0.10%	0.10%	0.10%	0.10%
Catering in the workplace	1.00%	1.00%	1.00%	1.00%
Gas Stations/Service Areas/ Convenience Stores	0.00%	0.00%	0.00%	0.00%
Kiosks	0.00%	0.00%	0.00%	0.00%
Total	100%	100%	100%	100%

The next step to consider was how the containers would be taken back by retailers. Table A-28 shows the proportions of each retail category which we have assumed would have an RVM in their store for automated take back of containers and the average number of RVMs per store, with the remaining proportion of each retail category assumed to take back containers manually. In assuming that the majority of containers would be likely to be returned during a daily two hour peak time (with all day Saturday also assumed to be peak hours) we found that the busiest hypermarket and supermarket RVMs would need to process around 34 containers a minute during peak times, based on an average of 3 RVMs per hypermarket and 2 RVMs per large supermarket. This is within the operating capacity of RVMs, which is typically around 30 to 45 container per minute.

Table A-28: Number of Retail Outlets Requiring RVMs and Number of RVMs per Store

Type of Retailer	% of Retailers Requiring an RVM	No. of RVMs per Store
Hypermarket (>2,500 m^2)	100%	3
Supermarket (1,000 - 2,499 m^2)	100%	2
Supermarket (400 - 999 m^2)	100%	1
Supermarket (100 - 399 m^2)	50%	1
Supermarket (< 100 m^2)	0%	
Traditional Store	0%	
Food Stores	25%	1
Restaurants and Hotels	0%	
Clubs, Bars and Pubs	0%	
Cafes	0%	
Other Bars	0%	
Catering in the workplace	0%	
Gas Stations/Service Areas/Convenience Stores	0%	

Source: Eunomia

From this analysis the total number of retail outlets requiring an RVM in Spain is calculated as around 20,231, with the total number of RVM machines at 24,103. To put this figure into context, in Germany (a country which places a similar number of one-way containers on the market per annum as Spain) the equilibrium number of RVMs is also circa 30,000.[44]

The number of businesses opting to join the system but <u>not</u> requiring an RVM is estimated at around 162,000.

The combined analysis of retail outlets, market distribution, container material type and likely take back methods, culminates in the initial flow of containers shown in Table A-29. From this analysis, it is thus assumed that 79% of container collection will be via automated take back, and 21% via manual take back.

Table A-29: Number of Containers Requiring Collection via RVMs or through Manual Take Back, millions

Product	RVMs	Manual
Glass ≤0.5 l	2,134	475
Glass >0.5 l	374	83
PET/HDPE ≤0.5 l	1,339	375
PET/HDPE >0.5 l	2,652	742
Cans (Fe.)	3,899	938
Cans (Al.)	975	235
Cartons ≤0.5 l	1,067	343
Cartons >0.5 l	404	130
Total	12,844	3,321

Source: Eunomia

A.3.2.2 Transport Costs

The main principles underlying the transport cost calculations for the DRS are:

- Backhauling using existing logistics networks is relatively common practice for larger retailers (e.g. supermarkets);
- Containers from smaller outlets are collected by logistics contractors using curtain-side, or back lift, lorries, in the range 12 to 18 tonnes;

[44] Personal communication with TOMRA, May 2010.

- Containers are transported either directly to recyclers via bulking/storage facilities (where already 'cleared') or to counting centres for clearing.[45]

The overall transport logistics system is summarised in Figure A-5.

Backhauling

One area which will provide a significant logistical efficiency and resultant financial savings is backhauling. This is where delivery vehicles that distribute products to shops fill the empty space with returned deposit containers, rather than the current practice which is to return to the retail logistics centre empty. Where possible, it is recommended to backhaul containers using existing logistics infrastructure. This would be a simpler task where a large retailer is in control of its own logistics or a large distribution company delivers the majority of the products to a store.

For smaller shops, backhauling will be less beneficial for the supplier, as transporting the smaller volume of containers to a recycler or counting centre will be less efficient. What the fulcrum of cost to benefit would be is unclear from this high level analysis. However, it is likely that wholesalers which deliver to almost all Spanish gas stations using their own logistics from their own central warehouse depots will use these trucks for backhauling (like the Lekkerland group does in Germany for instance). The bags with the manually returned containers will be picked up by the system operator at the wholesaler depot to minimise overall transport costs. What can be said in any case is that retailers and suppliers will seek to optimise their arrangements in the most appropriate manner and that back-hauling where possible will reduce the overall logistical costs of collecting and hauling material.

Estimates regarding the proportion of each retail category assumed to be able to backhaul are shown in Table A-30. The key assumptions in the setting of these conditions were:

- Almost all hypermarkets and larger supermarkets are likely to be able to backhaul using their existing distribution logistics;
- Similarly, almost all of the containers collected via Horeca in the DRS are likely to be backhauled by the distributors as they deliver new beverages for sale;
- The potential for backhauling is diminished when considering smaller grocery stores or other catering sectors. We have thus assumed that half of the containers collected through smaller stores such as traditional stores and food stores will be backhauled via beverage distributors.

As can be seen from Figure A-5 the backhauled containers from the retail outlets are transported back to either the retailer's own logistics depot or direct to one of the counting centres.[46] The types of retail outlets for which backhauling will be more likely are closely aligned to those which will be installing an automated take-back system,

[45] 'Cleared' means that the container has been processed and recorded as returned in the central system, and the subsequent handling fee and deposit can be paid out to the retailer.

[46] It is recognised that some optimisation, or expansion, of depots may be required.

such as an RVM. This means that almost all of the backhauled containers will already be 'cleared' in the central system and compacted ready for transport. Consequently, loading and unloading of the collection vehicles will be more efficient. Nonetheless, particularly for the material collected via clubs, bars and pubs, a small amount of clearing and compacting of containers will still be required. This will either take place at the centralised retailer logistics depots using automated high-speed counting devices or via transportation to one of the centrally-operated counting centres (the costs for which are discussed in Appendix A.3.2.4).

The marginal cost to the distribution company for backhauling to their centralised logistics depot would be a minor increase in fuel usage, due to the increased weight of the returning vehicles. Labour time is assumed to remain constant as vehicles need loading with returned logistics cages regardless.

The costs associated with backhauling containers were calculated as follows:

- Based on the percentage of backhauling per retailer type in Table A-30 the number of compacted and uncompacted containers to be collected via backhauling was calculated. It should be noted that the compacted containers collected via RVMs will already be 'cleared' in the DRS whereas the uncompacted containers will still need to be cleared through a counting centre.
- The costs of the transport logistics are strongly linked to the number of collection receptacles required to store the returned beverage containers, which in turn are driven by the number or beverage containers that can fit in each receptacle. For compacted containers collected in RVM bins we assumed each bin can fit either 500 glass bottles, or 800 plastic bottles, or 3,500 cans or 900 beverage cartons per bin.[47] For uncompacted containers we assumed that 40 glass bottles can be stored per crate and either 150 plastic bottles, or 200 cans or 100 cartons per bag (see Section A.3.2.3 for more on containment cost calculations). We then calculated how many collection receptacles would be filled per retailer per week, and therefore how many pickups would be likely to be required given the likely storage space in each retail outlet (and also taking into account that each lorry is only likely to have around 30% to 50% spare capacity for the beverage containers, given that they will also be likely to be already taking back other packaging such as card). The number of pickups required per retailer type per week is presented in Table A-30.
- We then multiplied the number of retailer outlets assumed to use backhauling to transport returned beverage containers by the number of pickups required per annum to derive the total number of backhaul pickups per annum.
- We assumed that 300km is travelled per pickup in order to deliver the containers back to the logistics depot or counting centre. We then multiplied

[47] Personal communication with TOMRA, August 2011.

the number of pickups required by 300km to give the total distance travelled per annum.

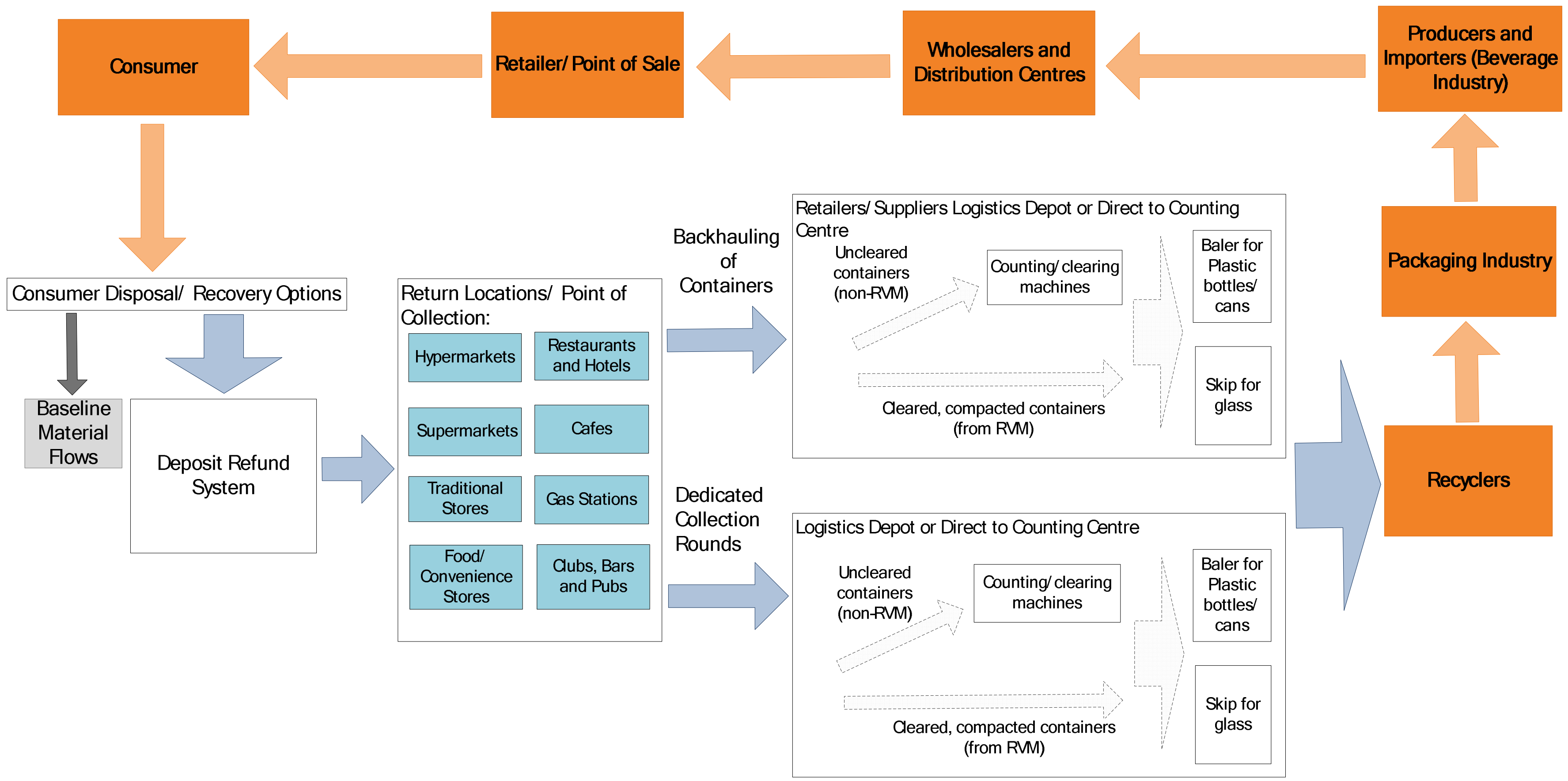
- The fuel consumption of the lorries was estimated at 3.9 km/litre when empty and 2.3 km/litre when full. Assuming that the containers add 10% by weight to lorry, the fuel consumption was calculated at 3.7km/litre for each journey i.e. 0.2 km/litre less than if the vehicle was empty on return to depot.
- Fuel was costed at €1.30 per litre.
- We then calculated the difference in fuel cost if empty compared to when 10% full, and determined a total cost of backhauling at €37million per annum.

Table A-30: Backhauling from Retailers and Number of Pickups required per Week

Type of Retailer	% of Retailers able to Backhaul	Average Number of Pickups Per Week
Hypermarket (>2,500 m^2)	90%	14
Supermarket (1,000 - 2,499 m^2)	90%	4
Supermarket (400 - 999 m^2)	90%	2
Supermarket (100 - 399 m^2)	80%	2
Supermarket (< 100 m^2)	50%	1
Traditional Store	50%	0.5
Food Stores	50%	1
Restaurants and Hotels	80%	0.5
Clubs, Bars and Pubs	90%	0.5
Cafes	80%	0.5
Other Bars	80%	0.5
Catering in the workplace	50%	0.5
Gas Stations/Service Areas/Convenience Stores	90%	1

Source: Eunomia

Figure A-5: Transport Requirements for Container Collection



Dedicated Collection Rounds

Particularly for smaller businesses the possibility of backhauling may be limited due to the multiple suppliers servicing the outlet. It is assumed that all those retailers not able to backhaul will require a dedicated collection.

Under these assumptions, just over 3.3 billion containers would require dedicated collections from around 54,000 locations throughout Spain every year. As illustrated in Figure A-5 the collected containers are transported to a logistics depot for bulking and onward transfer to reprocessors (if already cleared in the DRS) or for transport on to counting centres if not yet cleared in the DRS (for further information on counting centres see Appendix A.3.2.4). The setup would be similar to that described above at the retailers' logistics depots – requiring counting of un-cleared containers, baling of plastics, cans and cartons, and storage of glass cullet in skips. As described above, the types of stores installing RVMs are assumed to be similar to those which could effectively utilise backhauling. Therefore, the majority of containers collected on dedicated collection rounds will be uncleared and uncompacted.

The following vehicle setup is assumed for transporting the uncompacted, uncleared containers from retailer locations to the logistics depots:

- Vehicles will be 12 to 18 tonne curtain-siders, or back lifts;
- Sealed boxes for glass will be stacked on the floor of the vehicle; and
- Cages will be used to store bags of co-mingled plastic bottles, cartons and cans above the glass.

In reality, the design of the collection vehicles will vary according to service provider and will depend on the detailed logistics that are required for the collection systems in different areas. Nonetheless, the basic vehicle set-up described above should provide a logical starting point on which to model the required collection logistics at a Spanish-wide level.

A simple collection model was developed to determine the number of vehicle days that will be required per annum to collect the containers, and the cost of operation per vehicle. The key assumptions regarding vehicle volumes and collection times are presented in Table A-31. In order to determine the average volume per pickup, the following assumptions were required:

- Number of pickups required per retailer type per week (see Table A-32). This was calculated based on the number of containers returned to a particular retailer type and hence on the number of logistics containers/ collection receptacles that require collection each week in order to keep the amount of storage space to a manageable amount (see Appendix A.3.2.3 for further details).

- Bulk densities of the containers to be picked up, estimated based upon likely number per Europallet, and knowledge of wastes collected for recycling:[48,49]
  - Glass bottles – 250 kg/m³ compacted and 100 kg/m³ un-compacted;
  - Mixed plastic bottles, cans and beverage cartons – 100 kg/m³ compacted and 20 kg/m³ un-compacted.

In addition, it is assumed that drivers work a 10 hour day, 12% of which is non-driving time, including time for breaks and vehicle checks (to ensure that the amount of time spent driving is under the 9 hours per day required by EU regulations). The cost to operate a vehicle per day (including capital costs, the driver's wage, fuel costs, maintenance, a 10% profit margin and a 10% contingency) is estimated at around €443.

Table A-31: Dedicated Collection Round Assumptions

	Urban	Rural/Mixed
% of Retailers[50]	54%	46%
Number of Cages per Vehicle (each 2m3)	18	9
Average Vehicle Volume (m^3)	36	18
Average Volume per Collection per Annum (m^3)	1.4	1.4
Number of Collections before Vehicle is 90% Full	24	12
Time to Start of Round (min)	20	30
Time to Pick Up Containers per Collection Point (min)	5	5
Time Between Collection Points (min)	8	15
Time to Travel to and Offload Collected Material (min)	30	45
Time to Return from Tip to Base (min)	30	45

[48] Personal communication with TOMRA and Andy Grant, Eunomia, July 2010.

[49] Resource Futures (2009) *Bulk Density Study: Phase 2*, Report for WRAP, April 2009.

[50] Based on initial population analysis undertaken for household bring site collection system modelling (see Appendix A.1.2.1)

Table A-32: Number of Dedicated Collection Pickups required per Week

Type of Retailer	Number of Retailers Requiring a Collection	Pickups per Week (Dedicated Collection Rounds)
Hypermarket (>2,500 m^2)	44	14
Supermarket (1,000 - 2,499 m^2)	300	7
Supermarket (400 - 999 m^2)	3,913	3
Supermarket (100 - 399 m^2)	8,890	3
Supermarket (< 100 m^2)	10,078	1
Traditional Store	26,494	0.5
Food Stores/ Convenience Stores	29,844	1
Restaurants and Hotels	14,410	0.5
Clubs, Bars and Pubs	587	0.5
Cafes	68,651	0.5
Other Bars	2,288	0.5
Catering in the workplace	1,222	0.5
Gas Stations/Service Areas	5,893	1

The cost of onward transport to counting centres for those containers that need to be cleared in the DRS was also calculated. Based on the same bulky density values as specified above, and assuming that a 33 tonne lorry could transport approximately 64 m^3 of uncompacted containers per trip (at an 80% fill rate), the number of lorry trips required per annum to the eight counting centres across Spain was calculated. The average distance per trip was assumed to be 300 km and the total haulage cost was calculated at €1.1 per kilometre travelled. This cost was multiplied by the total distance travelled to generate a total haulage cost of €15million per annum.

The total cost of collecting containers through dedicated collection rounds is therefore estimated at €59 million (collection rounds plus onward haulage to counting centres). It should be noted that the approach to calculating dedicated collection round costs does not include any optimisation of logistics, and results in a relatively expensive cost per tonne of €220. This is because, in our simple collection model, the second round of collections each day does not result in a full vehicle load before tip. In reality, logistics companies would be likely to organise rounds more efficiently to ensure the vehicle is as full as possible at the end of each round, and therefore that less vehicles are required overall than has been modelled here.

A.3.2.3 Logistics Container Costs

Many permutations of setup for the transportation of containers are possible. The nature of the system is dependent upon whether or not the containers have been cleared through the DRS.

If the containers have already been cleared through the RVM/ automated machine in-store, the shape of the containers does not need to be preserved for downstream recognition. Consequently, the items are compacted and an applicable containment device used. Experience from other countries suggests that collapsible plastic bins are a useful mechanism for the transportation of compacted containers received through RVMs (see Figure A-6). When backhauling, these bins could be stored folded up in the vehicle and given to the retailer to replace the full bin.

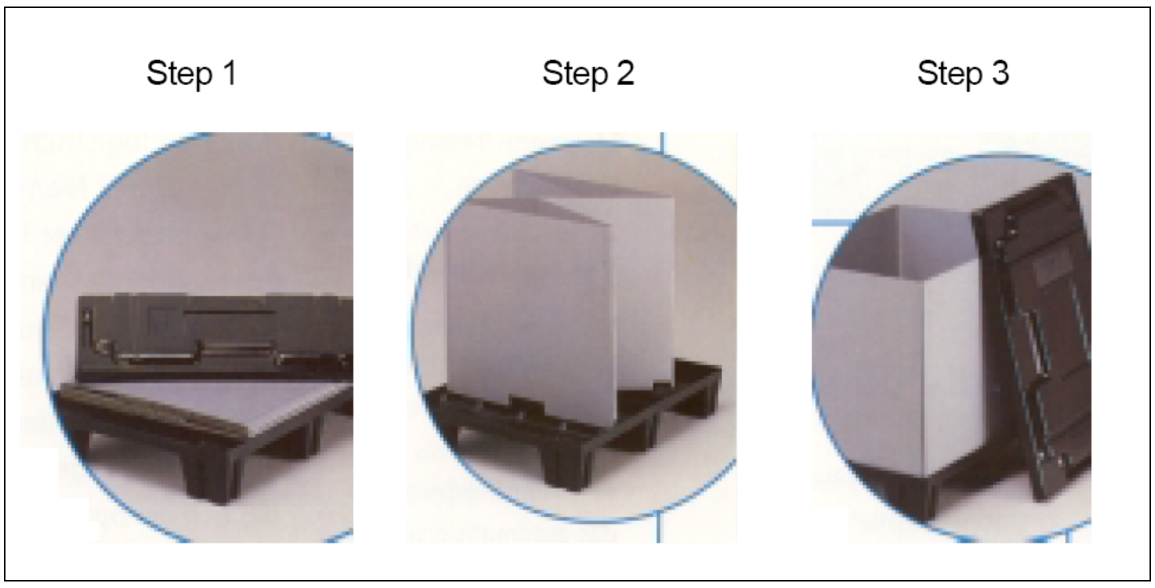
Alternatively, logistics companies could use existing delivery devices. Common practice is to use wheeled storage cages. However, placing the compacted containers in the cages may be time consuming. Taking a conservative high end approach (based on the current Michigan deposit system in USA), it has been assumed that new reusable and collapsible bins would be required by all retailers or logistics companies. The following assumptions have been made in the calculation of the resultant containment costs for the compacted material that is collected:

- It is assumed that each bin can hold either 500 compacted glass bottles, or 800 compacted plastic bottles, or 3,500 compacted cans or 900 compacted cartons;
- The resultant number of bins required to be collected per week is calculated as the total number of compacted containers collected via RVMs for each retail type multiplied by the number of retailers of each type collecting compacted containers via RVMs;
- The pick-up frequency is subsequently calculated to ensure a manageable number of bins per collection for each retail type;
- The number of bins collected per pick-up per retailer type is then calculated and multiplied by three so that there is always one set of bins at the store, one in transit and one at the depot ready to replace those picked up from the stores;
- The cost for one bin is €140 (including interest rate at 5% to reflect annualised cost over three year bin lifetime); and[51]
- A nominal charge or €1 per bin for cleaning has been included.

[51] Personal communication with TOMRA, May 2010

Based on these assumptions the total containment costs for transporting compacted containers is €2.3 million per annum.

Figure A-6: Collapsible Bins for Transporting Compacted Containers



For containers which have not been cleared, the transport mechanism has to be able to maintain the fidelity of the attributes used by the automated counting centres, for example, the barcode, shape and weight of the container. Therefore the transport process must retain these key attributes for each container. Plastics bottles, cans and cartons will sufficiently maintain their shape for recognition, as long as no direct pressure is exerted. Again, common experience from other countries, including Norway, Sweden and Germany, suggests that plastic bags are certainly sufficient for containment of plastic bottles and cans. Bags are stored either at the front of a shop, or in the backroom storage area in supporting frames. When full, they are sealed and tagged ready for collection (see Figure A-7).

Figure A-7: Plastic Bags with Empty Beverage Containers for Transportation

The number of bags required per year is estimated from the total number of containers requiring collection and the number of containers that can be transported in each bag. Each bag is designed to take approximately 150 PET/HDPE bottles, or 100 cartons or 200 cans.[52] The cost of a bag and a tag is modelled at €0.75. In reality, this cost could go down if bags are reused, or the purchasing power of the central system comes into play, and all bags are ordered in bulk and distributed to retailers accordingly.

For glass containers there is a much higher propensity for breakages due to the nature of the material. Therefore plastic crates are required to transport the containers to counting centres (see Figure A-8). The total number of crates required and the total cost was calculated based on the same approach as described for the compacted containers i.e. determine how many crates need to be collected per retailer type per week, multiplied by three so that a sufficient set of crates is available in circulation at any one time. The key assumptions are:

- Each crate can hold around 40 glass bottles. Crates will therefore need to be stackable in order to ensure that there is sufficient storage room in busy periods, particularly from retailers such as pubs;
- The cost for one crate is €13 (including an interest rate at 5% to reflect annualised cost over three year bin lifetime);[53,54]
- A nominal charge or €1 per crate has been included for cleaning.

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[52] TOMRA (2001), *Zentrale Organization Einweg Pfand Deutschland: Business Model Development Guide*

[53] Solent Plastics (2010) *Recycle Bins / Recycling Storage / Segregated Bins / Waste / Rubbish Bins*, Accessed 20th May 2010, http://www.solentplastics.co.uk/recycling-rubbish-waste-bins/

[54] PHS, Teacrate (2010) *Retail and Logistics*, Accessed 20th May 2010, http://www.teacrate.com/retail-and-logistics.aspx

Figure A-8: Plastic Crate for Transporting Glass Bottles

Based on the assumptions outlined above, the total cost of containment for uncompacted containers is estimated at €8.6 million per annum.

A.3.2.4 Counting Centre Costs

A counting machine is an automated machine which, simply put, counts and registers used beverage containers that have been collected manually by an individual retailer. They are high-speed devices which accept a mixed stream of beverage containers as their input. Any container included in the system, be it plastic, cartons, glass or metal should be recognised by the machines. The bar code on each container is scanned, and the information is uploaded onto a database in order for the central system to determine what deposits and handling fees need to be paid to the retailer where the respective bag was picked up from by the system.

A small number of counting machines will probably be required at some retailer logistics depot and supplier logistics depots, in order to clear any containers not received via RVMs. However, the majority of counting machines required would be those used by the central system.

The system design and costs are based on information provided by Anker-Andersen – a supplier of high-speed counting machines (HLZ) - which is based in Denmark.[55] The specification of the counting centre system is the need to process around 3.3 billion containers that are returned manually to stores around Spain. It should be noted that this reflects the ‘steady state’ system. In the first few years the number of centres required may be higher than assumed here, with more containers initially returned manually whilst the system beds in. The collection and transportation costs from the retailer to the counting centres have already been calculated in Appendix A.3.2.2. In order to determine the optimal number of counting centre locations and sizes, a detailed logistical analysis would be required across Spain. However, for the purposes of this analysis, we have assumed that, given the similar number of containers and

[55] http://www.anker-andersen.com/. It should be noted that there are also other suppliers of such equipment including Binder (based in Austria) and Eleiko (based in Sweden).

reasonably similar geographical area of Spain and Germany, there would be similar number of counting centres as in Germany with eight required in total across Spain. The key assumptions involved in the setup of the counting centres system are as follows:

1) Number of centres and machines required
   - Each larger high-speed machine can process 155 containers per minute, which equates to 69 million containers per annum;
   - There will be 8 centralised counting centres across Spain. Each centre will therefore need 6 high-speed machines in order to process the required number of containers.
2) Times of operation
   - Assume each machine operates for a total of 355 days per annum, enabling 10 days per annum for full machine service, to install any required IT updates etc;
   - Cleaning of each machine takes one hour per machine per day;
   - Maintenance of each machine also takes one hour per machine per day.
3) Labour costs
   - Labour costs for operating the centres are set at the same level as the retailer staff wages, at €14.59 per hour;[56]
   - Labour costs for cleaning and maintaining the counting centre machines are factored in at €17.50 per hour (20% higher than the machine operator wages);
   - Assumes that 9 staff will be required to fill and operate 6 machines in each counting centre. In order to run the machines for 21 hours each day (24 hours minus time for cleaning and maintenance) just under 4 shifts per week will be required;
   - There are 220 working days per employee per annum (accounting for holidays and sickness);
   - Equates to 53.5 full-time equivalent (FTE) staff required for filling and operating at each counting centre and 20 FTEs for cleaning and maintenance across all counting centres. The total number of staff employed is thus calculated at 448 FTEs.
4) Building costs
   - Industrial floor space rent has been estimated at €50 per m^2 per annum;[57]

[56] Instituto Nacional de Estadística (2011) *Encuesta Trimestral de Coste Laboral,* available at http://www.ine.es/metodologia/t22/t2230187.htm

[57] Based on reports undertaken by BNP Paribas on the *Real Estate Market Seville – 2009, Real Estate Market Valencia – 2009,* all reports available at http://www.realestate.bnpparibas.es/pages/etudes_sectorielles/resultrecherche.php?alias=gen_sect

- Estimate that each machine will require 100m² of floor space, with an additional 1,000 m² of floor space per counting centre for delivery bay, bulking, storage, office space etc;
- Power consumption assumed to be around 210 kWh per day per machine (including for the baler, which is shared between 2 machines), at a cost of €0.11 per kWh;[58]
- Also factors in €2,000 per centre per annum for other supplies such as the server, the network, telephones etc.

5) Investment costs
   - We assume a total cost of €200,000 per machine, plus an additional €100,000 for a compactor and baler for each machine;
   - Installation costs estimated at €20,000 per machine (costs are inclusive of the need to install one baler for every two machines);
   - The costs are annualised over five years, equating to just over €64,000 per annum per machine.

Consequently, the investment cost is calculated at €3.1 million per annum, with the operating costs at €13.7 million per annum, resulting in a total cost of €16.8 million per annum for the counting centre infrastructure.

A.3.2.5 Retailer Handling Costs

The calculations and assumptions used to determine the costs to retailers for taking back containers as part of the DRS are presented in Appendices A.3.2.6 to A.3.2.9. It should be noted that in order to calculate the handling costs we have assumed that the DRS is at a mature stage i.e. that RVMs have been rolled out/installed in all those retailers which have opted for automated take-back. In reality, in the first few years of the DRS, a higher percentage of retailers may need to take back containers manually whilst RVMs are being installed.

A.3.2.6 Reverse Vending Machine (RVM) Costs

The key cost elements associated with RVMs are a) capital costs (including installation) and b) operating costs.

Capital Costs

In terms of capital costs, average figures of €18,000 for the machine and €1,000 for the installation are assumed.[59] The installation fee includes fitting the machines in the store, and connecting to the back-office equipment (via ADSL cables etc). The back-office IT equipment is then connected to the internet – this is to link the

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eur_fiches_sectorielles&s_repl=secteur|retail%23pays|es&l=en&r=54&t=bnppre&ctx=1&s_wbg_menu=38&p=es&point=Retail&mode=list

[58] http://www.energy.eu/ - June 2011 industry price plus 10%

[59] Figures provided by TOMRA and are also aligned with the Sismega summary report.

machine to the central system. It should be noted that the impact on the cost of RVMs of including cartons as part of the DRS is as yet unknown (RVM and counting centre manufacturers are currently developing machines to process all four materials). Changes will, of course, be required to the existing machines in order to process cartons alongside glass, cans and plastics, but the machines will fundamentally operate in the same way as they currently do. In order to provide a more conservative approach to the costs of the DRS, we add an additional €2,000 to the cost of each RVM for processing the relatively small amount of cartons in the system.

The annual cost to the retailer for the RVM is based upon the assumption that the retailer would purchase an RVM and repay the loan over a period of 7 years.[60] The interest rate is assumed to be 5%.

An additional cost of 16% of the total RVM capital cost is also assumed for 50% of the retailers requiring RVMs, in order to account for any modifications required in those circumstances where the back-room needs significant adjustment in order to accommodate the machines. This cost is annualised based upon the assumption that the retailer would pay for any structural modifications over a period of 15 years at an assumed interest rate of 5%.

<u>Operating Costs</u>

Operating and maintenance costs are assumed to be 9% of the total capital cost of the machine.[61] Additional operating costs include the cost of paper roll for the receipt printer (an additional 1% of total annual costs), and the cost of replacing the compactors for compacting RVMs. The cost of replacing the compactors is €2,000. This has to be carried out on average after every 800,000 containers have been compacted.

<u>Total Cost</u>

The total annual cost to retailers for purchasing and operating RVMs is estimated to be around €165 million. Retailers are compensated for these costs through the handling fee payable per container returned to each store.

A.3.2.7 Retail Space Infringement Costs

Shop space will be required for stores installing RVMs, and storage space will be required for all retailers who take back containers. This will be a cost to the retail industry, and as such is to be compensated for by the central system. The methodology for calculating the financial impact on retailers for use of floor space is described below.

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[60] 7 years is also expected to be the lifetime of the machine.

[61] Personal communication with TOMRA, May 2010.

RVM Store Costs

The costs for retailers who install RVMs will include the cost of leasing what effectively becomes lost floor space in both the sales and the storage areas of the store, and the lost opportunity cost resulting from a reduction in floor space in the sales area.

It is estimated that each RVM will require 6m^2 of retailer floorspace. The rent payable per m^2 for the floorspace which will no longer be useable for other retail operations is calculated at €50/m^2/month, based on an average of the median retail space rents for Valencia and Seville.[62] The profit loss or opportunity cost associated with the lost floorspace is calculated as a 5% profit margin on the turnover associated with each m^2 of retail floor space. The turnover is calculated per store type and according to the number of RVMs (and hence floor space) that each retail type will need, with the average turnover assumed to be €5,880/m^2/annum for hypermarkets, €5,053/m^2/annum for larger supermarkets, €4,153/m^2/annum for medium supermarkets, €4,056/m^2/annum for small supermarkets and €4,702/m^2/annum for traditional/food stores.

There are just over 20,000 retail outlets that are likely to install RVMs. The cost to these retailers for loss of floor space and opportunity cost is around €120 million per annum.

Manual Take Back Store Costs

The only impingement on floor space when containers are taken back manually is the storage area. It is recognised that for some smaller businesses, this storage area may have to be on the shop floor. However, it is also assumed that for the majority of stores the storage will be at the back of the store rather than on the shop floor. We have thus assumed that there will be no profit loss associated with the container storage, but that the average rent of €50/m2/month will apply to all stores doing manual takeback.

If it is assumed that a containment bag can store, on average, 150 to 200 beverage containers (plastics, cans and cartons) and a containment crate can store around 40 glass bottles, then each retail outlet will amalgamate, on average, just under three containment bags and significantly less than one full crate per week (see Section A.3.2.3for container assumptions). In the dedicated collection modelling, we assume that the average collection frequency is just under twice per week (see Appendix A.3.2.8). Therefore the average retailer will have to store up to two bags and possibly also one crate in between pickups. An area of 2 m^2 has been used to calculate the subsequent space costs to each retailer for storing these bags/crates.

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[62] Based on reports undertaken by BNP Paribas on the *Real Estate Market Seville – 2009, Real Estate Market Valencia – 2009, The Retail Market in Spain (2006),* Informe Inmobiliario de Málaga y Área Metropolitana (2007), all reports available at http://www.realestate.bnpparibas.es/pages/etudes_sectorielles/resultrecherche.php?alias=gen_secteur_fiches_sectorielles&s_repl=secteur|retail%23pays|es&l=en&r=54&t=bnppre&ctx=1&s_wbg_menu=38&p=es&point=Retail&mode=list

There are just over 160,000 retail outlets who are likely to be 'manually handling' containers. The cost to these retailers for loss in floor space is around €194 million per annum.

In addition to these floor space costs, we also assume that there will be some additional initial cost in order for retailers to optimise their floor space to accommodate the manual take back of containers. We assume a cost of €100 per store to make any necessary alterations to the storage space, as well as one hour of staff time per store to determine and supervise any alterations that need to be made. The total cost, annualised over 15 years, equates to €1.2million per annum.

A.3.2.8 Labour Costs

The additional handling and collection of containers from retail outlets will demand labour time, and therefore additional costs will be incurred by the retailer. The two main activities requiring additional labour are:

1) Take back of containers from customers and placing in storage locations; and
2) Facilitating pickup of containers from the contracted logistics company.

The calculation of these cost elements is described as follows:

<u>Labour Costs for Customer Take Back via RVMs</u>

By making the following assumptions, it is possible to derive a cost of labour for customer take back via automated machines:

- Each 'average sized' RVM bin can hold 800 plastic bottles, or 3,500 cans, or 500 glass units or 900 cartons;
- The total number of RVM bins requiring emptying is thus calculated as the total number of units returned via RVMs for each container type (plastics/cartons, cans and glass) divided by the number of containers of that type that an RVM bin can hold, assuming a 90% fill per bin;
- It takes 5 min to empty each RVM bin once full;
- Each RVM is cleaned on a daily basis which takes an average of 5 minutes;
- It also takes an average of 3 seconds to process each RVM receipt at the till. In order to determine the number of receipts that need processing, we assume that each receipt covers an average of 10 containers; and
- We multiply the subsequent time requirements from a) emptying the bins, b) cleaning the RVMs and c) processing receipts by an average wage of €14.59 per hour (including holidays and sickness cover).[63]

The total cost estimated using this approach is around €33 million per annum.

<u>Labour Costs for Manual Customer Take Back</u>

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[63] Instituto Nacional de Estadística (2011) *Encuesta Trimestral de Coste Laboral,* available at http://www.ine.es/metodologia/t22/t2230187.htm

For retail stores, the labour costs for manual take back will be associated with additional time to collect the containers from the customer, pay the deposit, and place the containers in the designated storage area. Operational experience from existing systems shows that most retailers will have an intermediate storage bag close to the cashier. When it is full, the bag will be sealed and taken to the storage area.

The time taken for the cashier to accept an average of 5 containers and store them is estimated at 50 seconds. With the labour costs valued at €14.59 per hour, the total cost to retailers is calculated at €134 million. It could be argued that this is a somewhat conservative estimate. In reality, staff employed by some retailers, particularly the smaller stores, will be likely to be able to absorb a significant amount of the time required for manual take back into their existing contracted hours without requiring additional payment.

<u>Labour Costs to Facilitate Container Collection via Logistics Companies or for Backhauling</u>

In implementing a deposit refund system, there would potentially need to be an additional avenue for waste collection services for the retailer: in addition to the refuse and existing recyclable material collection, there will also be one for beverage containers (in the DRS system). Although it is assumed that the volume and hence frequency of refuse and non-DRS dry recycling collections would be reduced alongside the deposit system, the overall labour cost is assumed to be higher, given that staff would have to set out waste for collection on three separate occasions. Hence, an additional labour cost of 5 minutes per container pickup has been included in the calculations. Estimates for the number of pickups required per week for each of the main retail categories are provided in Table A-30 (backhauling) and Table A-32 (dedicated collections). Labour is again valued at €14.59 per hour.

The total cost of labour time to retailers for facilitating the collection of containers is estimated at €11million per annum.

A.3.2.9 Total Cost to Retailers (Space and Labour)

Based on the detail provided above regarding the costs to retailers associated with the space and labour requirements of the DRS, the total handling fee payable to the retailers is calculated at €648 million per annum (equivalent to €0.04 per container returned).

A.3.3 On-Going Costs for Central System

It has proved somewhat difficult to find much detailed information in relation to the breakdown of actual on-going costs associated with administration of the central system in those countries that currently operate a deposit refund system. Even where we have been able find an overall central system cost, little breakdown is provided as to how this has been calculated in order to try and apply equivalent costs to the Spanish situation. We have, however, been able to establish the numbers of staff involved in administration in the Palpa system in Finland (12 staff) and the Eestipandipakend system in Estonia (10 staff), systems which are similar to that which we have modelled for Spain, with the majority of functions outsourced (including collections, haulage, counting centres and bulking), and the admin system focusing on overseeing the whole process, database upkeep, accounting processes, marketing of materials and communications around promoting the deposit refund system to the public.[64,65] Although customer services is outsourced in the Palpa system, we were also able to establish that 2 to 3 staff are involved in the outsourced provision of customer services. We have thus been able to scale the staff numbers up to the Spanish situation based on population. In reality, economies of scale will be available from the larger central system team in Spain. The resource required will be partly linked to the number of retailers to be registered (which will be higher in Spain than in Finland), but will also be partly linked to the number of products to be registered, which will not vary as significantly according to population. We have thus assumed a 50% saving on the number of staff required to resource the central admin system based on upscaling according to population.

The overall on-going costs for the central system are presented in Table A-33. Given the importance of a fully integrated product database and financial accounting system in the smooth running of the central system administration function, and moreover an IT based, centrally organised anti-fraud monitoring system operated by the system operator, we have tried to be conservative in terms of the on-going IT costs that the system might face, and have thus factored in a total of €3.7 million IT costs per annum, to cover both the database and accounting system, and any additional system requirements for customer services.

For staffing costs, we have based the potential number of staff on discussions with Palpa (Finland), and we have assumed a total headcount of 65 people, with higher average salaries for the more technical staff than for the customer services advisors.[66]

For office space, a rent value of €18/m^2/month in 2008 (based on the office being located in Madrid) was multiplied by an approximate area requirement of 25m^2 per person to give a total office space cost of €342k per annum.[67] We have also included an additional €700k of support service costs to cover any legal or HR costs that might be incurred by the central system.

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[64] *Personal communication with Pasi Nurminen from Palpa, Finland, August 2010.*

[65] *Personal communication with Rauno Raal from Eestipandipakend, Estonia, June 2011.*

[66] *Personal communication with Pasi Nurminen from Palpa, Finland, August 2010.*

[67] BNP Paribas Real Estate (2009) *Real Estate Market Valencia – 2009*, available at http://www.realestate.bnpparibas.es/pages/etudes_sectorielles/resultrecherche.php?alias=gen_secteur_fiches_sectorielles&s_repl=secteur|retail%23pays|es&l=en&r=54&t=bnppre&ctx=&s_wbg_menu=38&p=es&point=Retail&mode=list

Table A-33: Costs for Administering the Central System

Item		Assumption	Total Cost (€M)
IT costs	Maintenance		€0.25M
	On-going hardware and software costs		€0.25M
	Licences	€50k per licence	€3.2M
	Total IT costs		€3.7M
Staff costs	Number of database/accounting staff	52	
	Average salary + on-costs (@25 %)	€38.5k	
	Number of customer services advisors	13	
	Average salary + on-costs (@25 %)	€29.6k	
	Total staff costs		€2.4M
Office space costs	Average leasing cost for fully equipped/furnished office	€656 per person per month	
	Total office space costs		€0.34M
Total support services costs (e.g. Legal, HR)			€0.7m
Total communications/marketing			€5.6M
TOTAL €m PER ANNUM			**€12.8M**

Finally, we calculated the required cost of communications and marketing based on the current legal requirement in Estonia to spend 1% of the DRS revenue per annum on communicating with the public. The overall cost of administering the system is thus calculated at €12.8million per annum.

A.3.4 Material Revenues

The incomes assumed for each material collected through the DRS are given in Table A-34. The incomes are higher than what has been modelled for the existing bring site collection system in Spain, reflecting the increase in quality and the decrease in sorting costs through the DRS.

Table A-34: Material Incomes in the DRS (€/tonne)

Material	Income (€/tonne)
Glass	€17
PET	€333
HDPE	€327
Cans (Al)	€900
Cans (Fe)	€210
Cartons	€0

A.3.5 Administration Fee

The administration fee payable by the producer/importer to the central system alongside the deposit has been calculated as follows:

Collection, Transport and Processing Cost + Central Admin System Cost + Handling Fees − Material Revenues − Unclaimed Deposits = Admin Fee

Calculating the administration fee in this way ensures that the balance of costs and benefits for the retailer and the central system is zero. The overall administration fee is subsequently divided by the number of containers that are placed on the market in order to obtain a unit cost to the producer/importer for each container that might potentially end up being returned and subsequently recycled as part of the DRS.

The administration fee payable by the producers for every unit placed on the market has been calculated at an average of €0.013 across all DRS material streams, based on a deposit value of €0.20 and a return rate of 89%. Weighted by the materials income received, the admin fee is presented per material stream in Table A-35. The calculated fees fall within the range of administration fees set by a number of existing deposit refund systems e.g. €0.01 to €0.05 per unit in Finland (dependent on material) and just over €0.02 per unit in Maine, USA.[68,69] It is important to note that the administration fee will be sensitive to the return rate, the deposit and the material value, a fact which is explored in more depth in the sensitivity analyses undertaken in the main report. The setting of the administration fee will thus need to be re-visited

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[68] http://www.palpa.fi/english

[69] http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0216B-06.pdf/$file/EE-0216B-06.pdf

over time following introduction of a deposit scheme to ensure that the fee continues to cover the cost of the system.

Table A-35: Admin Fee per Material Type (€)

Material	Admin Fee (€)
Glass	€0.020
Plastic	€0.013
Cans (Al)	€0.003
Cans (Fe)	€0.018
Cartons	€0.023
Average	€0.013

A.3.6 Set-Up Costs

As with the on-going administration costs of the central system, there is little detailed information publicly available on the initial set up costs that would be required for the DRS. We have therefore constructed the costs that we believe would be associated with setting up this type of system, based primarily on what tasks would be required and when, and the associated number of days that would be required for each task.[70] Day rates are mostly calculated at €1,200 for each of the tasks. A breakdown of the key tasks involved and the resource and capital costs that we suggest would be involved in developing and implementing the system are given in Table A-36.

It should be noted that the one-off costs presented here do not include the investment costs associated with purchasing items such as RVMs or counting centres; these investment costs have already been factored into the on-going operating costs of the DRS, based on the assumption that they will be leased or purchased over a certain number of years, rather than being purchased upfront.

Based on the modelling, a total cost of €31.3 million would be required to set up the central deposit refund system, plus an additional €1.7 million for the producers to change their labelling. It is worth noting that although some producers may need to change the label design in order to ensure that the correct barcode is applied to containers destined for the Spanish market, the actual changing over of labels will more than likely coincide with the periodical changes that the producers already have to make in their printing process; hence, as long as sufficient lead-in time is given to

[70] TOMRA (2001), *Zentrale Organization Einweg Pfand Deutschland: Business Model Development Guide.*

producers, then the cost of changes to labelling should be able to be kept to a minimum.

As stated previously, no literature has been unearthed which provides a detailed calculation of joining fees for either producers or retailers associated with these one-off costs. Joining fees vary across existing deposit schemes; for example, in Finland, the producer can opt to pay either a one-off lifetime joining fee or an annual joining fee over a 5 year period, and must also pay a bar code fee on each new product that is accepted into the system.[71] In Denmark, there is an annual joining fee for producers which is set annually and is calculated based on the producers' registered sales volumes for the previous year together with their expectations of the sales volumes for the year ahead; retailers can also pay an annual fee to make them eligible to receive handling fee payments.[72]

For the purposes of this high level modelling, we have not attempted to split the one-off costs into joining fees per producer or per retailer. A number of key decisions would require further consideration beyond this study in order to determine how the one-off costs of the system would be covered, including the following:

- Should both the producer and the retailer be charged a joining fee?
- If so, how should the one-off costs of the central system be split between the producer and the retailer?
- Should the fee be a one-off membership, or an ongoing annual fee, and should there be a company size limit for these fees?
- Should a 'per barcode' fee be charged on top of a more general fee in order to reflect the size of producer/ retail outlet?

[71] http://www.palpa.fi/english

[72] http://www.dansk-retursystem.dk/content/

Table A-36: Key Tasks and Resources involved in Implementing a Deposit Refund System

	Total Resources (Days) Required per Month to Deliver Task												Total Days	Resource Cost*	Capital Cost	Total Cost
Task	1	2	3	4	5	6	7	8	9	10	11	12				
Central System Costs																
Model Decisions																
Create reference groups	15	15											30	€36k		
Fee structures	10	10											20	€24k		
Decide on new central organisation	10	5											15	€18k		
Finalise stakeholder requirements	10	5											15	€18k		
Work out the clearing house model	20	20											40	€48k		
System security policy	5	5											10	€12k		
Logistics approach	5	5											10	€12k		
Nominate supervisory board		5											5	€6k		
Review and approve model			10										10	€12k		
Build Interim Organisation																
Appoint executive team		25											25	€30k		
Create legal entity			30										30	€36k		
Complete start-up budget			30										30	€36k		
Procure and secure financing			25										25	€30k		
System Construction																
Procure logistics transport pool and associated IT solutions (in-cab, hand-held etc)				50									50	€60k	€5,750k	
Find office for clearinghouse				10	10	10							30	€36k		

	Total Resources (Days) Required per Month to Deliver Task												Total Days	Resource Cost*	Capital Cost	Total Cost
Task	1	2	3	4	5	6	7	8	9	10	11	12				
Stakeholder communications				5	5	5	5	5	5	5	5	5	45	€54k		
Wider public advertising				20	20	20	20	20	20	20	30	30	200	€240k	€15,000k	
Build container database					3	3	3	3	3				15	€18k	€3,450k	
Stakeholder enrollment					5	5	5	5					20	€24k		
Clearinghouse solution					5	5	5	5	5				25	€30k		
Acquire or build processing centres					5	5	5	5	5	5	10	10	50	€60k		
Recruit staff				10	10	10	10	10	10	10	10	10	90	€108k		
Populate database										5	5	5	15	€18k		
Set up call centre				5	5	5	5	5	5	5	5	5	45	€54k	€2,000k	
Legal and consultancy fees (management of)	2	2	2	2	2	2	2	2	2	2	2	2	24	€28.8k	€4,000k	€31,950k
Producer Impacts																
Change labeling to meet requirements (based on additional 5 day resource to change label printing per producer, total 1,000 producers/ importers)**									5000				5000	€1,196k	€500k	€1,700k

**Day rates are set at €1,200 for all tasks except the producer and retailer impacts. A day rate of €120 has been used for the retailer impacts, based on staff in each outlet undertaking the store adjustments. A slightly higher day rate of €239 has been used for the producer impacts, for staff that work in printing the labels.*

***This is likely to be an over-estimate as in reality producers will already change labelling approx. every 6 months anyway so the new labelling requirements should simply form part of this usual cycle of adjustments.*

A.4.0 Additional Cost Modelling

In examining the complete waste management system for dealing with beverage container waste, additional cost assumptions are also required in order to model the potential effects of introducing a deposit refund system on the following waste management routes:

- Collection of containers through existing bring site system (refuse and recycling);
- Collection of containers through larger household collection points (Puntos Limpios) – recycling only;
- Commercial waste recycling / refuse collection; and
- Collection of containers from on-street litter bins and through street sweeping.

Determination of the change in costs for each of these collection routes associated with the introduction of a deposit scheme is described in the sections below. These figures will undoubtedly vary across the regions and sub-regions of Spain. However, for the purposes of the modelling presented here, we have tried to use a reasonable estimate of the likely costs for each collection route.

A.4.1.1 Existing Bring Site System

The baseline costs for the bring site system have already been discussed in Appendix A.2.0. This section outlines the key financial impacts of the changes in container mass flows into the bring site system (as highlighted in Table A-9). Before discussing the changes to the bring site system caused by the implementation of a DRS, we note that our model has assumed that the collection container provision, e.g. igloos does not to change. Each collection point is assumed to have one yellow bin (for lightweight packaging), one green bin (for glass), one blue bin (for paper and card), and two gray bins (for mixed waste) both before and after the DRS. As a result, the cost of these containers (i.e. the capital cost, cleaning cost, maintenance cost, replacement cost) does not change in the two scenarios modelled.

The elements of the existing collection service that do change are:

- The collection costs,
- The staff costs,
- The admin and overhead costs that are calculated as a percentage of the operational costs above,
- Revenues from material sales,
- Sorting costs and
- Disposal costs.

Essentially, the key variable that drives the change in collection costs is in the frequency at which the bins need to be collected; Table A-37 shows the average collection frequency calculated based on the baseline mass flows into the bring site system. Table A-38 illustrates the average collection frequency following the introduction of the DRS, where the majority of the beverage containers are no longer collected through the bring site system.

Table A-37: Average Collection Frequency per Week and Assumed Fill Rate to Trigger Collection (Baseline)

	Urban	Semi-Urban	Rural	Fill Rate (%)
Lightweight Packaging	2.32	1.95	1.40	66%
Glass	0.51	0.42	0.31	35%
Refuse	5.16	4.45	3.41	75%

Table A-38 Average Collection Frequency per Week and Assumed Fill Rate to Trigger Collection (Following Introduction of DRS)

	Urban	Semi-Urban	Rural	Fill Rate (%)
Lightweight Packaging	2.10	1.76	1.27	66%
Glass	0.31	0.26	0.19	35%
Refuse	5.01	4.32	3.31	75%

The result of the decrease in collection frequency is that the collection service can be provided with fewer vehicles and staff once the DRS materials are removed from the existing bring site system.

There is also a knock-on effect on the material income and sorting costs associated with the material collected in the lightweight packaging collection bins. These costs are calculated per tonne of material in the bin; as the tonnage decreases, so does the total sorting cost and the total material income. The balance of these two changes depends on the material. For example, there is a saving on sorting costs of about €309 for the reduction in recycling of one tonne of materials while the loss in material income for PET, for example, is €266 per tonne so there is a net benefit of €42 for each tonne of plastic removed from the existing bring recycling system.

Along the same lines, the avoided disposal savings that result from the diversion of the beverage containers out of the refuse bin and into the DRS are calculated based on a disposal cost of €36.17 per tonne for the lower disposal cost scenario and €80 per tonne for the higher disposal cost scenario.

In order to determine which stakeholder would derive what savings from the existing bring site system, the following logic was applied:

- Any change in the collection frequency (and hence in the resultant collection cost) of the lightweight packaging collection bins, and in the sorting costs and materials income from the lightweight packaging material is a change in cost to the producers, passed through from Ecoembes.

- Any change in the collection frequency (and hence in the resultant collection cost) of the glass collection bins, and in the sorting costs and materials income from the glass is a change in cost to the producers, passed through from Ecovidrio.
- Any change in the collection frequency (and hence in the resultant collection cost) of the refuse collection bins, and in the avoided disposal costs that result from less material being collected in the refuse stream is a change in cost to the municipalities.

The overall cost and/or benefit to the existing bring system is shown in Table A-39. The elements discussed above are all represented here. The collection costs to both the Local Authorities (gray bins) and the Producer Responsibility Schemes (yellow and green bins) decrease by €12M and €15M respectively. The sorting cost decreases (benefit) for the mixed recyclables in the yellow bins, while there is a loss in material income (so this is classed as a 'cost'); the disposal cost to the local authorities is also lower because they no longer pay for the disposal of materials which arose in residual waste before the DDRS was implemented. Finally, since the collection costs decrease, the overheads for the collection service also decrease.

Table A-39: Overall Cost and Benefit of Different Components of Existing Bring System Due to the Implementation of a DRS. Positive Values are Net Costs and Negative Values are a Net Benefit.

Item	Total Cost (€M) to Local Authorities	Total Cost (€M) to PR Schemes
Collection	-12.24	-15.36
Sorting	0.00	-17.22
Disposal/Material Income	-20.73	11.20
Overheads	-9.70	-6.30
Total	**-42.67**	**-27.68**

The change in costs in the bring site system are discussed further in the main report.

A.4.1.2 Larger Household Collection Points (Puntos Limpios)

The costs of operating puntos limpios will vary considerably depending upon the setup of the collection points (their size, staffing, number of material streams accepted etc). Again we aim to estimate a single conservative figure for use in the cost benefit analysis.

The incremental cost of recycling waste at larger household collection points is estimated at around €70 per tonne.[73] This figure includes staff costs, handling costs and additional capital costs to handle the waste. However, we have assumed that there will only be minimal changes in the collection point infrastructure as a result of a decrease in beverage container tonnages in comparison to the baseline situation. Therefore, there will be no savings resulting from reduced capital expenditure and the avoided costs of recycling would be lower than the figure given. We have thus used a lower figure of €17 per tonne to represent savings in handling and staff time for a reduction in containers deposited at Puntos Limpios.

A.4.1.3 Commercial Collection

The costs of collecting beverage containers from commercial premises for recycling or disposal are based on the same collection cost principles as detailed in Appendix A.2.1, and are estimated at:

- Plastics, metals and cartons: €271 per tonne;
- Glass: €149 per tonne; and
- Refuse: €63 per tonne.

The costs associated with commercial refuse collections are included here because, in diverting additional material out of the refuse waste stream and into the deposit system, there will be a saving due to the reduction in demand for the refuse service. In addition to the reduction in costs of collecting commercial refuse, there will also be a further saving associated with the reduction in 'disposal' or 'recovery' costs. It was noted in Appendix A.4.1.1 that this cost is around €36.17 per tonne for the lower disposal cost scenario, and around €80 per tonne for the higher disposal cost scenario. Therefore, this saving is also included for every tonne of commercial refuse waste that is diverted into the DRS.

A.4.1.4 Litter / Street Sweepings

There is little information about the composition of and collection costs for managing waste deposited in litter bins or collected by street sweeping. In general however, it would be expected that the cost per tonne for such collections would be relatively high, given the small amount of waste collected at each collection point and that street sweeping, in particular, is labour-intensive.

For this study we have estimated that, where litter is concerned, 80% of beverage containers are placed in litter bins, with the remaining 20% being thrown onto the street and later being picked up by local authority contractors or being left as uncollected litter in the environment. Based on street sweeping costs in the Catalunya area, we estimate the savings from avoided street sweeping could be as

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[73] Eunomia (2010) *Economics of Waste Management in London*, Appendices to Final Report for GLA

high as €1,500 per tonne, and for collection from litter bins (or on-the-go recycling bins), around €250 per tonne of avoided waste. It could be argued however that some of the savings in relation to street sweeping and litter bin collections might not, in fact, materialise. Street sweepers still need to sweep streets because the non-deposit litter still persists and has to be collected. The counter argument would be that there are savings on time (and volume, though the significance of this depends on the method of collection) and that the collection savings would be made in the manner suggested. Indeed, a reduced level of littering associated with highly visible items such as beverage packaging may have the effect of suppressing littering with other items (on the basis that litter tends to beget more of the same).

In order to provide a conservative approach, we have assumed that only 25% of the costs per tonne of street sweeping and litter bin emptying are actually realised from the reduction in beverage cans requiring collection following implementation of the DRS. We have also credited 100% of the subsequent disposal cost savings that result from the reduction in beverage containers collected, based on a disposal cost of €36.17 per tonne for the lower disposal cost scenario and €80 per tonne for the higher disposal cost scenario.