Have We Got the Bottle? Implementing a Deposit Refund Scheme in the UK

A report for the Campaign to Protect Rural England

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Campaign to Protect Rural England

The Campaign to Protect Rural England (CPRE) is a charity that campaigns for a sustainable future for the English countryside, a vital but undervalued environmental, economic and social asset to the nation.

We want a beautiful, tranquil and diverse countryside that everyone can value and enjoy. We promote positive solutions for the long-term future of the countryside, ones which respect the character of England's natural and built landscapes.

We aim to:

- Influence land use in town and country for people and nature.
- Protect and enchance beauty, tranquillity and local distinctiveness.
- Increase and harness public and political support for the countryside.

CPRE's *Stop the Drop* campaign is working to stop the blight of litter and fly-tipping on our countryside, cities, waterways, towns and villages.

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Contents

1.0 Introduction and Background 5

1.1 What are Deposit Refund Schemes 7

2.0 Deposit Refund Schemes in the UK 7

2.1 Scotland 14

2.2 Summary View 15

3.0 Economic Rationale for Deposit Refund Schemes 15

3.1 Summary View 17

4.0 Possible Benefits of Deposit Refund Schemes 18

4.1 Increasing Recycling 18

4.2 Effects on Littering 24

4.3 Implications for Transport 31

4.4 Summary View 32

5.0 Methodology for Cost Benefit Analysis 33

5.1 Summary of Existing Deposit Systems Worldwide 34

5.2 Mass Flows – Baseline and Scenarios 35

5.3 UK Deposit Refund System Model 38

5.4 Cost Reduction in Existing Waste Collection Systems 46

5.5 Environmental Impacts 50

5.6 Cost Benefit Analysis 52

6.0 Results from Cost Benefit Analysis 54

6.1 Complementary System 54

6.2 Parallel System 65

6.3 Sensitivities 68

6.4 One-Off Costs 78

6.5 Single Market Considerations 79

6.6 Cross Border Issues – Private Trade in Alcohol bringing Non-Deposit Containers into the UK 82

7.0 Summary and Conclusions 84

A.1.0 Review of Deposit Refund Systems 92

A.2.0 Cost Benefit Analysis Model 100

A.2.1 Materials to be Included in Deposit Refund System 102

A.2.2 Baseline 103

A.2.3 Scenarios..113
A.3.0 The Deposit Refund System Model...119
A.3.1 The Deposit and Return Rates 123
A.3.2 Handling, Collection, Logistics, and Processing..125
A.3.3 On-Going Costs for Central System...147
A.3.4 Material Revenues 149
A.3.5 Administration Fee..149
A.3.6 Set-Up Costs..150
A.4.0 Additional Cost Modelling 154
A.5.0 Environmental Impacts 158

1.0 Introduction and Background

Eunomia Research & Consulting is pleased to present this report to the Campaign to Protect Rural England (CPRE). The report investigates the environmental and financial implications of the introduction of a UK-wide deposit refund system (DRS).

In April 2008, CPRE launched its *Stop the Drop* campaign against litter and fly-tipping, with the twin aims of getting existing litter picked up and preventing further litter being dropped. As part of the campaign it worked with Policy Exchange in 2009 to publish *Litterbugs: How to deal with the problem of littering*[1], which detailed a suite of proposals for addressing litter.

One of the key recommendations of that report was for the introduction of a national deposit scheme, linked into broader waste and recycling policies, in light of the research findings that deposit refund schemes (DRSs) significantly reduce litter and help to promote virtuous cycles of behaviour.

Discussion regarding DRSs is often polarised between the views of ardent supporters, and those of equally vehement opponents. The available theoretical literature, however, suggests that such schemes are an efficient means of increasing recycling rates and reducing litter, though a key issue in moving from theory to practice is determining the costs of administering and implementing the scheme.

A review of secondary literature, however, does not shed much further light on the matter. In one such review, we recently concluded:[2]

> *Views appear to be polarised regarding the costs of introducing such a scheme, and few studies from the available literature would appear to enable one to confidently assert that the approach incurs costs well above the additional benefits which might be derived. There are, however, indications that such schemes would need to be designed with great care to ensure costs were aligned with the hoped-for benefits.*

There is, therefore, a pressing need to understand what might be the costs and benefits of introducing such a scheme, recognising that it would provide an efficient means to increase recycling and reduce littering.

The aim of this report, therefore, is to investigate the costs and benefits of a UK-wide DRS and advance the debate on the benefits and disadvantages of DRSs.[3] Through bottom-up modelling, we sought to answer the following question:

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[1] Policy Exchange and CPRE (2009) *Litterbugs: How to deal with the problem of littering*, London: Policy Exchange, 2009.

[2] Eunomia et al. (2009) *International Review of Waste Management Policy: Annexes to Main Report,* Report for Department of the Environment, Heritage and Local Government, Ireland, September 2009.

'How do the benefits of introducing a UK-wide DRS for certain beverage container packaging compare with the costs of implementation and operation?'

The report is particularly timely given the devolved administrations active commitment to achieving zero waste economies and the publication in May 2010 of the Coalition's Programme for Government, which states that:

"We will work towards a 'zero waste' economy, encourage councils to pay people to recycle, and work to reduce littering".[4]

This report details how DRSs can offer the opportunity to reduce littering, to increase recycling and consequently to increase the amount of waste that is diverted from landfill and other residual waste treatment options. Individuals are able to return their empty containers whilst 'on the go' and to subsequently recoup their deposit, with the system thus encouraging them to deal with their waste in a responsible manner. Hence the twin objectives of reducing littering and increasing recycling can be met.

Significantly, this study uses logistics modelling to understand how the costs of household waste collections change when the DRS is put in place. To our knowledge, no study has carried out this work in a satisfactory manner. It is, however, crucial for understanding the true costs (net of savings) of introducing a DRS.[5]

Furthermore, most existing studies only assume one scenario, where the existing kerbside collection systems remain in place. This study examines the costs and benefits associated with introducing a DRS in the UK under two scenarios. First, it models a *complementary* system, which means beverage containers are no longer collected at the kerbside. Second, it looks at a *parallel* system, where the household kerbside systems for beverage containers target the same range of materials that are covered by the DRS.

In addition, the report looks in considerable detail at the potential environmental benefits associated with the increase in material collection, above existing systems, as well as the potential savings derived from removing deposit-bearing litter from the environment. It also seeks to understand the associated negative effects – the disamenity - of litter, though the literature here is somewhat lacking and highlights a clear need for further research.

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[3] We note that this research was undertaken by the consultants on the understanding that the results may not be favourable. The aim was always to be as objective as possible, despite the orientation of CPRE. CPRE was also aware that the results might not support its views.

[4] HM Government (2010) *The Coalition: Our Programme for Government*, available at http://www.cabinetoffice.gov.uk/media/409088/pfg_coalition.pdf

[5] The closest any study comes to doing this adequately is a study by BDA Group in Australia. The study most often cited by opponents of deposit schemes is one by BIO Intelligence Service, which includes no serious attempt to model the change in the cost of the kerbside collection logistics.

1.1 What are Deposit Refund Schemes

DRSs have been defined as follows:

> *"A deposit-refund system is the surcharge on the price of potentially polluting products. When pollution is avoided by returning the products or their residuals, a refund of the surcharge is granted."* OECD, Glossary of Statistical Terms.[6]

A DRS encourages the return of the materials into an organised reuse, recycling or treatment / disposal process. The producers typically finance the process through the payment of an administration fee on each container. Drinks containers are the most common target of DRSs, though economic theory suggests the schemes could be applicable to hazardous materials and other waste streams, subject to transaction costs being minimised. The systems can encourage recycling and / or reuse where otherwise it is easy to dispose of containers with the residual waste or for them to be discarded as litter. The same policy mechanism can also be used to target difficult to dispose of, or hazardous, items to ensure that these do not reach the residual waste stream. This can be considered a waste prevention policy as it reduces the hazardousness of materials in the waste stream.

Non-drinks container examples include:

- Batteries (Swedish Östhammar example) and car batteries (Germany);[7] and
- Tyres (Maine, USA).

Finally, some countries, such as Sweden, make use of vehicle scrapping charges, which discourages the dumping of vehicle bodies in rural areas and ensures that cars are returned to registered scrapping destinations at the end of their life.[8]

Appendix A.1.0 details a number of countries and states which have made use of deposit schemes.

2.0 Deposit Refund Schemes in the UK

Some readers will be old enough to remember that in the 1970's, in the UK, one often paid a deposit on bottles of fizzy drinks and beer. When the drink was finished, one would return empty bottles to the store, or even have them collected from the front door as part of the milkman service, in order to retrieve the deposit. The system led to high return rates for glass bottles, which were typically washed for refilling. The bottles were designed for re-use many times over.

Since the broad demise of these schemes in the UK (though they are still applied in some notable cases, for example the A. G. Barr scheme in Scotland), there have been various studies which have looked at the use of deposit refunds here.

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[6] http://stats.oecd.org/glossary/detail.asp?ID=594

[7] http://www.eeb.org/activities/waste/EEB-mini-brief-deposit-schemes-for-Batteries-March2004.pdf

[8] The (sometimes temporary) scrapping charges which have become popular across nations in the context of the current economic decline have their precedent in the more permanent schemes which some countries employ to ensure that end-of-life vehicles are returned to an appropriate recycler.

This Chapter critically reviews the way in which previous Governments have appraised the potential for using DRSs in the UK. It highlights the fact that particular views have been formed, even in the absence of the evidence which would be required to enable one to develop such views on an objective basis.

One of the initial review studies was undertaken by ERL (now ERM) in 1992.[9] The study's remit was to look at the general applicability of economic instruments in the field of waste management. Deposit refunds scored poorly in that they were not considered applicable to the bulk of waste being managed.

In the second half of the 1990s, the UK introduced its own mechanism for seeking to ensure compliance with the obligations placed upon EU Member States through the Packaging Directive. The mechanism which eventually emerged, following a protracted gestation, was based upon tradable 'compliance notes', though opinion is somewhat divided as to whether the tradability of these compliance notes – the Packaging Recovery Notes (PRNs) and the Packaging Export Recovery Note (PERNs) - was intended at the initial design stage.[10]

Since 1997, the existing system – which leads to periodic setting of new targets, associated fluctuations in the value of the PRNs and PERNs in line with the relative tightness of their supply relative to their demand, and periodic anxiety regarding whether and if targets might be met - has been the focus of policy-related activity in the UK. This is despite the fact that the system has a number of shortcomings. Perhaps the most notable of these is that the bulk of the cost of compliance does not fall upon those whom it should most obviously fall i.e. the producers and consumers of 'packaged' products. Instead, taxpayers shoulder much of the burden of compliance, so that there is no relationship between packaging consumption and the contribution made to meeting the costs of compliance. There are obvious alternatives which would readily rectify the situation, such as taking the means of financing compliance outside the tax system and placing it upon consumption, so effectively aligning the system with the well-established polluter-pays principle.[11]

Notwithstanding the continuation of the existing policy (albeit with periodic revisions), there have been a number of occasions where alternatives were closely

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[9] ERL (1992) *Economic Instruments and Recovery of Resources from Wastes*. HMSO, London Environmental Resources Management (then ERL).

[10] One of the authors of this report was involved in work for what was then the Department for the Environment, Transport and the Regions (DETR) to explore the nature of the changes which might usefully be made to capitalise on the de facto tradability of PRNs and PERNs (see ECOTEC (1998) *Packaging Regulations: gathering Evidence on PRNs and the Impact of the regulations on Local Authority recycling*, Final Report to DETR, June 1998), the point being that the scheme did not obviously exhibit some of the fundamental prerequisites which might be expected of a rational scheme of tradable 'evidence'.

[11] As discussed below, the Packaging Strategy claims that an independent group reviewed alternatives and effectively determined that 'variations' on the existing scheme were superior. As we discuss below, we have not been able to find the evidence referred to in the Packaging Strategy.

considered. In the Strategy Unit's review of waste strategy in 2002, it was suggested that:[12]

> *Action is needed in the following five areas to put the right long term economic and regulatory framework in place: […]*
> *[…] new measures to encourage reuse, such as deposit-refund schemes and designing civic amenity sites for re-use;*

The document included a number of recommendations, one of which was as follows:

> ***Recommendation 3**: Defra and WRAP should consider the options for increasing incentives for the re-use of goods. More work is needed to assess the preferred means for different products and to establish where the impact on the waste stream would be greatest.*

Defra responded to the Strategy Unit's recommendations in 2003. It noted, in response to the recommendation regarding re-use:[13]

> *The Strategy Unit has suggested deposit refund schemes as one way of encouraging individuals to participate actively in reuse and recycling. Defra is commissioning a joint study, with other interested departments, to update previous work on the benefits and costs of such schemes with a view to identifying the contribution they could make to increased reuse and recycling.*

The study that was subsequently commissioned was undertaken by Oakdene Hollins in 2004. [14] The findings of this study were somewhat divided, according to what the DRS was trying to achieve. The study noted that using DRS as an effective instrument for promoting re-use in the UK would probably not deliver the required payback, given that the majority of packaging is already one-way in the UK, and hence there would be significant expense associated with setting up the refillables processing infrastructure, and producers would be likely to continue using one-way packaging anyway.

However, on the positive side, the study reported that introduction of a DRS in the UK on one-way packaging would generate an increase in recycling and a reduction in litter, and that, based on their approach of calculating the expected costs associated with achieving recycling targets using the existing policy mix, introducing a DRS was found to generate a surplus for every option. The study noted that the overall costs of running such a system would be highly dependent on the return rate of containers, and that the 'unclaimed' deposits were the principle cause of the overall surplus. Final positive notes from the study included the following:

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[12] Strategy Unit (2002) Waste Not, Want Not: A Strategy for Tackling the Waste Problem in England, December 2002.

[13] Defra (2003) Government Response to Strategy Unit Report 'Waste Not, Want Not', HMSO: February 2003.

[14] Oakdene Hollins (2004) Deposit Return Systems for Packaging: Applying International Experience to the UK, report prepared for Defra, December 2004

A DRS targeted on light-weight containers, cans and plastic bottles, would integrate well with the existing policy mix that provides incentives for Local Authorities to collect heavy and/or biodegradable wastes.

Establishing a new social habit of returning containers to redeem deposits may create a platform on which other more sustainable patterns of consumption could be built in the future.

This study was subjected to a Peer Review by Perchards. This review made some legitimate comments of a critical nature regarding the report. It picked apart the distinction between European and US-type systems, and made cogent remarks about the operations of DRSs for refillables. At the same time, it made some critical remarks which seem slightly unfair towards the study, notably around the authors' views regarding the effects of a DRS on the PRN market.

In conclusion, the authors noted:[15]

We conclude that the report does not meet the project specification. We cannot see how it could be used to aid policy formulation unless it was completely rewritten.

This is a strong recommendation, and one which seems somewhat uncharitable. The Peer Review report itself is not without flaws, some of them amounting to basic misunderstandings. It is usually the nature of a peer review to seek to improve the quality of a report in progress rather than to completely cast it aside. On the Oakene Hollins recommendation that a DRS be applied to selected non-refillable beverage containers, they state:

the information provided in the report to support this conclusion is muddled and disjointed. Although they have recommended this option, the report lacks a thorough discussion of how such a DRS might be structured, how it would operate, and how it would be funded. We challenge the proposal that it should be funded by unredeemed deposits since this would create an economic incentive to the operators not to achieve a high return rate.

The latter comment is instructive given that elsewhere, the peer reviewers suggest that at the specified level of deposit, the return rate proposed by Oakdene Hollins might be too high. It is inconsistent to suggest on the one hand that the suggested return rate is too high, yet on the other to criticise the consultants for suggesting that a DRS might be funded through unclaimed deposits. As we highlight in the work below, the likelihood that system costs are covered by the revenue from unclaimed deposits becomes high at the low return rates which Perchards seem to suggest should be used at the consultants' proposed level of deposit.

A more recent review was carried out by ERM.[16] Although this later study does not fully reference the Oakdene Hollins work undertaken following the Strategy Unit review, it states, in describing the background to the project, that:

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[15] 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.

Defra commissioned a report on deposit schemes in 2004. Its basic findings suggested that a deposit system would be problematic. However, there has been renewed interest in the possible use of deposit systems and the use of reverse vending as a collection method for beverage containers.

There is no indication as to why the previous study found DRSs to be 'problematic'. In passing, we note that the ERM study continued: [17]

In particular, the Campaign to Protect Rural England (CPRE) supports the introduction of a deposit system as a means to reduce litter. CPRE has recently launched a campaign with this aim in mind.

The ERM study set out to answer a series of questions. The approach to providing answers to these was based largely upon gathering opinion from organisations involved in the packaging chain (see Jane Kennedy's written statement in May 2009, quoted later in this section). There was no attempt to understand the cost implications of the introduction of such a scheme, nor any serious attempt to quantify potential benefits. These were considered outside the study's scope. Consequently, the evidence required in order to answer a number of key questions was never provided. Somewhat surprisingly, this did not stop the authors from offering answers to these questions, even in the absence of the necessary evidence to support them. Furthermore, these unsubstantiated views were taken forward in the subsequent Government thinking of the time.

ERM made the following closing comment in their study:

It is not disputed that a deposit scheme would increase recycling, but alternative schemes could achieve the same or better results at a lower cost.

This is not demonstrated in their work, and as such can only be regarded as speculation. The study includes no figures relating to the costs of intensifying kerbside collection systems relative to the costs of implementing a DRS. It also reaches the view that deposit schemes *do* usually achieve higher recycling rates than other schemes, so the final comment regarding the achievement of 'the same or better results' actually contradicts views expressed elsewhere in the report.

The closest the study comes to providing evidence in respect of costs is a single paragraph containing no figures:

Providing financial support for the expansion of council collection schemes offers a relatively cost-effective means of continuing the trend of improving rates. Furthermore, the investment would cover a much wider range of materials – not only certain beverage containers, but other items of packaging, and non-packaging materials as well.

Notwithstanding the absence of evidence, the same message is restated in Defra's Packaging Strategy of 2009:[18]

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

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

In July 2008, Defra commissioned consultants ERM to study the feasibility of setting up a deposit scheme for drinks containers in the UK. The study examined whether deposit schemes were likely to increase recycling and to reduce litter. It considered the role of reverse vending, the possible impact of deposits on existing collection systems, the issues that would need to be considered in setting up a deposit system, and possible alternatives to deposits. It looked at the experience of deposits in four countries – Denmark, Germany, the Netherlands and Sweden – to draw lessons for a possible UK scheme. The study concluded that deposit systems are likely to increase recycling but that other measures may achieve the same goals more cheaply. An effective deposit and return scheme could divert materials from existing arrangements such as bottle banks or kerbside collections, which have been developed, for the most part, with public funding.

Under a different take-back model, retailers could introduce their own bring banks for a wide range of packaging materials. Tesco and Sainsbury's have both trialed this in various formats. On the positive side, this could be seen as the logical extension of producer responsibility, relieving local authorities of their duty to collect packaging waste. On the negative side, the ability to provide this infrastructure is limited by space, and accessibility for householders is likely to be an issue. Also, this would deprive local authorities of a source of revenue by taking valuable recyclates away. Were this system to replace local authority collections, it is likely that the amount of packaging collected for recycling would drop, as the effort of getting the recyclates to the collection points would be more onerous for the public than kerbside collections.

Yet another model would be for retailers and manufacturers to complement local authority provisions by setting up bring banks for items that may not otherwise be widely collected by local authorities. This has been done by the carton industry body ACE UK (Alliance for Beverage Cartons and the Environment) to ensure that cartons, such as those made by Tetra Pak are widely collected across the UK. Deposit and bring systems which involve human interaction tend to result in high quality materials. The design of unsupervised bring banks makes a significant difference to their use and contamination.

Unless take-back provisions are made mandatory, and cover the range of materials which is currently being collected by local authorities, local authority collections would need to continue in parallel. Overall, the operation of two parallel systems is likely to increase costs to consumers and taxpayers, with uncertain results on the quantities collected.

Some of this is based on supposition, whilst other statements present only half the picture. The statements to the effect that local authorities would lose a source of revenue, and that the operation of two parallel systems would likely increase costs, are both statements which reflect only part of the overall picture. They make no

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[18] Defra (2009) Making the Most of Packaging: A Strategy for a Low-carbon Economy, June 2009

reference to the possible savings on logistics, and on sorting of local authority collected materials, which would occur if a deposit scheme was introduced. They also fail to take into account any additional benefits the scheme could provide.

The Packaging Strategy discussed deposit schemes as an alternative means to fund packaging recycling. It noted:

> *In the second half of 2008, the independent Packaging Recycling Action Group (PRAG) set up a working group to look at funding mechanisms. It compared variations on the last three options above* [ie. including deposit refunds] *against a set of criteria including, among other things, the likely effectiveness of each option in terms of increasing quality and quantity, value for money, ease of implementation and visibility to consumers and local authorities. Variations on the current system consistently scored higher than the alternatives.*

There is no report arising from the PRAG working group referenced in the Packaging Strategy. We have not been able to track down any document which arrived at this view, and indeed, our attempts to do so suggest that the view attributed to the PRAG – that variations on the current system offered the best way forward – does not accurately represent the views expressed by the PRAG.

A briefing from the Industry Council for Packaging and the Environment (INCPEN) may be referencing the same group when it states:[19]

> *A group advising the UK government concluded recently that a deposit system could cost between £1 billion and £7 billion to establish, depending on how the system was set up.*

The basis for this estimate is not made clear, and again, there is no study referenced. The breadth of the range in the cost estimate suggests that the analysis was a cursory one.

Similar lines have been taken by Ministers in Written Answers to Parliamentary Questions. The then Environment Minister responded as follows to a written question on 13 May 2009:[20]

> ***Mr. Drew:*** *To ask the Secretary of State for Environment, Food and Rural Affairs (1) what steps he has considered to increase levels of plastic and glass bottle recycling; if he will bring forward proposals to promote bottle return schemes in shops; and if he will make a statement; [273465]*
>
> *(2) what measures he has considered to increase levels of plastic and glass bottle recycling; what consideration he has given to tax incentives for (a) companies who recycle, (b) companies who do not and (c) the promotion of bottle return schemes in shops; and if he will make a statement. [273380]*

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[19] Incpen (2008) Mandatory Deposits on Packaging, May 2008.

[20] Written Answers to Questions, Wednesday 13 May 2009 Column 757W http://www.publications.parliament.uk/pa/cm200809/cmhansrd/cm090513/text/90513w0001.htm#09051353000016

__Jane Kennedy:__ [...] In December 2008 DEFRA published a report into packaging deposit systems and the role they might play in increasing recovery and recycling of single use drink containers (plastic, aluminium and glass) in the UK. The report was completed in consultation with a range of industry stakeholders and reviewed deposit systems in four other EU member states to assess the implications of introducing such a system in the UK.

The report concluded that while deposit schemes would increase recycling, alternative schemes could achieve the same or better results at a lower cost, as the relative cost of introducing a deposit scheme system was high. For example, the deposit scheme operating in Germany costs three times as much per container as a household collection system.

However, the Government are keeping an open mind in regard to deposit schemes and 'reverse vending', where vending machines take used bottles and cans for recycling and usually give a reward such as supermarket loyalty points or vouchers. A number of reverse vending systems are being set up by major retailers and the performance of these systems is being monitored.

It is not possible to speak about what is or is not 'relatively cost effective' without knowing what the relative costs are. We have seen no information from any study which would suggest that work to understand the relative costs has actually been undertaken.

2.1 Scotland

The Climate Change (Scotland) Bill contains powers to introduce deposit and return schemes in Scotland. In a consultation on legislative measures to implement a zero waste policy, the Scottish Government recommended this in 2008.[21]

However, this recommendation was diluted by the time of the consultation on the Zero Waste Plan:[22]

As outlined throughout the draft Plan, the Government, working with partners, is already taking steps to improve recycling facilities across Scotland and plans to take further steps.

For example, section 3.6 of the draft Plan notes that the Scottish Government is convening a round table to consider what more could be done to establish recycling zones in public places right across Scotland. If voluntary measures to increase recycling should not succeed, then the Scottish Government would consider if the regulatory route should be followed.

In the final version of the plan, there is no mention of DRSs, though there is mention of a study to review options for *'extended producer responsibility and "take-back" schemes in Scotland.'*[23]

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[21] Scottish Government (2008) Consultation on Legislative Measures to Implement Zero Waste, July 2008, http://www.scotland.gov.uk/Resource/Doc/1056/0063943.pdf

[22] Scottish Government (2009) Scotland's Zero Waste Plan: Consultation, Annex N - Packaging, August 2009, http://www.scotland.gov.uk/Resource/Doc/282143/0085295.pdf

2.2 Summary View

The apparently established line that alternatives to deposit refunds could achieve the same or better results at lower cost than a deposit scheme remains to be clearly demonstrated. Although it is suggested, in the previous Minister's response, that the past Government retained an open mind on this matter, the ease with which its mind seems to have been closed contrasts with this avowed openness. The view of ERM, and the opinions subsequently expressed by Defra and its Ministers, appears to lack any firm basis.

There is a clear need for some objective assessment of what the relative costs, and benefits might be for DRSs. This study is intended to fill this gap with regard to the UK.

3.0 Economic Rationale for Deposit Refund Schemes

DRSs are a particular form of product tax/recycling subsidy. In such programmes, also known as 'bottle bill' programmes, consumers pay a deposit (tax) on a container at the time of purchase. This should, in theory, be set at the extra social cost of improper disposal over the net recycling cost (assuming there is already an Advance Disposal Fee (ADF) on the manufacturer equal to the net recycling cost). This means that if the product is improperly disposed of, that individual pays the external cost of improper disposal by foregoing the refund, which would typically be set equal to the initial deposit. As with many environmental policy instruments, the theory is somewhat simpler than the practice. As we discuss later in the report, for example, the basis for valuing the social cost of improper disposal is not as strong as one would like.

The distinction between DRSs on the one hand, and ADFs coupled with a household recycling refund on the other, is in the re-collection of the product at the end of its useful life. Deposit schemes generally involve a separate collection path, rather than being collected as part of the municipal recycling system.

Several theoretical studies have argued that a deposit/refund is the best policy in the presence of illegal disposal.[24] Palmer et al modelled paper, glass, plastic, aluminium, and steel. They found a substantial difference in the intervention levels necessary to achieve reductions in disposal with the various policies. A $45/ton deposit /refund would reduce all wastes by 10%. Alternatively, the government

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[23] Scottish Government (2010) Scotland's Zero Waste Plan, June 2010, http://www.scotland.gov.uk/Resource/Doc/314168/0099749.pdf

[24] T. Dinan (1993) Economic Efficiency Effects of Alternative Policies for Reducing Waste Disposal, *Journal of Environmental Economics and Management* 25: 242–56; D. Fullerton and T. C. Kinnemann (1995), Garbage Recycling and Illicit Burning or Dumping, *Journal of Environmental Economics and Management*, 29 (1); Peter S. Menell (1990) Beyond the Throwaway Society: An Incentive Approach to Regulating Municipal Solid Waste, *Ecology Law Quarterly*, vol. 17, pp. 655-739; Hilary Sigman (1995) A Comparison of Public Policies for Lead Recycling, *RAND Journal of Economics*, vol. 26, no. 3 (Autumn), pp. 452-478.

could obtain a comparable reduction using an ADF of $85/ton or a recycling subsidy of $98/ton.

A key point is that the deposit/refund creates incentives for both recycling and source reduction, whereas an ADF or a recycling subsidy takes advantage of only recycling or source reduction in isolation.[25] However, it is important to note that the theoretical studies, in abstracting from the real world situation, have not taken into account all the potential costs of administering such schemes. In fact they are not precisely modelling existing 'bottle bill' programmes, but rather a more generalised version of deposits and refunds, applied 'upstream' on manufacturers and recyclers.

In a further study, Palmer and Walls accept that in practice there could be significant administrative costs associated with refunding deposits, which could reduce the efficiency of the approach.[26] This issue is discussed by Palmer et al with numerical estimates of the effects of administrative costs on the overall efficiency of deposit refunds relative to product taxes and recycling subsidies.[27] Viewing their results alongside empirical evidence from Ackerman et al., they suggest that administrative costs may be of the same order as the cost savings from using a deposit/refund.[28] Due to such considerations, Palmer et al., Fullerton and Kinnaman, and Palmer and Walls all argue that deposit refunds should be imposed upstream on producers rather than on final consumers to minimise administration and transaction costs.[29]

Most theoretical studies recommend DRSs as economically efficient mechanisms to increase rates of recycling.[30] This includes UK-based reviews, such as that undertaken by Turner et al (1996) which stated:[31]

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[25] K. Palmer, H. Sigman and M. Walls (1997) The Cost of Reducing Municipal Solid Waste, *Journal of Environmental Economics and Management* 33, 128-50.

[26] Palmer and Walls (1997) Optimal Policies for Solid Waste Disposal Taxes, Subsidies and Standards. *Journal of Public Economics* 65(8): 193-205.

[27] K. Palmer, H. Sigman and M. Walls (1997) The Cost of Reducing Municipal Solid Waste, *Journal of Environmental Economics and Management* 33, 128-50.

[28] Frank Ackerman, Dmitri Cavander, John Stutz, and Brian Zuckerman (1995) *Preliminary Analysis: The Costs and Benefits of Bottle Bills*, Draft report to U.S. EPA/Office of Solid Waste and Emergency Response, Boston, Mass.: Tellus Institute.

[29] D. Fullerton and T. C. Kinnemann (1995), Garbage Recycling and Illicit Burning or Dumping, *Journal of Environmental Economics and Management*, 29 (1); Palmer et al (1997); Palmer and Walls (1997).

[30] See, for example, Dinan, T.M. (1993) Economic Efficiency Effects of Alternative Policies for Reducing Waste Disposal, *Journal of Environmental Economics and Management*, 25: 242-256.; Fullerton, D. and Kinnaman, T. (1995) Garbage, Recycling and Illicit Burning or Dumping, *Journal of Environment Economics and Management*, 29: 78-91; Pearce, D.W. and R.K. Turner (1993) Market-based approaches to solid waste management, *Resources, Conservation and Recycling* 8: 63-90. Porter, R.C. (1978) A Social Benefit Cost Analysis of Mandatory Deposits on Beverage Containers, *Journal of Environmental Economics and Management*, 5: 351-375. Sigman, H. (1995) A Comparison of Public Policies for Lead Recycling, *Rand Journal of Economics* 26: 452-478; Thomas Skinner and Don Fullerton (1999), The Economics of Residential Solid Waste Management, *NBER Working Paper 7326* http://www.nber.org/papers/w7326; K. Palmer and M. Walls (1999) Extended Product Responsibility: An Economic Assessment of Alternative Policies, *Discussion Paper 99-12*, January

The environmental economics literature has analysed the relative merits, in economic efficiency terms, of a number of economic instruments and regulatory approaches to the solid waste disposal and recycling balance issue (Dinan, 1993; Fullerton and Kinnaman, 1995; Sigman, 1995). The general finding was that policies focusing only on input use or on waste outputs cannot generate the optimal (economically efficient) balance between recycling, disposal and production output. Thus recycling subsidies directed at input use cannot generate the efficient amount of waste disposal unless coupled with a tax or subsidy on consumption. Primary product taxes need to be coupled with both an output tax and a tax on other production inputs to be economically efficient. A regulatory measure such as a recycling content standard also cannot generate the efficient level of output and waste disposal unless it is augmented by taxes on other inputs to production, together with either a tax or a subsidy on the final product. Acquiring the detailed firm-specific information necessary in order to set the efficient levels of taxes and standard is clearly not a practicable proposition for public policy makers.

***This same body of analysis finds that the deposit-refund instrument (in which the product tax and the refund are equal to the marginal social cost of waste disposal) is an efficient mechanism and is equivalent to taxing disposal (for nonreturners) but without the attendant illegal disposal problems. The efficiency advantage of the deposit-refund instrument will in practice be reduced the higher the administration and consumer inconvenience costs involved. (Porter, 1978; Pearce and Turner, 1993).** […]*

The waste management policy area is one in which a greater use of economic instruments does seem warranted. The combination of landfill tax and recycling credits to be introduced in the UK is in a rough and ready way a step in this direction. This policy reorientation is however only partial and efficiency gains still remain untapped, given the fact that the landfill tax does not reflect the full social costs of waste disposal in the UK. Economic analysis finds the deposit refund instrument to be highly rated in economic efficiency terms and also has applications in some hazardous waste problems.

The theoretical case in favour of deposit refunds appears, therefore, to be quite compelling.

3.1 Summary View

One could be forgiven for being surprised – given the generally supportive view in respect of the theoretical literature – that deposit schemes are not more widely applied than they already are. However, the theoretical studies tend to be considered abstract from reality, in that they do not fully consider the costs of

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1999, Washington DC: Resources for the Future; Don Fullerton and Amy Raub (2003) Economic Analysis of Solid Waste Management Policies, in OECD (2004) *Addressing the Economics of Waste*, Paris: OECD.

[31] R. Kerry Turner, J. Powell, A. Craighill (1996) Green Taxes, Waste Management And Political Economy, *CSERGE Working Paper WM 96-03.*

administering such schemes in real terms. Once again, this highlights the need for studies which consider the range of possible costs and benefits which may be associated with DRSs.

4.0 Possible Benefits of Deposit Refund Schemes

DRSs are reported, in the literature, to have a range of possible environmental benefits. The key ones mentioned in the literature are:

1. Increasing the recycling of containers covered by deposits (for refill or recycling);
2. Reducing the extent of littering;
3. Increasing the use of / reducing the extent of decline in the use of refillables; and
4. Avoiding harmful chemicals being mobilised in the environment (usually not in beverage schemes, eg. lead acid batteries, or pesticides).

In addition, there are likely to be some effects on the efficiency of logistics with regard to both kerbside collections and the DRSs. Significantly, this study uses logistics modelling to understand how the costs of household waste collections change when the DRS is put in place, as well as to establish the key drivers in terms of the logistics costs of the DRS itself. To our knowledge, no study has carried out this work in a satisfactory manner.

In the discussion that follows, we consider the literature in respect of the first two issues. The third, regarding refillables, is not a key aspect of the scheme we propose (see below).[32] The fourth does not obviously apply to packaging, though there is some evidence to suggest that the effects of packaging on the marine environment do indeed give rise to such concerns (touched upon below in the consideration of effects on littering).

4.1 Increasing Recycling

Ideally, one has some indication of 'before' and 'after' performance, controlling for other variables. To some extent, this is made difficult by the absence of usable data. Surprisingly few studies actually take this approach.

Some data allows for comparison of performance in areas with and without deposits. In the US, in 1999, the recycling performance of states with and without deposits in place is shown in Figure 4-1. The recycling rates, and the number of containers recovered per capita, were far higher in the deposit states. However, this could simply be evidence of the absence of adequate collection infrastructure in the no-deposit states, so it cannot be considered as robust evidence.

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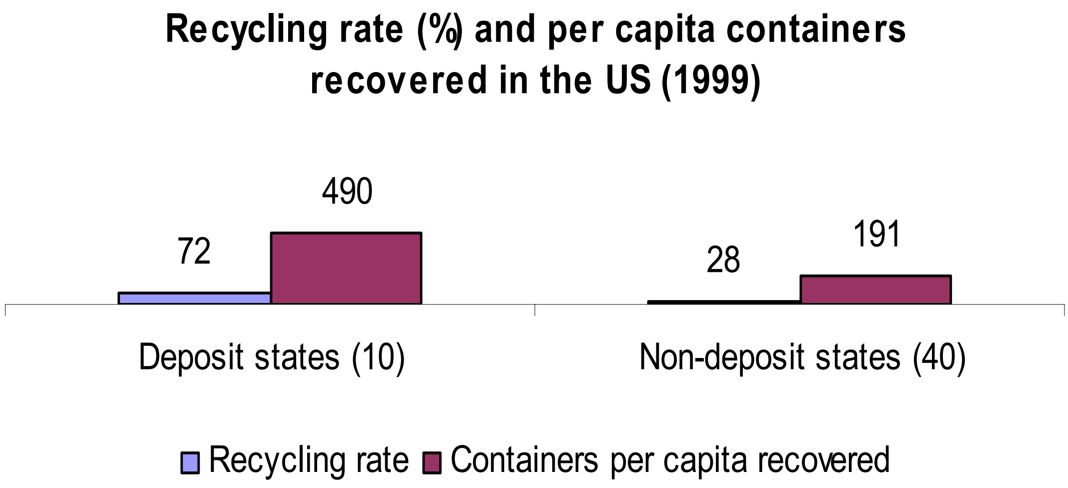
[32] For a discussion regarding the refillables issue, see Eunomia et al. (2009) *International Review of Waste Management Policy: Annexes to Main Report,* Report for Department of the Environment, Heritage and Local Government, Ireland, September 2009.

Figure 4-1: Performance of US States With and Without Deposits, 1999



Of some interest is the performance of deposit schemes in the context of wider recycling systems. In Sweden, for example, the recycling rate for all plastic packaging increased from 17% to 30% between 2003 and 2005 (44% in 2006). In the same period, recycling rates for Polyethylene terephthalate (PET) plastics under the deposit scheme were 77% to 82% (85% in 2007).

Once again, this, in and of itself, might not prove much. The components of plastic packaging are many and varied, and PET bottles are readily recyclable. Perhaps more telling, however, is the performance in respect of metals. Recycling rates for all metal packaging were around 65% in 2004-2005, but the recycling rate for aluminium under the DRS was 85% to 86% in the years 2002 to 2007. The return rate for glass bottles is 99% on 33cl bottles and 90% on 50cl bottles.[33] In Denmark, return rates in 2007 were 84% for cans, 93% for plastic bottles and 91% for glass bottles.[34]

Similarly, in Germany, recycling rates in 2005 were 50%, 85%, 76% and 79% for plastics, tinplate, aluminium and glass respectively. The reported return rates under the deposit scheme are 95-99%.[35,36]

Figure 4-2 shows collection rates achieved in 2002 by international deposit schemes. This shows that very few countries see low rates of return, with some jurisdictions achieving close to 100% return rates. As would be expected under economic theory, deposit scheme return rates increase as the deposit increases,

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[33] http://www.sverigesbryggerier.se/eng/1-emballage/1-index.html, accessed January 2009.

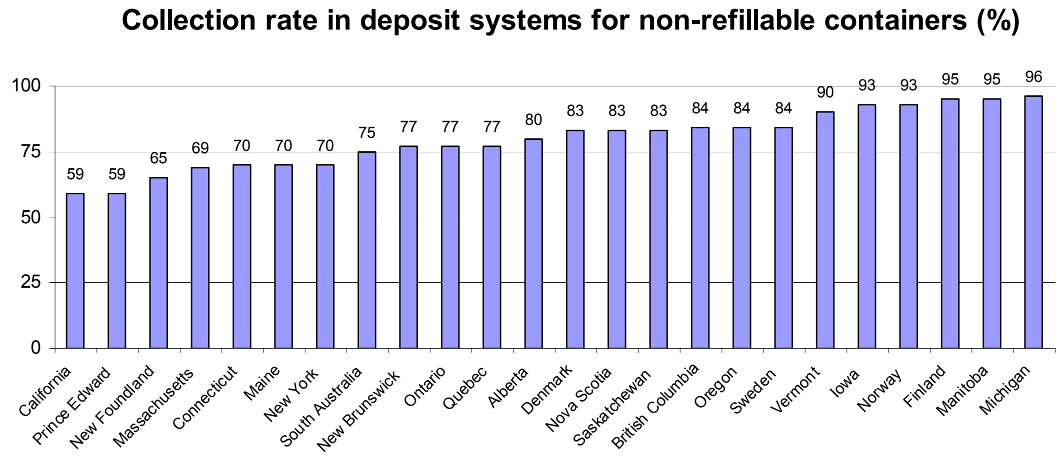
[34] ERM (2008) *Review of Packaging Deposit Systems for the UK,* Report for DEFRA, December 2008, accessed from http://randd.defra.gov.uk/Document.aspx?Document=WR1203_7722_FRP.pdf

[35] Wolfgang Ringel (2008) *The German Deposit System on One Way Beverage Packaging*, Presentation to the first Global Deposit Summit, Berlin 2008.

[36] Data from the DPG (Deutsche Pfandsystem GmbH (System Operator)) in March 2010 puts the 2009/10 return rate for PET bottles at 98.5%.

with higher deposits leading to an enhanced incentive (see Figure 4-3). Figures for Denmark are shown in Figure 4-4.

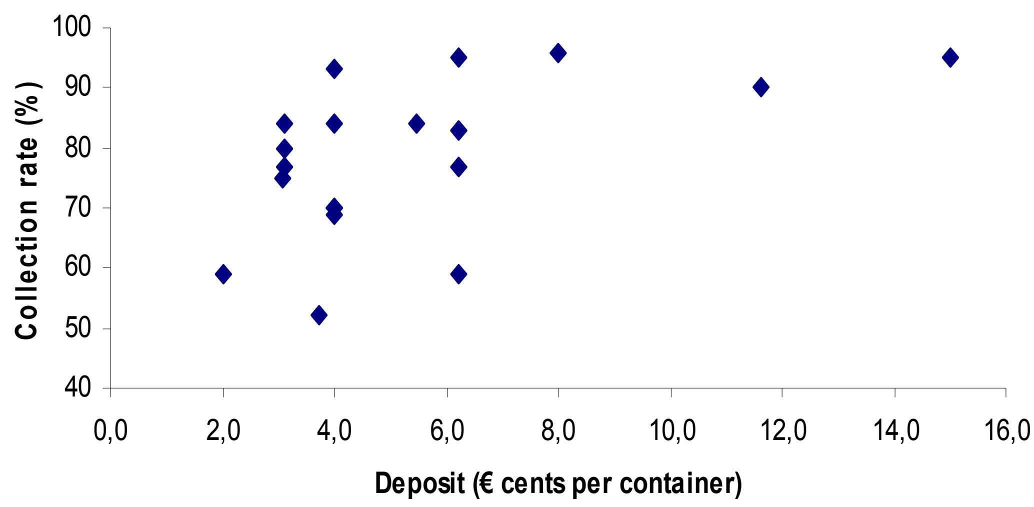
Figure 4-2: Collection Rates for Non-refillable Containers in Deposit Systems, 2002



Note: Figures based on data collected from system operators, data from 2002

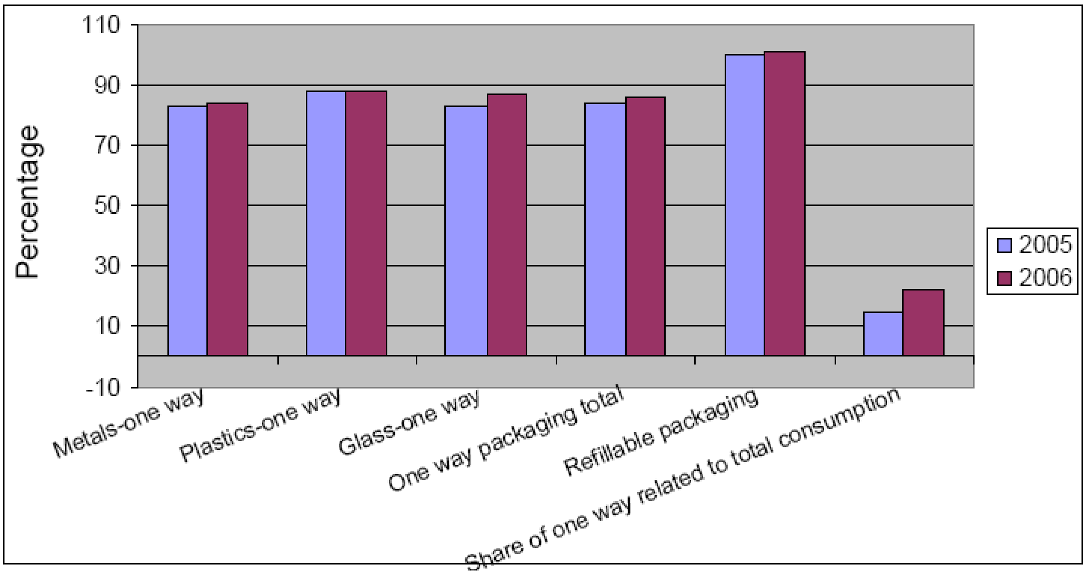
Source: Wolfgang Ringel (2008) Introduction on Deposit Refund Systems, Scottish Government Litter Summit, Edinburgh 26th November 2008.

Figure 4-3: Relationship Between Level of Deposit and Return Rate



Source: System operators, Container Recycling Institute, Data from 1997-2002

Figure 4-4: Return Percentages of One Way & Refillable Beverages in Denmark



Source: Christian Fischer (2008) Producer Responsibility Schemes Versus Deposits and Taxes- Danish Experiences, PRO Europe Congress, 15 May 2008

Taiwan differs from the European context, as the deposit refund scheme started without any other producer responsibility systems in place. The scheme therefore acted in isolation to increase recycling, first of PET and later with a number of other materials. Taiwan now claims a 100% PET recycling rate, using its DRS.

Some have suggested that it is not the case that recycling rates are higher under deposit schemes. However, those who suggest this usually do so on the basis of reviewing recycling rates for *all* packaging. For example, the European Organisation for Packaging and the Environment (EUROPEN) argues:[37]

> *There are no compensating benefits with regard to an overall improvement in recycling performance. The Perchards report showed that overall recycling rates in Member States with deposit systems are not higher than those of comparable EU countries where there are no special arrangements for beverage containers.*

Deposits, however, do not apply to *all* packaging. The Perchards report itself states:[38]

> ***It is certainly true that deposit systems for non-refillable beverage containers can achieve higher recycling rates for the beverage containers affected than when these containers are handled through general recycling systems.*** *However European experience shows that* ***deposit systems do not achieve a***

[37] EUROPEN (2007) Economic Instruments in Packaging and Packaging Waste Policy, Brussels: EUROPEN.

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

higher recycling rate for all packaging of a given material, because beverage containers represent too small a proportion of the total tonnage of that packaging material.

Drinks containers typically represent only about 10% of all packaging and the recycling rate for beverage containers in general recycling systems is likely to be higher than the recycling rate for all packaging of the same materials.

The report then alludes to the performance of Belgium in respect of the recycling of *all* packaging even though this is clearly not a good comparator for reasons which the previous extract makes clear (the targeted materials – beverage containers – are a relatively small fraction of all packaging). In particular, the largest fraction of the packaging stream is *always* paper and card, which is also an easy, and relatively low cost, material to recycle. Consequently, in most countries, the packaging recycling rate will be heavily influenced by capture of a material that is irrelevant to any sensible discussion regarding DRSs.

Perchards responded to a similar criticism in a previous report, where they had earlier suggested that the recycling rates achieved in deposit schemes were no greater than those achieved in other countries through presenting targets related to all packaging.[39] They responded:

We decided to make a comparison based on overall recycling rates achieved because the Packaging and Packaging Waste Directive repealed the Directive on containers of liquids for human consumption, reflecting that the scope of policy has broadened out to all packaging. A further expansion and/or restructuring of EU policy is now under consideration which may result in targets for all products of specific materials. Thus, specific arrangements just for beverage containers go against the trend in EU policy in this area.

GRA has challenged our line of argument, saying that the fact that deposit systems handle only a small amount of packaging is no reason not to have a deposit system. GRA used a medical analogy to illustrate argument – if you have a medicine that can cure 10% of the patients, but not the other 90%, is there a reason not to use the medicine for the 10%? However, this is not an exact analogy, because a medicine does exist for a significant proportion of the other 90% of packaging, namely selective collection.

Several other stakeholders have also challenged the basis of our comparison, arguing that a clearer picture would emerge from a comparison based on recycling rates for household packaging waste alone, or, even better, of beverage containers between deposit states and Member States relying on packaging recovery systems. Unfortunately, though, we were not able to obtain data which would have enabled us to pursue this suggestion.

This argument fails to counter the possibility that it might be possible to design a system which targets the 10% through one system and targets the remaining 90% through another. No one advocating DRSs is necessarily arguing *against* 'selective collection' of, for example, cardboard or wood. Equally, several successful selective

[39] Perchards (2005) Study on the Progress of the Implementation and Impact of Directive 94/62/EC on the Functioning of the Internal Market, Final Report to the European Commission, May 2005.

collection systems for packaging – notably the Belgian one - achieve high rates of recycling without targeting non-bottle plastics from households.

So, the question remains open as to whether a complementary system or, when correctly modelled, a parallel system of selective collection and DRS might be superior to either one acting independently. The rather obvious point is that the costs of an existing recycling system are unlikely to remain the same when substantial quantities of generally low density beverage packaging are no longer being collected. This question has only really been examined in one study as far as we are aware (see later in this Section). Generally, the question regarding costs has not been properly answered for the simple reason that the question which really matters has not been interrogated in sufficient depth. This research attempts to shed light upon what the implied changes in costs and benefits might actually be.

This is not to deny the possibility of high recycling rates of packaging being achieved without DRSs. Other EU countries, such as Belgium, have achieved impressive recycling performance without them. Based on its Fost Plus managed packaging collection system, Belgium recycled 67% of plastic bottles in 2007 (comprising both Polyethylene terephthalate (PET) and High-density polyethylene (HDPE)) and 97.5% of metal packaging (steel and aluminium cans).[40] Belgium has a producer responsibility scheme in place which is fully funded by obligated industry. It also sets targets well above those prevailing in the UK at present, and also has near-universal implementation of so-called 'pay as you throw' schemes at the household level, a policy which the Coalition Government has clearly set itself against. One might still argue, even in this case, that there might be room for improvement through use of a deposit scheme where plastic bottles are concerned.

In the UK, Alupro, the aluminium industry's trade body, says 98% of English households have kerbside collections of aluminium cans, but capture rates can be anywhere between 30% and 70%.[41] The 'cans-only' recycling rate was estimated to be 52% in 2008.[42] Therefore, even with a 'free to the consumer' system (in terms of marginal cost), and very widespread coverage, the capture rate is still much less than is seen in countries with a DRS. This may be partly a reflection of the fact that 35% of aluminium cans are consumed away from home, in the workplace, and at sports, leisure and travel locations, according to Alupro. Consequently, this waste stream would be one for which DRSs may be well suited, not least since such containers would subsequently then be less likely to arise as litter, with individuals encouraged to recycle whilst 'on the go' in order to claim back their deposits.

For plastic bottles, according to RECOUP, with 18.1 million (72%) of the UK's 26 million households receiving kerbside collections (and bring schemes also in place), the recycling rate in 2009 was 39%. If the same average performance was maintained, the recycling rate would increase to 55% under universal coverage by

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[40] Fost Plus (2007) *Annual Report*, http://www.fostplus.be/files/EN/8/GB_AR.pdf

[41] Ends Report (2009) *Defra Report Rejects the case for Bottle Deposits*, January 2009 http://www.endsreport.com/index.cfm?action=report.article&articleID=20119&q=deposit%20refund&boolean_mode=all

[42] Alupro website, http://www.alupro.org.uk/facts%20and%20figures.htm, accessed May 2009.

kerbside services. The 55% figure appears to be well below what is routinely achieved by DRSs, though it must be stated that the RECOUP data covers all plastic bottles, whereas deposit schemes do not always cover 100% of all plastic bottles (see Section 5.2 below).

4.2 Effects on Littering

There is evidence to suggest that deposit refund policies can reduce litter and even reduce the number of lacerations caused by glass in the environment.[43] Several one-way deposit systems were implemented with the clear objective of reducing littering (eg. Sweden, British Columbia, California, Michigan and others, with Hawaii a more recent example of this trend). The potential for DRSs to be effective in reducing littering has an intuitively plausible rationale - if the deposit is significant and the consumer does decide to litter, the possibility exists that someone else will pick up the container to redeem the deposit. INCPEN suggests that this can worsen the litter situation in some cases. They make the statement that:[44]

> *Perversely, a deposit can contribute to the litter problem. There have been reports of homeless people emptying litter bins to obtain deposit containers, leaving other items on the street.*

There is no evidence offered to support this view.

The Container Recycling Institute suggested significant reductions in littering following the introduction of deposits in some US states (see Figure 4-5). The effects on used beverage containers (UBCs) and on total litter are shown as being between 70-80% and 30-40%, respectively. It must be said, however, that all studies of this nature suffer in terms of the lack of clarity about the metric used to measure the contribution of beverage containers to total litter. It is not clear what the most relevant indicator should be (counts, volume, hazardousness, etc.) partly because no systematic studies have been carried out, to our knowledge, to understand the contribution of different attributes of litter to the disamenity suffered by those who experience litter. There is also the significant matter of cost to be considered since clearing litter costs an ever-increasing amount of public money. Indeed, recent figures from the Department of Communities and Local Government show that the amount spent by local authorities in England on cleaning up litter and street cleansing rose by almost £100M in the last year to £858M in 2009/10.[45]

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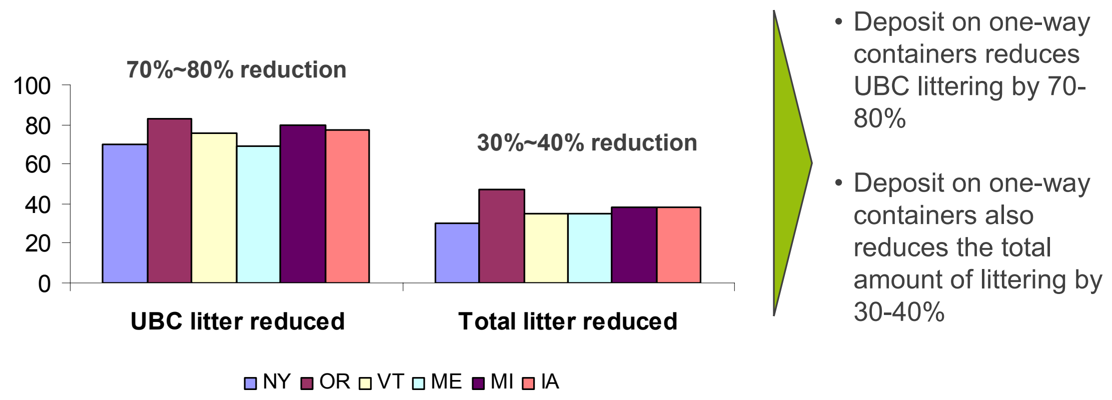
[43] M. Douglas Baker, MD, Sally E. Moore, and Paul H. Wise, MD, PhD, MPH, "The Impact of 'Bottle Bill' Legislation on the Incidence of Lacerations in Childhood", *American Journal of Public Health*, October 1986.

[44] Incpen (2008) Mandatory Deposits on Packaging, May 2008.

[45] http://communities.gov.uk/publications/corporate/statistics/financialstatistics202010

Figure 4-5: Reduction in Littering in US States Linked to Deposit Schemes

Reduction of littering in 6 US states after the introduction of container deposit systems.



Source: Container Recycling Institute, USA

The Policy Exchange and CPRE report, Litterbugs,[46] cited a study suggesting litter in New York State declined by 30% in the wake of the use of a DRS.[47] Over the past 25 years, according to official figures, the New York State Returnable Container Act 1983:

1. Reduced container litter by 70-80% and roadside litter by 70%;[48]
2. Achieved redemption rates between 65-80%.[49]

Where counter-arguments to the 'litter reduction' effect are put forward, these very rarely challenge the likely reality of this effect. Indeed, the counter-arguments tend to adopt the view that this effect is not significant because beverage containers constitute only a small proportion of litter.

Even if one accepts the argument that this might be true, implicit in the counter-argument appears to be an assumption that if litter 'is there', then the amount of it is not a matter of any importance, or more specifically, that the reduction in the quantity of beverage packaging in litter is of no significance. Yet none of the literature actually offers any evidence to support this implied claim. The validity of the implied claim is also affected by the nature of the assumption (as highlighted above) concerning the metric used to measure 'litter'. What the right metric might

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[46] Policy Exchange and CPRE (2009) *Litterbugs: How to Deal with the Problem of Littering*, London: Policy Exchange, 2009.

[47] New York Public Interest Research Group, www.nypirg.org/enviro/bottlebill/myths.html ; Bottle Bill Resource Guide, www.bottlebill.org/legislation/usa/newyork.html

[48] Kruman J, Bottle Bill at 25, New York State Conservationist, August 2007, New York State Department of Environmental Conservation, www.dec.ny.gov/chemical/8500.html

[49] New York State Department of Environmental Conservation Beverage Container Deposit And Redemption Statistics: October 2004 - September 2005, 2006.

be has not, as discussed above, been given adequate consideration by either advocates, or detractors, of the effects of deposit schemes.

Generally, the argument tends to be that beverage containers are a small fraction of litter, and that therefore, eliminating this would not solve the litter problem. A limitation of this argument is that it assumes that the relevant indicator regarding litter is the measure used in the surveys referred to, typically, 'counts' of litter.

It could easily be argued that the disamenity effect of litter is as much a function of its volume, and possibly its potential to persist, than simply the number of items (ie. the counts). Given the relative insignificance – in volume terms – of chewing gum and cigarette ends, it could be considered that beverage containers actually contribute significantly to litter-related disamenity due to their contribution to the visibility of litter.

For example, a 2008 survey by ENCAMS for INCPEN highlighted that there were 44,040 counts of cigarette butts as compared with 582 counts of beverage containers (201 counts of 'soft drinks cans, 188 soft drink plastic bottles, and 90 alcohol cans, 44 alcohol glass bottles, 43 drinks cartons, 9 alcohol cartons, 4 alcohol plastic bottles and 3 soft drink glass bottles (see Table 4-1)). An article by Register suggests that 20 cigarette butts occupy a volume of 10ml.[50] The 44,040 butts would occupy, therefore, 22.02 litres. By contrast, the bottles and cans would occupy around 163 litres in their uncompacted form. In other words, though accounting for around 1.5% of the counts as compare with cigarette butts, they would occupy around seven times the volume in their uncompacted form. The plastic bottles alone (which are less readily compacted than, for example, cans) would occupy more than three times the volume of the cigarette butts at an average size of 330ml (which could be an underestimate). This highlights the fact that if count data is a poor proxy for perceived impact of litter, and if volume is a more appropriate one, then beverage packaging is a significant contributor to litter, this being disproportionately large relative to its prevalence in surveys based only on 'counts'.

Table 4-1: Raw Data from ENCAMS 2008 Survey for INCPEN

Type of Litter	Count	Type of Litter	Count
Gum Staining	175,690	Drinks Cartons	43
Cigarette Ends	44,040	Comm. Warehouse Packaging	40
Sweet Wrapper	916	Other Paper Litter	38
Cigarette Related	366	Post Office Elastic Bands	34
Other Litter	335	Drinking Straws	29
Discarded Food & Drink	220	Commercial Industry Packaging	24
Soft Drink Cans	201	Commercial Office Packaging	24
Plastic Soft Drink Bottles	188	ATM Receipt	17

[50] Kathleen M. Register (2000) Cigarette Butts as Litter—Toxic as Well as Ugly, *"Underwater Naturalist"*, *Bulletin of the American Littoral Society*, Volume 25, Number 2, August 2000, http://www.longwood.edu/cleanva/ciglitterarticle.htm

Fast Food Packaging	188	Lottery Related	16
Soft Drink Bottle Tops	183	Commercial Packaging	16
Snack Packaging	168	Match Boxes	14
Matches	135	Commercial Flyers	11
3D Gum	118	Other Travel Tickets	9
Tissue	93	Cartons for Alcohol	9
Alcohol Drinks Cans	90	Construction other Materials	8
Till Receipts	85	Warehousing other Materials	6
Other Materials	79	Commercial Office other Materials	6
Carrier Bags	78	Paper Bags	4
Travel Tickets	67	Plastic Bottles for Alcohol	4
Alcoholic Bottle Tops	60	Commercial Food Other	4
Drink Cups	52	Commercial Construction Pack	4
Lolly/Ice Cream Related	51	Batteries	3
Gum Wrappers	50	Commercial other Retail	3
Discarded Newspaper	47	Soft Drink Glass Bottles	3
Glass Alcohol Bottles	44	Telephone Related	2
TOTAL			223,915

Source: ENCAMS (2009) Litter Composition Survey of England, Aug-Oct 2008, report for Incpen, March 2009.

In their review of the Oakdene Hollins report for Defra, Perchards were critical of the study's examination of the effect of deposit refunds on litter even though the principal objective of the study was, as noted by Perchards to "ascertain either of these approaches [ie. DRS for reuse and/or for recycling of packaging] will confer positive benefit over and above current policy approach to managing" packaging waste." It is difficult to understand why this would not be a legitimate area of inquiry given the overriding objective, but Perchards state:[51]

> *'litter abatement was not referred to in the Defra specification, and we wonder why it was discussed so thoroughly'.*

Interestingly, they themselves enter the debate around litter, highlighting, as they do so, work from the US which demonstrated that DRSs have, on average, the effect of eliminating 81% of all deposit-related litter in the US.

They also show results for litter reduction in the US, drawing on the work of Syrek, which highlights the difference in the effect of DRSs when the effect on litter is considered from the perspective of items, or from the perspective of volume. Studies relying on counts indicate that DRSs may have a small impact if large numbers of other items are present. On a volume basis, however, DRSs seem to achieve, in the figures highlighted by Perchards, a reduction of the order of 33-38% in total litter (the figures can exceed 30% on an item basis too).

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[51] 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

These figures hardly look like the basis for an argument not to examine the effects of DRSs on litter. Rather, it looks like a very good one for doing so, the more so since the author upon whose work they rely has noted:

> *'Litter is usually considered to be first and foremost a visual form of pollution where the larger items are more visible to pedestrians and doubly so to motorists. However, the primary problem with including the small items is they bias the results towards the less visible components of litter.*[52]

It should also be noted that the US systems discussed were not achieving the same return rates as many European systems. The effect on litter reduction might be expected to be higher in systems where the return rates are higher.

Perchards go on to cite a statement from the same US author who uses, as representative of the cost of removing one beverage container from litter through DRSs, the cost of handling 164 containers through the DRS scheme. The author notes

> *Note that this analysis is concerned only with litter reduction and ignores any impacts such a program might have on waste reduction or materials and energy conservation*

One might have thought that given that something else was happening with 163 other containers (being collected and recycled), this approach to analysing the costs of litter reduction might have been deemed completely and utterly inappropriate, yet this is given as credible evidence that DRSs are an expensive form of litter reduction. The same claim is made, incidentally, by INCPEN:[53]

> *Recent work by Syrek in 2003 shows that under US conditions, deposits are by far the most expensive way of eliminating an item of litter. He also points out that unlike the 1970s, when a relatively large percentage of containers ended up as litter, recent surveys show that even in non-deposit states less than 0.3% of all containers now end up as litter.*

This is not credible research. It is rather like assuming that the cost of a meal for one person at a wedding are equal to the whole cost of the wedding meal, when there are 163 other people at the same wedding

In jurisdictions such as Hawaii, where the prevalence of beverage containers in litter has been a motivation for the introduction of a DRS, the problem also extends to pollution of the marine environment. One report from the State of Hawaii shows how beverage containers have changed in terms of their prevalence in litter (debris) over time.[54] The data are shown in Table 4-2 and Table 4-3.

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[52] Steven Stein and Daniel Syrek (2005) New Jersey Litter Survey: 2004, A Baseline Survey of Litter at 94 Street and Highway Locations, Report for the New Jersey Clean Communities Council, January 28, 2005. http://www.njclean.org/2004-New-Jersey-Litter-Report.pdf

[53] INCPEN (2008) Mandatory Deposits on Packaging, http://www.incpen.org/pages/data/MANDATORY%20DEPOSITS%20May%202008.pdf

[54] State Of Hawaii Department Of Health (2008) Pursuant To Sections 342g-102.5(H), 342g-114.5(B), And 342g-123, Hawaii Revised Statutes, Requiring The Department Of Health To Give A Report On

Table 4-2: Counts of Debris Found During Cleanup in Hawaii since the Start of the Deposit Refund Scheme in October 2002

Beverage Container Type	2003	2004	2005	2006	2007
Glass Bottles	7,687	11,362	7,194	5,759	5,008
Plastic Bottles	5,246	5,215	3,824	4,799	2,965
Metal Cans	4,946	6,894	3,518	3,959	2,932
Total	**17,879**	**23,471**	**14,430**	**14,517**	**10,905**

Source: State Of Hawaii Department Of Health (2008) Pursuant To Sections 342g-102.5(H), 342g-114.5(B), And 342g-123, Hawaii Revised Statutes, Requiring The Department Of Health To Give A Report On The Activities Of The Deposit Beverage Container Program, Report To The Twenty-Fifth Legislature State Of Hawaii 2009, November 2008

Table 4-3: Percentage of Total Debris Collected During Cleanup

Beverage Bottles & Cans	2003	2004	2005	2006	2007
Glass, Metal, & Plastic	15.9%	14.5%	12.3%	8.7%	6.7%

Source: State Of Hawaii Department Of Health (2008) Pursuant To Sections 342g-102.5(H), 342g-114.5(B), And 342g-123, Hawaii Revised Statutes, Requiring The Department Of Health To Give A Report On The Activities Of The Deposit Beverage Container Program, Report To The Twenty-Fifth Legislature State Of Hawaii 2009, November 2008

The report notes:

> *While there appears to be a downward trend in the number of bottles and cans found at beaches, beverage containers, along with associated caps and lids, continue to be a large portion of beach litter. This is why it is important to continue to place a deposit on beverage containers to decrease the temptation to litter and increase the incentive to recycle.*

An interesting feature of the Hawaii data is that it shows the problem is not simply one of terrestrial litter. Indeed, beverage containers appear to be (relatively) more problematic in underwater cleanups (see Table 4-4).

Regarding plastics in particular, a UNEP report notes the prevalence of plastic bottles, caps and bags among the key forms of marine litter giving rise to increasingly serious problems at sea. Evidently, in the marine environment, it is the

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The Activities Of The Deposit Beverage Container Program, Report To The Twenty-Fifth Legislature State Of Hawaii 2009, November 2008.

longevity and potential harm caused by plastics that makes them of particular concern.[55]

Table 4-4: Top Five Debris Items Collected During the 2007 Cleanup

Land Cleanups Only	Number of Debris Items	Percent of Total Collected
1. Cigarettes & Filters	72,053	44.7%
2. Caps & Lids	21,210	13.1%
3. Food Wrappers and Containers	16,554	10.3%
4. Beverage Containers *(glass, metal, plastic)*	10,505	6.5%
5. Cups, Plates, and Utensils	7,331	4.5%
Underwater Cleanups Only	**Number of Debris Items**	**Percent of Total Collected**
1. Fishing Line	1081	54%
2. Beverage Containers *(glass, metal)*	393	19.6%
3. Cigarettes, Filters, & Cigar Tips	248	12.3%
4. Food Wrappers and Containers	55	2.7%
5. Caps & Lids	39	1.9%

Source: State Of Hawaii Department Of Health (2008) Pursuant To Sections 342g-102.5(H), 342g-114.5(B), And 342g-123, Hawaii Revised Statutes, Requiring The Department Of Health To Give A Report On The Activities Of The Deposit Beverage Container Program, Report To The Twenty-Fifth Legislature State Of Hawaii 2009, November 2008

A study undertaken in Australia suggested that deposit schemes were likely to be the most effective policy option for reducing litter amongst those considered for improving recycling:[56]

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[55] Ljubomir Jeftic, Seba Sheavly, and Ellik Adler (2009) *Marine Litter: A Global Challenge*, Report for UNEP, April 2009, http://www.unep.org/regionalseas/marinelitter/publications/docs/Marine_Litter_A_Global_Challenge.pdf

[56] BDA Group (2009) *Beverage Container Investigation*, Report for the EPHC beverage Container Working Group, March 2009.

A national CDS [container deposit scheme] is expected to provide the greatest reduction in overall litter levels, with the potential to provide a 6% reduction in the total national litter count and a 19% reduction in the total national litter volume.

Finally, there is another way in which removal of used beverage containers from litter could contribute to cleaner streets. Given that beverage containers are relatively voluminous items, their removal from litter bins would leave more room for other waste. The CPRE's Litterbugs report confirms that 91% of the public believe that increasing the number of bins is the most effective way of reducing litter.[57] A useful parallel approach might be to free up space in existing bins. The report cites the New York bottle bill as reducing container litter by 70-80%. Clean-up costs, as well as landfill costs, were reduced. The scheme enjoys solid public support (84% of voters in 2004) and so has been extended in 2009 to cover non-carbonated drinks, which make up 27% of beverage sales.

4.3 Implications for Transport

Perchards suggested that introducing a deposit scheme in Ireland would be unfavourable from an environmental perspective, partly owing to the duplication in logistics:[58]

Deposit containers would be transported separately for recycling from other packaging. That would mean additional trucks, with increased energy and carbon impacts. One set of trucks would collect containers from retailers and another would transport packaging waste collected from the existing bring and kerbside system. Deposit containers would have to be kept separate from other packaging. It may sometimes be possible to collect both together, as deposit packs would have to be in sealed containers, but collection contracts would be awarded separately for each stream, so this arrangement would often not be possible.

This argument is unconvincing and shows little comprehension of the factors affecting collection logistics. Currently, in Ireland, as in the UK, much of the collection of dry recyclables makes use of kerbside collections. The removal of low bulk density beverage containers (plastic and cans) from the collected waste stream would have the effect of freeing up volume in containers, and on recycling vehicles, improving the logistics for the collection of other materials using the existing collection schemes.

Given:

- That the logistics of picking up relatively large quantities per pick-up from specific collection points would be favourable under a deposit scheme;

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[57] A. Lewis, P. Turton and T. Sweetman (2009) *Litterbugs: How to Deal with the Problem of Littering*, Report for CPRE, March 2009.

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

- The absence of a need for sorting at a dedicated sorting facility (with its own energy demand); and
- The likely very low loss rates in the recycling process because of the pre-segregated nature of the material,

then the argument made would appear to amount to pure speculation, based upon an extraordinarily unlikely scenario in which there is no effect on the logistics of the pre-existing system, even when low bulk density materials are removed from that collection.

Furthermore, if the recovery of containers through a deposit scheme is very high, arguably, there is limited need for a 'duplicate' scheme. Indeed, this closely approximates to the Danish approach. A considerable part of the literature speaks of the possible duplication in cost of running parallel schemes. The commentary overlooks the point that when captures are very high from deposit schemes, then there is very little duplication, and kerbside schemes can concentrate on optimising the logistics of collecting the remaining materials, such as paper and card.

4.4 Summary View

The evidence suggests that DRSs are likely to increase the capture of the targeted materials for recycling. This is unsurprising as the deposit gives the purchaser an incentive to take the material back to an appropriate location in order to generate a refund.

The captures achieved appear to be influenced by the level of the deposit applied. This is in line with what is expected by economic theory.

The schemes also appear to influence the prevalence of litter. It is true that deposit schemes do not affect littering of items such as cigarette butts or chewing gum, both of which are prevalent in terms of counts, but the contribution of beverage packaging to the volume of litter appears to be disproportionately large relative to its prevalence as revealed in surveys based on counts. Hence, DRSs affect the volume of litter in a manner which is disproportionate to the prevalence of beverage packaging in litter as recorded through 'counts'. There are good reasons to believe that the volume of litter (not the 'count') is what gives rise to the associated disamenity.

The suggestion that transport impacts are significantly worsened when DRSs are introduced is not based upon detailed analysis. There is a requirement to understand how the logistics of the DRS reduce the transport movements in the kerbside scheme (for recyclables as well as refuse). Only when these effects are understood can the net effect be quantified.

5.0 Methodology for Cost Benefit Analysis

In order to examine the potential costs and benefits associated with the introduction of a DRS in the UK, the following key steps were employed:

1) Review of existing DRSs worldwide;
2) Formulation of high-level design of a DRS to be modelled for the UK (including range of materials);
3) Establishment of baseline tonnages of waste collected at the kerbside, through bring sites, as commercial waste, via on-the-go recycling and from street sweepings, and also the total number of units placed on the market. In order to maximise the potential impact of introducing a DRS, we have modelled a system that covers the following beverage container materials:[59]

    A) Plastic bottles made from PET;
    B) Metal cans, both steel and aluminium; and
    C) Glass beverage containers.

    The modelled system targets non-refillable containers, because the market for refillables in the UK is much smaller than for non-refillables and there will typically already be systems of collection for re-use of refillables e.g. glass milk bottles.[60]

4) Determination of tonnages that would be diverted from each of these waste flows into the DRS in:

    A) a complementary system; and
    B) a parallel system.

5) Establishment of the costs and revenues for both the complementary and parallel DRSs;
6) Determination of changes in costs relative to the baseline achieved by changing the flow of deposit-bearing waste into kerbside collections, bring sites, commercial waste stream, on-the-go recycling and street sweepings, and the DRS;
7) Determination of key environmental impacts (benefits and disbenefits) associated with complementary and parallel systems in relation to the baseline. To include the disamenity associated with litter;

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[59] Few systems cover, for example, cartons such as tetrapak. One of the reasons for this relates to the shape of the containers. Advances in reverse vending machine technology are expected to make it possible to include beverage cartons in future schemes.

[60] CRR (2009) *Policy Study: Refillables – Evaluation of Market Opportunity in the UK*, Centre for Remanufacturing and Reuse, August 2009, available at http://www.remanufacturing.org.uk/pdf/story/1p317.pdf?-session=RemanSession:42F9475818a2d30D7AXwp1883067

8) Estimation of the impact of the scheme on the flows of revenues through the Packaging Recovery Note/ Packaging Export Recovery Note (PRN/PERN) system; and

9) Pulling all figures together to produce a cost benefit analysis for the introduction of a DRS in the UK.

The key inputs and assumptions used for each of these steps are outlined in the remainder of this section.

5.1 Summary of Existing Deposit Systems Worldwide

In order to determine the high-level configuration of the DRS model for the UK, we were able to draw on a substantial amount of existing literature regarding current DRSs in place worldwide. This literature included the following studies:

- BIO Intelligence Service (2005) *Environmental- and Cost Efficiency of Household Packaging Waste Collection Systems: Impact of a Deposit System on an Existing Multimaterial Kerbside Selective Collection System*, report written for Apeal.
- ERM (2008) *Review of Packaging Deposits System for the UK*, Final Report produced for Defra, December 2008.
- 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.
- Eunomia et al. (2009) *International Review of Waste Management Policy: Annexes to Main Report*, Report for Department of the Environment, Heritage and Local Government, Ireland, September 2009.
- EUROPEN (2007) *Economic Instruments in Packaging and Packaging Waste Policy*, Brussels: EUROPEN.
- Oakdene Hollins (2004) *Deposit Return Systems for Packaging: Applying International Experience to the UK,* report for Defra, December 2004
- Oakdene Hollins (2008) *Refillable Glass Beverage Container Systems in the UK,* Report for WRAP, 26 June 2008.
- Perchards (2007) *Study on Factual Implementation of a Nationwide Take-back System in Germany After 1 May 2006*, Final Report, 14 February 2007.
- Robert C. Anderson (2004) *International Experience with Economic Incentives for Protecting the Environment*, Report for US EPA, Nov 2004;
- Covec Report (2008) *Potential Impacts of the Waste Minimisation (Solids) Bill: Update Report*, Report for Packaging Council of New Zealand, May 2008, http://www.pca.org.au/uploads/00548.pdf ;
- N. Tojo, T. Lindhqvist and G. Davis (2001) *OECD Seminar on Extended Producer Responsibility, EPR: Programme Implementation and Assessment,* Seminar for the OECD, December 2001

- RDC-Environment & Pira International (2003) *Evaluation of costs and benefits for the achievement of reuse and recycling targets for the different packaging materials in the frame of the packaging and packaging waste directive,* Report for the European Commission, March 2003
- D. O'Connor (1996) *Applying Economic Instruments in Developing Countries: From Theory to Implementation,* OECD Development Centre, May 1996

A summary of the international DRSs currently in place can be found in Appendix A.1.0. From the literature available, and predominantly based on previous work undertaken by Eunomia, we were looking to extract the key lessons learned from existing systems in order to determine a preferred high-level model for the UK.[61] An outline of the chosen system is given in Section 5.3.

5.2 Mass Flows – Baseline and Scenarios

The first step in the development of the quantitative model was to decide which beverage containers could be covered by a deposit scheme.

The materials we have included in the DRS are one-way (non-refillable) beverage containers. The following containers were considered to be relevant:

1) Plastic bottles made from PET eg. containers for fizzy drinks, mineral water, squash. The recycling symbol on these products is:

2) Metal cans, both steel and aluminium eg. containers for fizzy soft drinks, alcoholic beverages, energy drinks etc.
3) Glass beverage containers eg. beer bottles, wine bottles, soft drink bottles etc.

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:

- 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.
- Beverage containers are more likely than other types of food-based containers to be consumed away from home and thus end up as litter.[62]
- Hygiene issues – particularly in association with plastic milk bottles, but also for other food-based containers; hygiene issues associated with milk bottles

[61] Eunomia et al. (2009) *International Review of Waste Management Policy: Annexes to Main Report,* Report for Department of the Environment, Heritage and Local Government, Ireland, September 2009.

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

have been stated as a reason for not including high-density polyethylene (HDPE) in existing DRSs.[63]

The modelled system targets non-refillable beverage containers, because the market for refillables in the UK is much smaller than for non-refillables and there will typically already be systems of collection for re-use of refillables, eg. glass milk bottles.[64] For the purposes of this modelling, we have thus considered refillables as 'exempt' from the deposit scheme. If the system we are proposing were to be implemented, then we would suggest that exemptions for refillables should be supported only where return rates exceed a minimum level (probably in excess of 75%). This minimum return rate would ensure that any producers seeking to switch to refillable beverage containers in order to circumvent the deposit scheme would still need to meet relatively high return rates for these containers, and would thus also contribute to the improvement in the management of beverage containers across the UK. Focusing on non-refillables in the DRS will exploit the potential for increased recycling rates, lead to an increase in the quality of material collected for recycling through the deposit mechanism and reduce litter levels.

The second step in building the cost benefit analysis model was to consider the current material flows in the UK, where the waste arises and how much of the waste is sent for recycling compared to how much requires disposal. Figure 5-1 indicates the possible material flows in our container universe (before the DRS).

In this study we have assumed the baseline year is around 2015; the landfill tax escalator will have increased to £80 per tonne by 2014/15, and by this time, it is also likely that fully comprehensive kerbside collection services will have been rolled out to all households in the UK.[65] In order to provide direct comparison, the ensuing changes to the baseline as a result of the introduction of a DRS have also been modelled based on the same year.

Relevant data sources covering all of the elements shown in Figure 5-1 were used to extract information relating to the containers we are considering. Many of the data sources do not provide disaggregation down to the level required, so some assumptions were required to break down material fractions into the following elements:

- Glass Bottles ≤500 ml
- Glass Bottles >500 ml
- PET Bottles ≤500 ml
- PET Bottles >500 ml

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

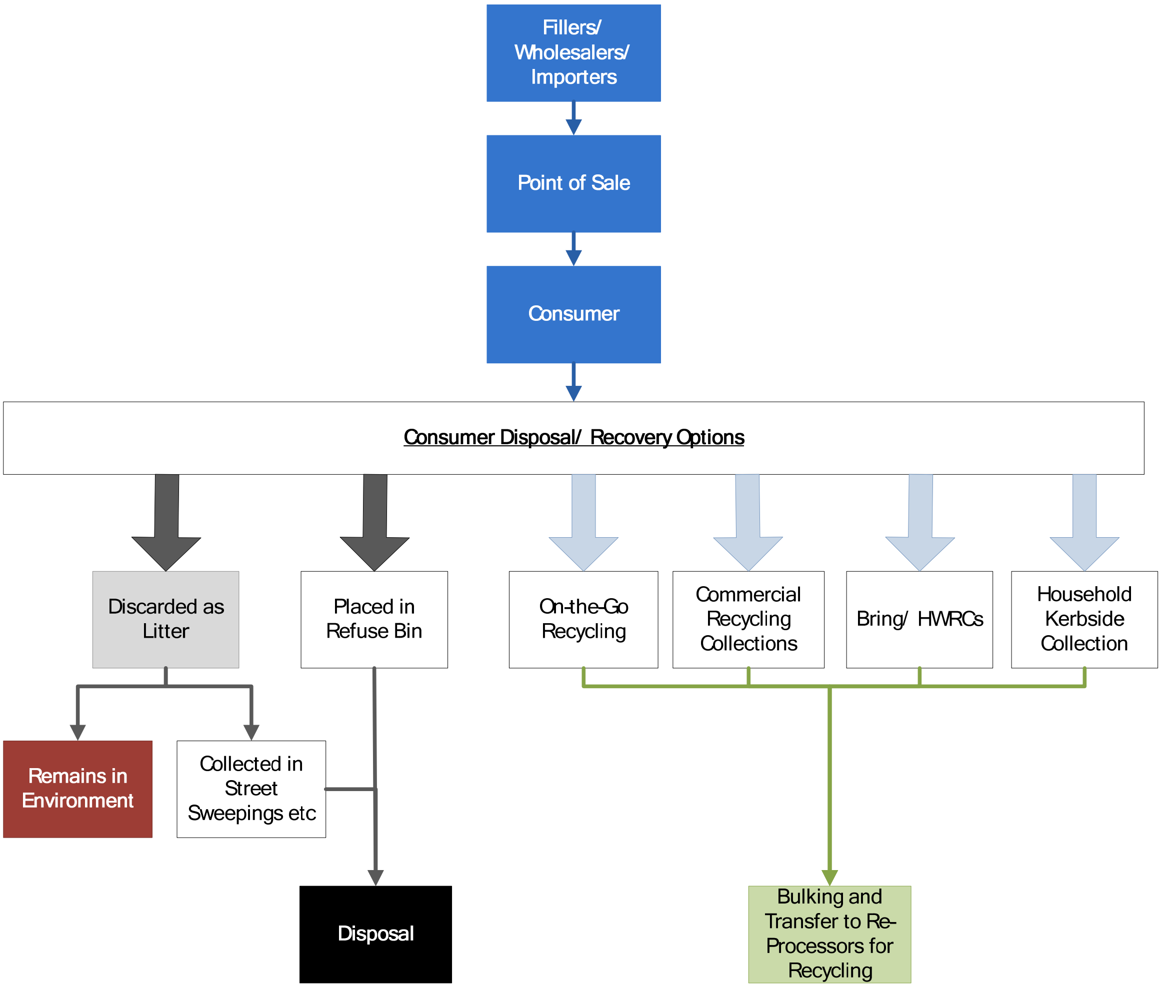
[64] CRR (2009) *Policy Study: Refillables – Evaluation of Market Opportunity in the UK*, Centre for Remanufacturing and Reuse, August 2009, available at http://www.remanufacturing.org.uk/pdf/story/1p317.pdf?-session=RemanSession:42F9475818a2d30D7AXwp1883067

[65] 'Fully comprehensive' means a system that would collect all of the containers within the scope of this study.

- Cans (Ferrous)
- Cans (Aluminium)

All the data sources and assumptions are set out in Appendix A.2.0.

Figure 5-1: Possible Container Material Flows (Pre-Deposit Refund System)



Source: Eunomia

The final step was to model the quantitative impacts of introducing a DRS. In order to show some of the variation in the overall costs of the system in relation to different potential configurations that might occur in the UK, two scenarios were considered as follows:

> **Complementary** – where no beverage containers are collected at the kerbside ie. the DRS is complementary to the existing kerbside schemes; and
>
> **Parallel** – where the household kerbside systems for beverage containers operate in parallel to the DRS.

Some general principles relating to each of the scenarios were considered. These principles centred on the likely return rates that might be expected in the complementary and parallel DRSs. The modelling then established what containers would be left in the remaining current waste collection routes (kerbside collections, bring sites/Household Waste Recycling Centres (HWRCs), commercial waste collections, on-the-go recycling, street sweeping, left in the environment), and the subsequent costs and benefits associated with both the DRS and other waste collection routes. The approach taken was to calculate the change in material flows that is brought about by the introduction of a DRS and, from this, to calculate the change in cost (rather than building up the total costs of managing all beverage containers in the UK both with, and without, a DRS). Nonetheless, for some elements of the system, changes could only be calculated through understanding absolute costs both before and after the introduction of the deposit scheme, and then subtracting the one from the other (eg. kerbside collection costs). The assumptions relating to the mass flows in the system are fully considered in Appendix A.2.2.

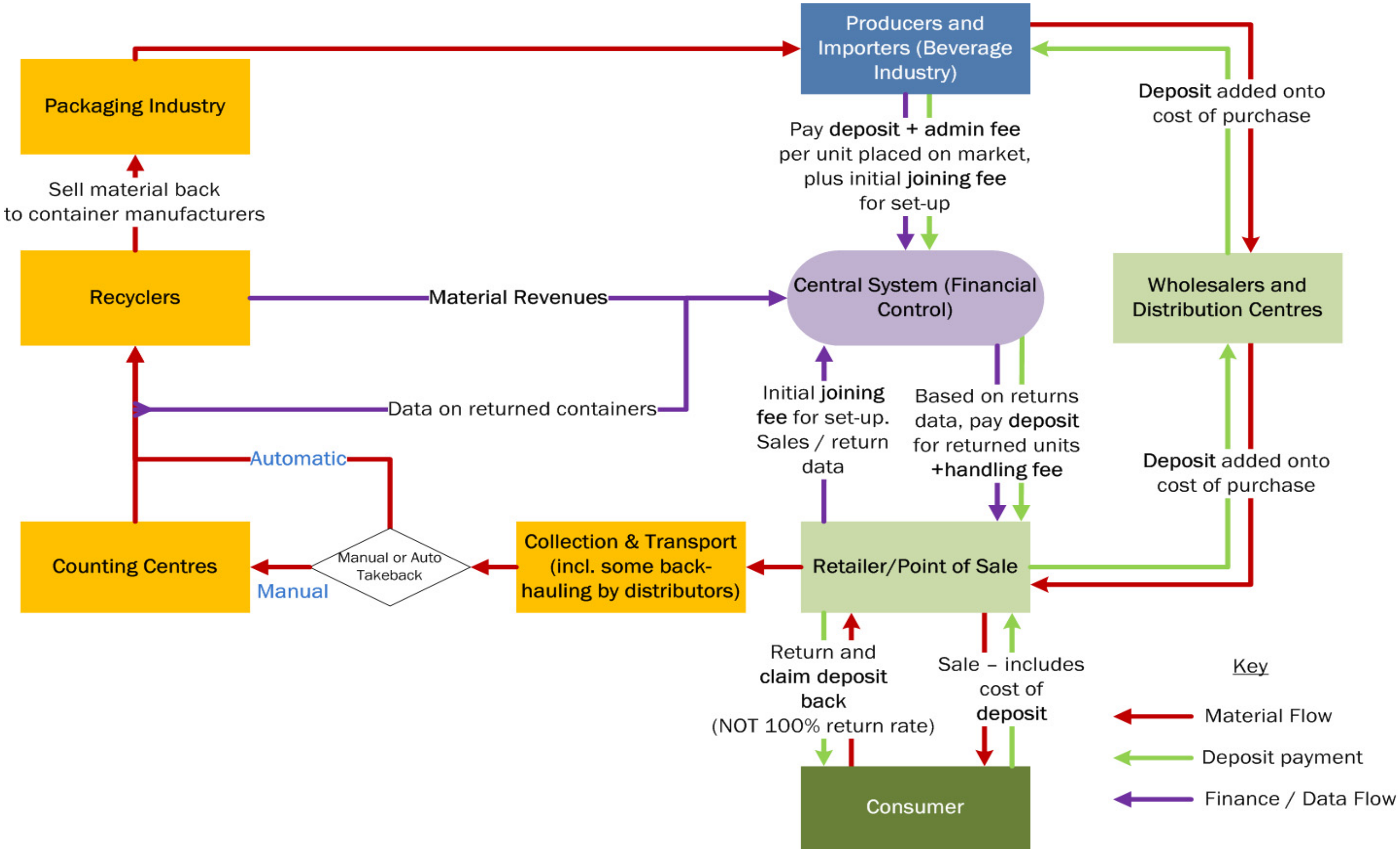
5.3 UK Deposit Refund System Model

The various stakeholders involved in operating a DRS are likely to include:

- 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 (NGOs), industry bodies, producers, breweries and retailers;
- The manufacturers of containers, producers and importers of beverages and industries that 'fill' the containers;
- Any retailers which sell beverages in the UK;
- All consumers which purchase beverages in the UK; and
- Businesses and organisations involved with the collection, sorting and reprocessing of waste containers.

Within the DRS, 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 UK's DRS model developed for this study is given in Figure 5-2.

Figure 5-2: Deposit Refund Model



Source: Eunomia

The system developed for this study is based on similar principles to the systems which exist in Denmark (Dansk Retursystem) and other Scandinavian countries (Norsk Resirk, Returpack and Palpa), and in a number of provinces within Canada (ENCORP Atlantic Ltd, ENCORP Pacific Inc), although the details reflect the UK's structure of retailing. The operation of the system is outlined 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 set each year 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 other take-back centres, the deposit is paid to them by the retailer. This puts the retailer out of pocket, so the retailer then sends the returns data to the central system, which then reimburses the retailer for those returned containers for which a deposit has been paid out to the consumer. Thus the circle of deposit payments is closed. As the return rate for containers is not 100%, the unclaimed deposits result in revenue being retained by the system, which can be used 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). Handling fees are reviewed and adjusted each year;
- Returned empty containers are collected in a number of ways. Automated systems of collection use reverse vending machines or automated counting machines. Manual collection is also possible. in this instance the retailer accepts the container, over the counter, and stores it in bags or crates within the store/outlet for transport;[66]
- Where the containers are collected via an automated machine, the sorted (and predominantly compacted) material can be transported directly to a recycler, with material revenues being paid back into the central system.

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[66] This differs to the typical systems employed in countries such as Sweden and Canada, where collections occur at a small number of redemption centres rather than at every retail outlet. We believe that in order to maximize 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 the UK, 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 higher number of collection points via both automated and manual methods of collection, similar to systems used in Norway and Denmark.

Material revenues will also be paid on those containers that are collected manually, though this material will first have to be transported to a dedicated centre for counting, sorting and compacting, before it can be hauled on to a recycling facility. These 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 DRS. A significant one-off cost will be required to initially set up the DRS, 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 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' capacity. 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, rather than going through a central system.[67] Given the array of problems that have been highlighted in association with the German system, that this system has been recognised as an expensive scheme and that the scheme was originally partly set up to try to encourage the refillables market, we chose to model a central system for the UK and learnt from the issues that have occurred in the German system.[68,69]

It is also worth noting the recent communication from the European Commission, which states several safeguards that need to be respected in relation to how a DRS should be designed in order to ensure a fair, open and transparent system, including:

1) A countrywide system (which could be run either via a non-government organisation (NGO), a government body or via the producers/distributors concerned, and which may consist of more than one system operator so long as the systems are compatible with each other). This will:

    A) Ensure a sufficient number of return points for consumers to encourage participation in the system.

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[67] 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.

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

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

B) Avoid ‘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.

2) A system which is open to all economic participators in the sector concerned – including imported products under non-discriminatory conditions. This will avoid creating an unjustified barrier to trade or distorting competition.

3) A system which ensures that there is no discrimination between those products that are exempt and those that are subject to a deposit and that any differentiation is based on objective criteria, ie. in principle, focus on material and not on content of beverages as it is the former which drives the environmental performance of the system.

Point 1 is addressed by the use of a central system approach to the UK deposit refund model, as discussed above. In addition, we have modeled the UK system as requiring a collection point at almost all retail outlets that sell beverage containers, in order to ensure a sufficient number of return points for consumers and to remove the need for consumers to travel individually to redemption centres to return containers. In order to give the retailer a choice in how returned containers are subsequently collected, and to make the return easier for larger stores to which most containers would be likely to be returned, we have also modeled each retail outlet as either using an automated system of collection (eg. reverse vending machine or automated counting centre) or a manual collection, where the retailer takes back the container over the counter and stores the containers in bags/crates within, or at the front of the store/outlet for onward transport. This approach is similar to the collections offered in countries such as Norway and Denmark.

In addressing Point 2 and Point 3, we have included all non-refillable beverage containers placed on the UK market by both domestic and international producers in our modelling, and have targeted beverage containers according to material (see Section 5.2).

Finally, it should also be noted that the material revenues used in the DRS varied from those used in the kerbside collection system. Given the higher quality material that can be collected in the DRS and the greater amount of material that will be handled by one central system, the values used for PET, steel and aluminium collected through this system are higher than those collected at the kerbside.[70] On the other hand, we have assumed that the value of glass will be the same, irrespective of whether collected via a deposit scheme or at the kerbside. This is highly favourable to the kerbside schemes, recognising that many commingled systems will not produce glass of a quality suitable for re-melt. Details of the material revenues used in the modelling can be found in Appendix A.3.4.

One of the crucial elements in the deposit model is the setting of the deposit itself. The overall deposit rates modelled are given in Table 5-1, based on achieving a 90% return rate.

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[70] Both sets of values are based on a combination of Letsrecycle figures (http://www.letsrecycle.com/) and our own market knowledge.

Table 5-1: Proposed Deposits for Containers in UK Deposit Refund System

Container size	% of UK market	Deposit
≤ 500ml	65%	**£0.15**
> 500ml	35%	**£0.30**
Overall		**£0.20**

The choice to model two deposit rates for different container sizes was based on the majority of existing deposit schemes worldwide. The choice of deposit was calculated in two key stages. Firstly, the return rate was plotted as a function of the deposit across existing schemes (see Figure 5-3), in order to establish what deposit would be required to reach a 90% deposit rate. The deposits were converted from the local currency of the DRS to GB Pounds (GBP) using OECD Purchasing Power Parities (PPP) from 2008 to give a better estimate of the value of the deposit than simply using the current exchange rate.[71] Figure 5-3 illustrates that, in order to achieve a return rate of 90%, the deposit should be set at around 20p per container. Secondly, UK market research shows that approximately 65% of potential deposit refund containers sold have volumes less than or equal to 500ml, while 35% have volumes greater than 500ml.[72] Using this split, we set the deposit at 15p for small containers and 30p for large containers.

In respect of the relationship between deposits and return rates, Perchards questioned Oakdene Hollins' assumption regarding return rates:

> *OH* [Oakdene Hollins] *claim that "international experience shows that a deposit of 5p per container should result in a 70% return rate." They do not explain why a 12p deposit on refillable containers in the UK 25 years ago produced a return rate which was of the same order of magnitude.*
>
> *There is a big difference in the return rates achieved when sales are typically made by the crate – for beer or bottled waters, in countries where there is strong product loyalty often associated with local manufacture. Sales by the crate have never been the custom in the UK, where supermarkets did not stock soft drinks or beer until the advent of non-refillable bottles and cans and changes in the licensing laws.*

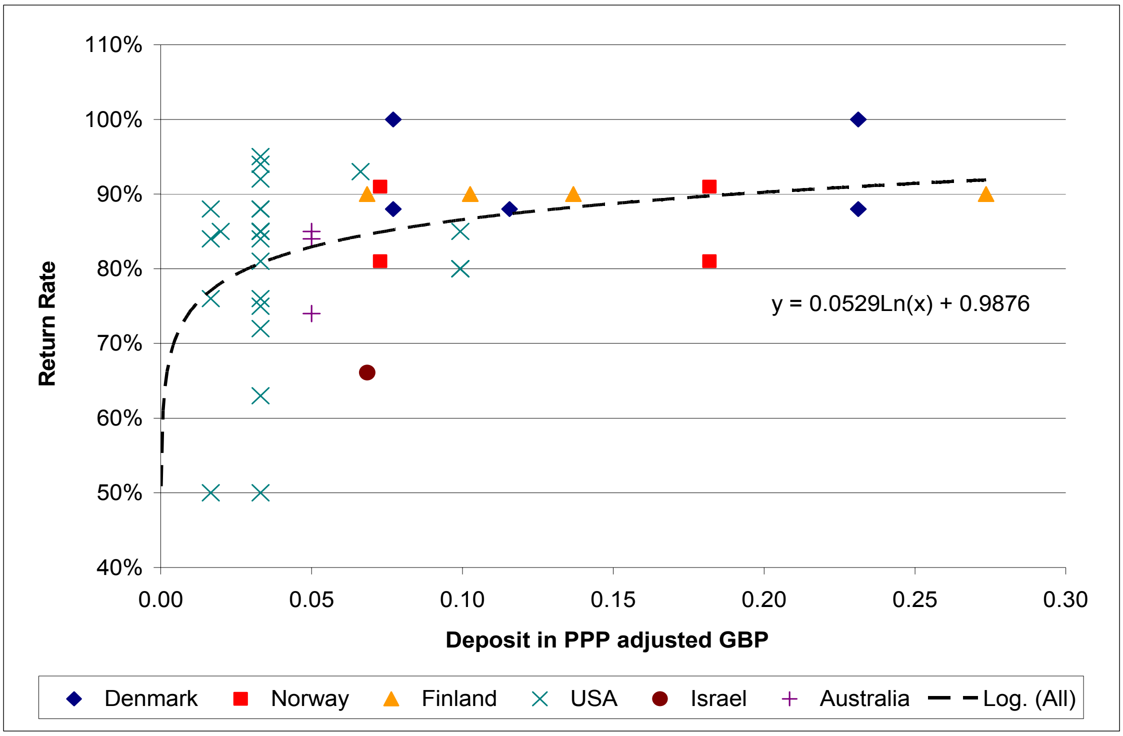
If what is being claimed is that the only jurisdictions which achieve high return rates are those where the majority of sales are in crates, then this is not true. Our approach assumes that the principle motivation driving returns is an economic one.

---

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

[72] Personal communication with Canadean®, May 2010, http://www.canadean.com/

Figure 5-3: Return Rates as a Function of Deposits in PPP-Adjusted GB Pounds.



Source: Eunomia

Elsewhere, Perchards note:

> *Swedish law mandates a 90% return rate for aluminium beverage cans but the deposit set by the Swedish deposit system is only 50 öre (3p). The return rate each year is stable and 85% was achieved in 2003. This suggests that, although the level of the deposit can affect the return rate achieved, other factors are also significant, for instance*
>
> - *the habit of return not being lost*
> - *ease of return and maybe consumer incentives (reverse vending machines)*
> - *buying by the crate rather than buying individual bottles, so there is one single high-value transaction.*

It is reasonable to assume that other factors will play a role in determining levels of take back, notably the ease of return, but it is unreasonable to suggest that the magnitude of the incentive is of limited relative significance. It is also not reasonable to assume that a 'habit of return' cannot be re-established once lost. Such 'habits' have to be established in order to be, subsequently, lost, and their establishment and demise tends to track the existence or otherwise of DRSs. The

Swedish economist, Thomas Sterner, made interesting observations of this nature. Regarding aluminium cans, he notes:[73]

> *Recycling rates have passed 90 percent and it appears that the increase in nominal deposits from 25 to 50 ore in 1987 has played a role. The fact that the real value of deposits has fallen since then does no, however, seem to have reduced collection. Maybe there have been changes in attitude and information or ease of deposition. [....] Perhaps deposits are important just as signals to change behaviour, which then has its own inertia.*

Regarding wine and liquor bottles, in the same country (Sweden), he notes:

> *The nominal deposits rose from just 15 ore to 2.00 SSEK/bottle. In real terms, the increase has been more than 100 percent since 1970. It appears that the recycling rate goes up each time the nominal deposit rises.*

This highlights the fact that the way people respond to deposits is likely to be complex, but there seems little reason to believe there will be no price effect. There appears, in any case, to be no basis for an assumption that a 'habit' cannot, therefore, be established anew. The system we have proposed makes returns convenient so should support such habit reformation. These habits do not exist independently of DRSs, but rather, the DRSs tend to generate them (and as Sterner suggests, these habits may be characterised by some 'inertia').

Other key elements involved in modelling the DRS include determination of the handling fee payable to the retailers. This is based on acquiring an understanding of the retail landscape across the UK, the likely proportion of retailers that would use automated machines compared to manual take-back, the cost to the retailers of the take-back process, and the costs of transport, containers and counting centres required to deliver the collected containers for re-processing. In addition, the on-going administrative costs associated with running the central system were determined, as were the one-off costs associated with initial set up of the system.

It is important to note that the DRS in the UK will be different from those in other countries because:

a) There are very few DRSs left operating in the UK (especially for alcoholic beverages, beer bottles etc), so most containers are one-way and will be eligible for inclusion in the system;

b) Modern behavioural attitudes appear to place a premium on waste collection activities which make minimal demands on personal time - thus drop-off ought to be quick and locations easily accessible;

c) There is a relatively high population density; and

d) The historic nature of retail outlets has led to a structure which is essentially characterised by large numbers of small outlets operating in a decentralised

[73] 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

manner (clearly many have now been replaced by larger supermarkets, but a considerable number remain).

All of these points mean that the system must have the ability to collect 1) large quantities of glass, especially from pubs and bars; 2) a high proportion of containers from a large number of dispersed outlets, and on a frequent basis; and 3) ensure that take back is possible through easily accessible locations, with minimal take back time.

Following establishment of the retail landscape, the handling fee was calculated by ensuring the following elements were included in the cost calculations:

- RVMs (reverse vending machines);
- Retail Space Infringements;
- Labour;
    - Pickup / Unloading;
    - Take Back;
- Transport;
- Counting; and
- Containers.

Figure 5-4 summarises the key components modelled in the DRS in the UK. Full details of the step-by-step assumptions used in relation to the development of the DRS are described in Appendix A.3.0.

5.4 Cost Reduction in Existing Waste Collection Systems

One of the key elements missing in the majority of existing studies on DRSs (see Section 5.1) is the reduction in costs associated with fewer containers having to be collected through all the routes set out in Figure 5-4. Even where this reduction has been modelled in previous studies, it has been modelled rather poorly. This oversight will result in an over-statement of the potential cost to society associated with the introduction of a deposit refund scheme. Therefore, one of the key components of this study was the *inclusion* of all relevant costs, most importantly the change in costs from household kerbside collection systems.

Eunomia's proprietary waste collection model, Hermes, has been used to investigate the effect of implementing a DRS in the UK on kerbside collection schemes. Hermes is a sophisticated spreadsheet-based tool that allows a wide range of local authority specific and collection scheme specific variables to be modelled. The optimisation of these variables allows us to build scenarios to reflect local circumstances accurately. The main outputs of the model are recycling performance and cost.

Eunomia is confident that Hermes is as reliable a tool as any of its kind. It has been used to model systems for authorities that collectively manage around 25% of the UK's total municipal waste. It is used to support contract procurement advice and contract dispute resolution by building 'shadow' bids against which contractors' tender submissions can be tested. Hermes has also been used in the context of studies of relevance to national policy, and to undertake a cost benefit analysis for the kerbside collection of food waste across the UK.[74] See Appendix A.2.0 for more details.

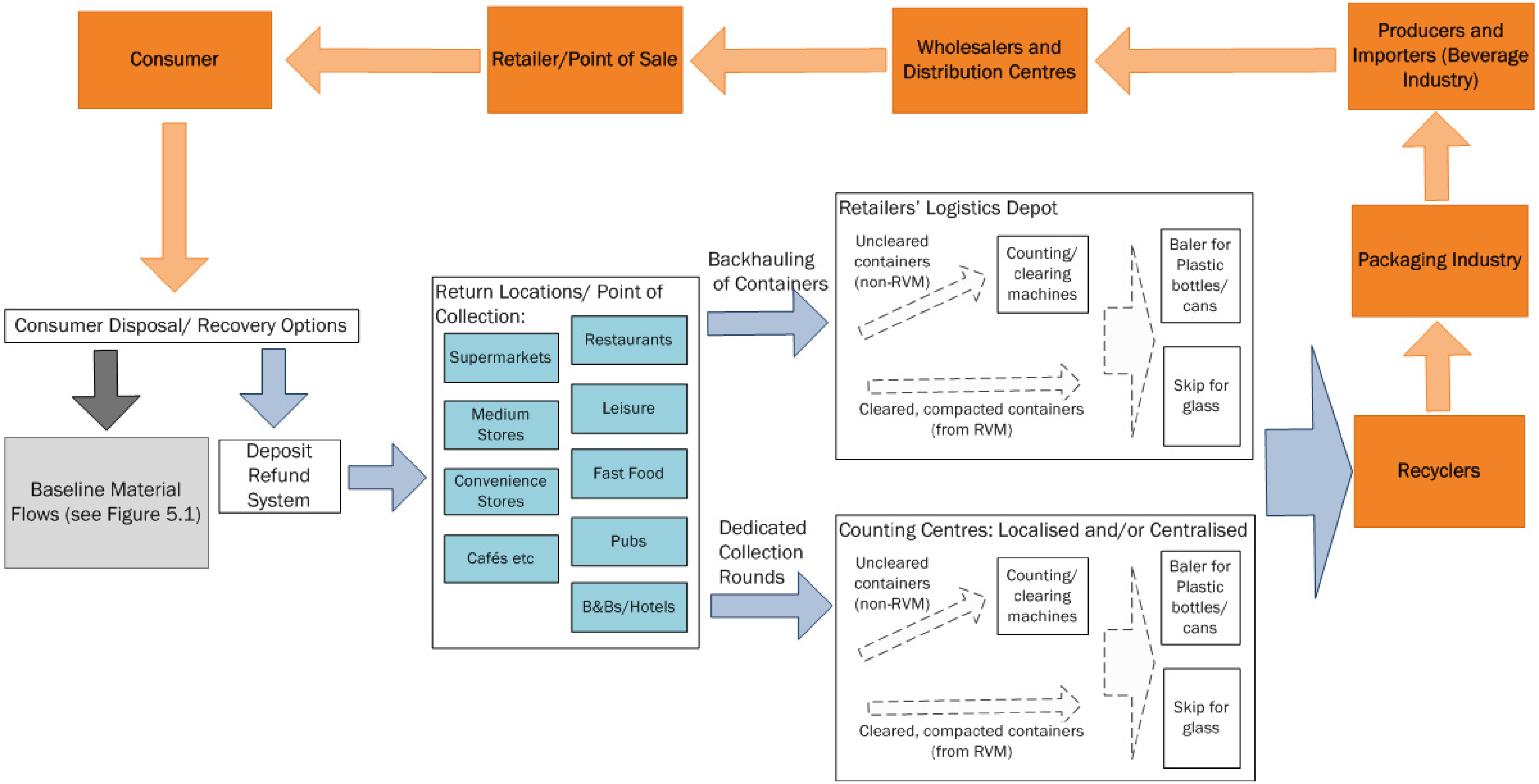
Costs for all the other services that would be impacted by the introduction of a DRS were also modelled. Appendix A.4.0 provides full details for each of the following cost elements:

- Collection of containers through bring sites;
- Collection of containers through Household Waste Recycling Centres (HWRCs) – both recycling and disposal;
- Commercial waste recycling / refuse collection; and
- Collection of containers from on-street litter bins and through street sweeping.

Finally, it is worth considering the implications of a DRS for the existing policy regarding packaging recycling. The UK's Producer Responsibility (PR) scheme is based upon a system of tradable compliance credits. The value of these credits drops when the supply of the compliance credits far exceeds demand. For example, targets for paper and card recycling are easily met at present, so the value of Packaging Recovery Notes (PRNs) for paper and wood are around £2 per tonne. The materials for which the level of performance is closer to what is required by the targets are those which would be covered by a DRS (plastics, glass, steel and aluminium).

[74] Eunomia (2007) *Dealing with Food Waste in the UK,* report for WRAP, March 2007

Figure 5-4: Key Components Modelled in the Deposit Refund System in the UK



It would be expected, therefore, that the deposit scheme would reduce the price of PRNs against counterfactual levels. It is difficult to know what this price reduction might be. The value of PRN and PERN sales in past years has been as high as £100 million, though it has more commonly been of the order of £50 million (see Table 5-2). It seems not unreasonable to imagine that industry would see the cost of PRNs fall by something in the order of £30 million as a result of the DRS, owing to the increase in recycling. This seems particularly likely as the Government considers increased packaging recycling targets.[75]

If targets were not to increase so significantly, it might be that the DRS could lead to a diminished need for the existing PRN mechanism. The key material would probably be plastics, for which the potential for significant increases in packaging recycling relates to a range of materials, of which the beverage container is only one. Disbanding the existing policy might have significant benefits for companies in terms of the efforts they make to demonstrate compliance. It would also eliminate the costs of administering the policy at the UK level. These cost reductions may be significant for companies across the UK, and for the public sector.

It should be noted that similar points were made by Oakdene Hollins in their work for Defra, where there is discussion of the DRS overwhelming the existing PRN system. Perchards, though, were critical of Oakdene Hollins' assessment of the effect of a DRS on the (then) existing UK packaging system, in particular on the price of PRNs. We find the Perchards comments demonstrative of a lack of understanding of the workings of the existing market mechanism. The following paragraph highlights the extent of the confused views held by the reviewers:

> *PRNs are a market-based instrument. We think that much more thought is needed to the impact on the PRN mechanism of a legally mandated DRS, which is a command-and-control mechanism. One of the objectives of the PRN system is to provide funding for collection, the idea being that PRN revenues will allocate this efficiently. A deposit system would interfere with this – its expense would make it unlikely to survive the competition with cheaper collection systems in the PRN system. PRNs would need to be revised to take account of it.*

Quite what this means, perhaps only the authors know. However, most commentators, including the OECD, for example, would argue that a DRS is no more 'command and control' than the PRN mechanism, driven, as that is, by the year to year setting of recycling targets (which then influence the price of the PRNs). The argument that a DRS would not survive because of its expense is to make light of the fact that at the end of life, a consumer would have the option of either placing the material in a kerbside container and receiving no deposit, or returning the material to a vendor and recouping the deposit. It seems reasonable to assume that if returns are convenient, consumers will choose the latter route.

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[75] Defra (2010) Implementing the Packaging Strategy: Recovery and Recycling Targets, Funding Transparency and Technical Changes: A Consultation on Proposed Changes to the Producer Responsibility Obligations (Packaging Waste) Regulations 2007 (as amended), March 2010.

In concluding, they state:

> *A more thorough discussion is needed of the possible interplay between a DRS and the existing PRN system. We found it hard to understand how OH concluded that PRN prices for the materials handled through a DRS would fall to zero. The pack types that they recommend should be handled through a DRS (plastic bottles, alu cans and possible some glass) represent only a proportion of the packaging of those materials. The PRN system is a market mechanism which, in our view, would need to be adapted if a DRS for selected non-refillable containers were introduced.*

This exhibits a complete lack of appreciation of the fact that the value of PRNs reflects the imbalance, at the margin, of the supply of PRNs and the demand on the part of obligated companies / compliance schemes for this evidence. If the additional material collected by a DRS implies that packaging recycling targets in a given year will be easily exceeded, then the value of PRNs would indeed fall close to zero, just as it did in 2003 when the Government opted not to increase targets from 2002 levels. The point here is that the market for PRNs is tightest for the same materials typically targeted by a DRS.

5.5 Environmental Impacts

Environmental impacts associated with the introduction of a DRS will occur from the following processes:

1) Changes in the recycling of beverage containers;
2) Changes in the disposal of beverage containers; and
3) Changes in emissions associated with the collection and transportation of containers to recyclers.

Regarding environmental benefits associated with diverting beverage container waste from disposal, it should be noted that we have assumed 25% of the UK's waste will be managed though thermal facilities in the future, with the remainder going to landfill (see Appendix A.5.1.4). This is particularly important in the context of PET, as avoidance of the disposal of plastics via thermal treatment would lead to a significant reduction in greenhouse gas (GHG) emissions, whereas avoidance of the disposal of plastics via landfill would have little overall impact on emissions.

The two main elements considered in modelling the environmental impacts associated with the collection, recycling and disposal of beverage containers were a) GHG emissions and b) air quality impacts. The approach to valuing these two components is set out in Appendix A.5.0.

Table 5-2: Expenditure on PRNs and PERNs, 1999 - 2005

	1999 - 2001		2003		2004		2005	
	PRN	PERN	PRN	PERN	PRN	PERN	PRN	PERN
Paper	£69,400,000	£3,900,000	£22,245,337	£1,744,263	£12,915,351	£3,938,957	£17,373,786	£12,447,897
Compost							£4,889	
Glass	£16,600,000	£700,000	£8,223,179	£959,118	£10,600,571	£2,561,816	£15,642,454	£5,997,046
Steel	£10,500,000	£4,400,000	£1,229,585	£1,245,237	£2,460,142	£2,181,782	£9,006,337	£18,631,570
Aluminium	£800,000	£100,000	£432,628	£61,052	£779,113	£759,497	£1,859,214	£1,224,424
Plastics	£15,100,000	£2,700,000	£1,634,515	£615,845	£1,792,668	£1,755,251	£6,960,361	£8,866,465
Wood	£8,600,000		£5,322,252	£0	£5,254,424		£8,391,940	£0
Recovery								
Clinical			£7,855		£5,529			
EfW			£2,168		£7,897			
EFW (MSW)			£5,352,903		£480,622			
RDF			£102,663		£72,382			
Recovery Total			£5,465,589		£566,430		£677,973	
Totals	£121,000,000	£12,000,000	£44,553,085	£4,625,515	£34,368,699	£11,197,303	£59,916,954	£47,167,402
PRN + PPERN	£133,000,000		£49,178,600		£45,566,002		£107,084,356	

Source: Defra

Furthermore, there is a negative environmental impact, or disamenity, associated with uncollected litter. A study by Cambridge Economic Associates indicates that the average household would be willing to pay £25 per annum to live in a neighbourhood where the streets are kept clean.[76] Unfortunately, however, this value does not cover the potential willingness to pay to remove litter from rural areas, and, as far as we are aware, there are no studies attempting to place a value on the disamenity experienced in such circumstances in the UK.

The only significant study of this nature of which we are aware was carried out in Australia by Pricewaterhouse Coopers. This indicated that households are willing to pay, on average, AUS $4.15 per 1% reduction in litter. The quantification of 'reduction' is not clear, but if, in line with the work of Stein and Syrek, we take the view that size (volume) is a proxy for visual impact, and that visual impact is what residents most notice, then we might assume that households interpreted this in terms of volume reduction.[77]

Assuming this to be the case, then if one also assumes:

- Beverage cans occupying 25% by volume of litter (which may be conservative);[78] and
- 80% reduction in beverage-related litter as a result of a DRS[79]

then the effective reduction in litter volume would be equivalent to 20% of the total. Using the Pricewaterhouse Coopers figures, converted to UK exchange rates (we have used the rate UK£ 1 = AUS $1.73), the value of this would be £48 per household.

This gives a net figure, across 26 million households in the UK, of £1,248 million per annum.

5.6 Cost Benefit Analysis

The principle objective of the cost benefit analysis was to identify the net cost or benefit to society from the introduction of a DRS in the UK. Conventionally, this net cost or benefit is represented as follows:

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[76] Cambridge Economic Associates et al (2010) Developmental Work to Value the Impact of Regeneration, Technical Report: Environmental Quality and Amenity, May 2010

[77] Steven Stein and Daniel Syrek (2005) New Jersey Litter Survey: 2004, A Baseline Survey of Litter at 94 Street and Highway Locations, Report for the New Jersey Clean Communities Council, January 28, 2005. http://www.njclean.org/2004-New-Jersey-Litter-Report.pdf

[78] The analysis in Section 4.2 above suggests that the effect of DRSs on the volume reduction in litter in the US may be well above this figure, and in systems which are achieving lower return rates than the one modelled here. In addition, the analysis of the composition of litter in the UK is at least suggestive of a relatively high proportion of the volume being occupied by beverage containers.

[79] These figures are typical of the levels of reduction reported under DRSs for beverage containers (see, for example, 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).

Cost or Benefit = Financial Costs + Environmental Costs

In this study, the environmental costs comprise the impacts of GHG emissions and other air emissions, expressed in monetary terms. The main sources of environmental impacts are given in the previous section.

In conventional cost-benefit analysis, the approach taken would be to strip out taxes and subsidies from Government and to cost all environmental impacts. This approach ensures that double counting is avoided. One of the reasons (though not the only one) for doing this is that if the analysis includes *both* the financial costs, inclusive of taxes and subsidies, and the environmental impacts of dealing with waste, there is a risk of double counting where the taxes and subsidies are themselves designed to reflect environmental impacts.

In practice, however, this tends to lead to figures which are unfamiliar to those engaged in the industry, and which do not reflect the incentives which they face within the market place. The most obvious example, perhaps, is with landfilling. Here, the tax stands at £48 per tonne, rising to £80 per tonne by 2014/15. The impacts of landfilling cans, however, are not expected to be anywhere close to £80 per tonne (the principal externalities of landfill relate to methane generation, and cans do not biodegrade in landfills). However, actors in the market still need to pay the tax.

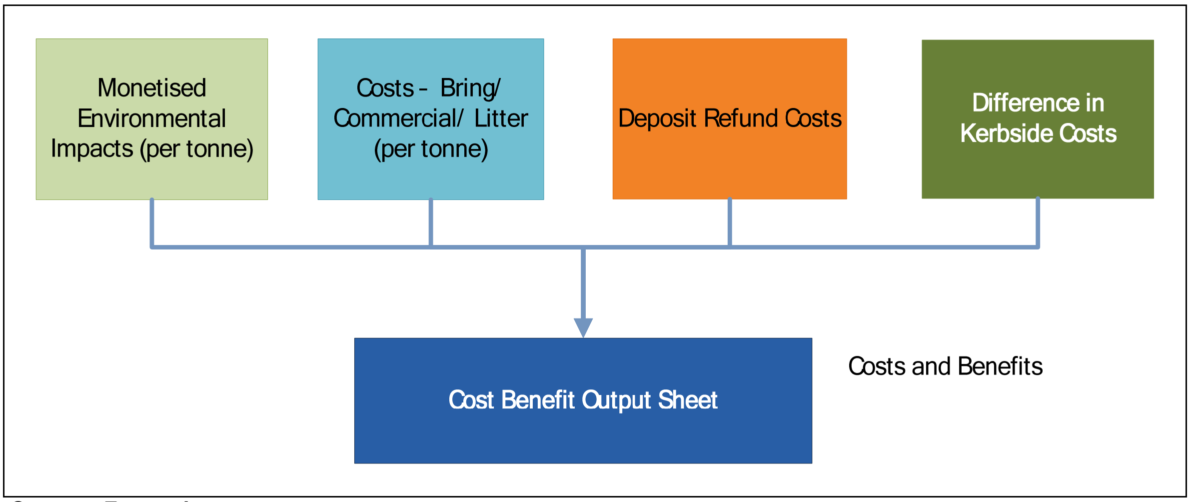
In our approach, therefore, so as to ensure that the financial figures represent the actual costs to operators, but recognising also the potential for double counting, the approach we have taken is:

1. To model costs as they would be 'in the market'
2. To include in the environmental analysis only those impacts which are either
    a. not covered by existing policies or
    b. addressed by policies, but where the impact exceeds the level of internalisation implied by the policies which are in place (we have included only the element of the environmental impact that is not internalised by the policy).

This approach has the merit of reflecting 'actual costs' in the market, but also ensures there is no double counting of the environmental impacts associated with different ways of managing waste (which would occur if the impacts under 2b were considered even where impacts are already internalised in market prices by policy).

In this study, we have attempted to build as comprehensive a model as possible in terms of covering all the costs and benefits associated with the collection and management of wastes. These include capital costs, operating costs, labour costs, opportunity cost of lost retail or storage space, disposal costs, material revenues and deposits unclaimed or 'lost' by the consumer. Full details of each stage of the modelling, including a detailed methodology, data sources, and individual cost elements are presented in Appendix A.2.0 to Appendix A.5.0. Figure 5-5 provides a summary of the key elements that have been considered in calculating the overall cost or benefit of introducing a DRS in the UK.

Figure 5-5: Cost Benefit Analysis Model - Overview



Source: Eunomia

6.0 Results from Cost Benefit Analysis

Following the methodology described in the previous section, the overall costs and benefits associated with the introduction of a DRS in the UK have been calculated, the results of which are presented in this section. As noted before, this will form the basis of answering the research question:

> *'How do the benefits of introducing a UK-wide DRS for certain beverage container packaging compare with the costs of implementation and operation?'*

The costs in this analysis have all been measured relative to a baseline. This baseline encompasses a situation from 2015 onwards, where full kerbside collection services have been rolled out to all households in the UK. The overall costs therefore represent a change to rather than an absolute cost of service provision. However, the costs associated with the DRS will represent the annualised running costs of the system, as there is no such system operating in the baseline.

To explain how the total costs for each scenario are derived, the DRS costs will be described first, followed by the additional financial impacts, the monetised environmental costs, and finally, the sum of these elements. The costs and benefits associated with the complementary DRS will be described first, followed by the key differences between this system and the parallel DRS. Some of the key factors affecting the results are then considered in a series of sensitivity analyses.

6.1 Complementary System

The complementary system is one where the DRS *complements* rather than *competes* against existing household collection services. This is enacted by changing the service specification of the existing kerbside systems in such a way that the householder is obliged not to place the relevant beverage containers in their recycling box, bag or bin. Note that because the system might still collect glass jars, metal food cans or other plastic packaging, the “mis-use” of this system would not compromise the recycling system. Indeed, operators would have an incentive to ensure that deposit container “contaminants” are segregated from the remainder of the material so as to obtain the deposit revenues from them, though the nature of the collection scheme might determine how straightforward or difficult this might be.

Under this scenario, therefore, all beverage container waste being collected from household recycling services is eliminated from the model. It is, however, assumed that 5% of containers still end up in household refuse, as some people will not change their behaviour patterns as a consequence of paying the deposit and will deem the additional effort required to return any containers too significant. A small decrease has also been modelled in the change in management of containers though other routes, so that the overall return rate of containers in the DRS is calculated as 90% (see Appendix A.4.0). This return rate is based upon the value of the deposit placed on the container and similar return rates from other countries (see Appendix A.3.1).

The share of annual costs and revenues involved in the operation of the DRS are shown in Figure 6-1. The administration fee payable by the producer for each unit placed on the market is calculated in order to bridge the outstanding imbalance between the costs and revenues in the central system. Hence the overall system is one in which all ‘net costs’ are recovered ie. *the system costs equal the system revenues*.

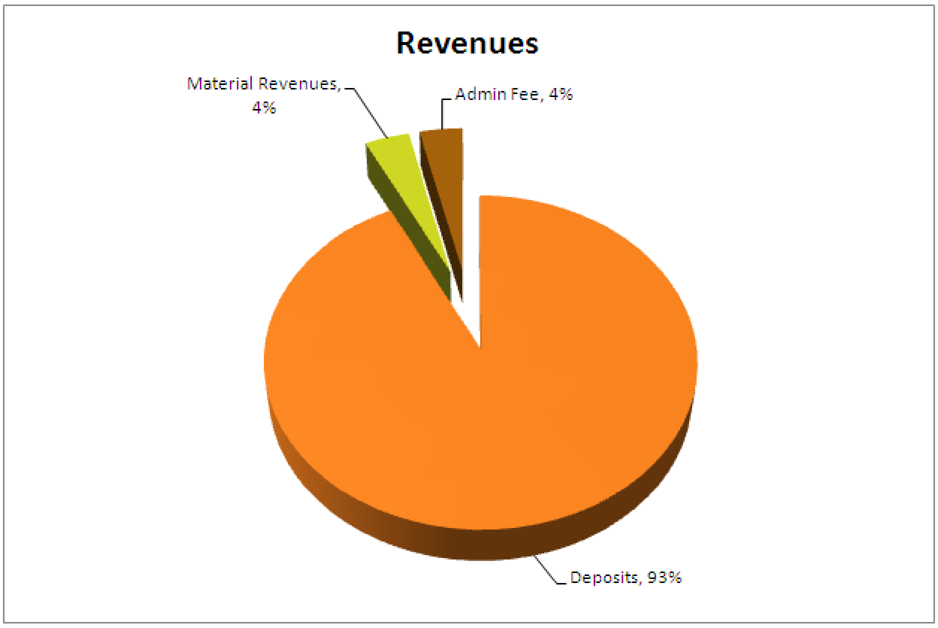
Figure 6-1 shows the overall proportions of revenues and costs in the system. It does not, however, provide any indication of who would be paying for which element. As such, Figure 6-2 illustrates the flows of money throughout the DRS for each of the key stakeholders. It is important to note that throughout this cost benefit analysis, and in the sensitivity analysis that follows, a positive figure represents a ‘benefit’ and a negative figure represents a ‘cost’ to the stakeholder in question or for the overall system.

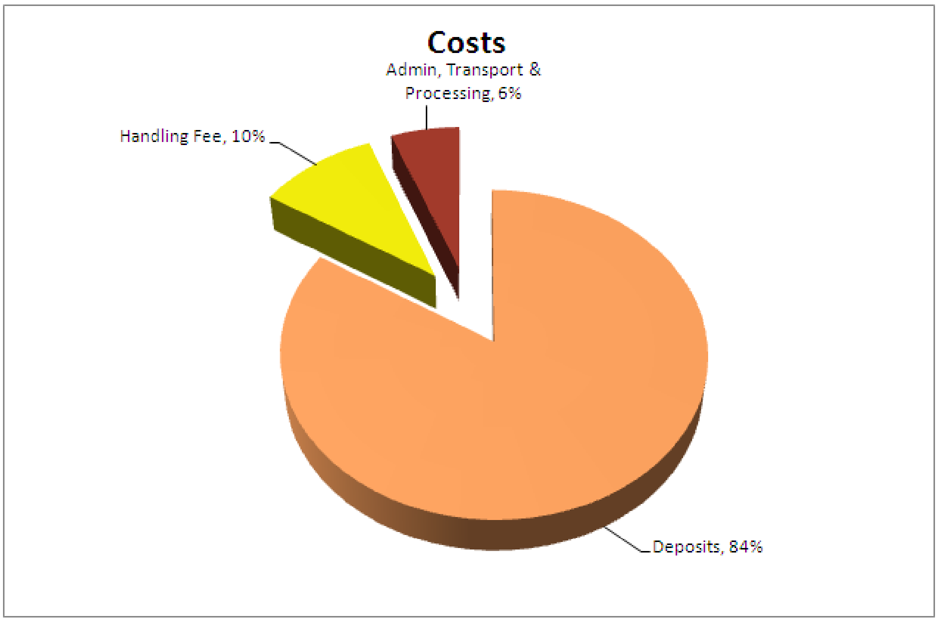
The key points to draw from Figure 6-2 are:

- Handling costs for the retailers are estimated to be around £576 million per annum. We have modelled that these costs would be compensated by the central system through a per unit administration fee of 4p for retailers with Reverse Vending Machines (RVMs), and 1p for those without. Collection and counting costs, financed by the central system, are likely to be around £337 million per year. Hence the retailers are compensated for all their costs, so the net cost to them is zero;
- The consumers who do not, or cannot, return the containers they purchase will lose the deposits they have paid – this is signified by the grey box in Figure 6-2. At an overall 90% return rate, consumers would forfeit a total of £491 million of unclaimed deposits. In our model, this revenue helps fund the operation of the system. For this reason, it is important to have complementary targets in place to ensure that the system is not designed so as to ‘deliberately underperform’, and enable full funding through unclaimed

deposits. With targets in place, the system would likely be designed with a deposit set at a rate designed to deliver the desired performance level, consistent with the level of infrastructure provision. The provision of many easily-reached return points should minimise the level of unclaimed deposits as long as the deposit it set at a reasonable level.

Figure 6-1: Revenues and Costs in Operation of Deposit Refund System – Complementary Scenario



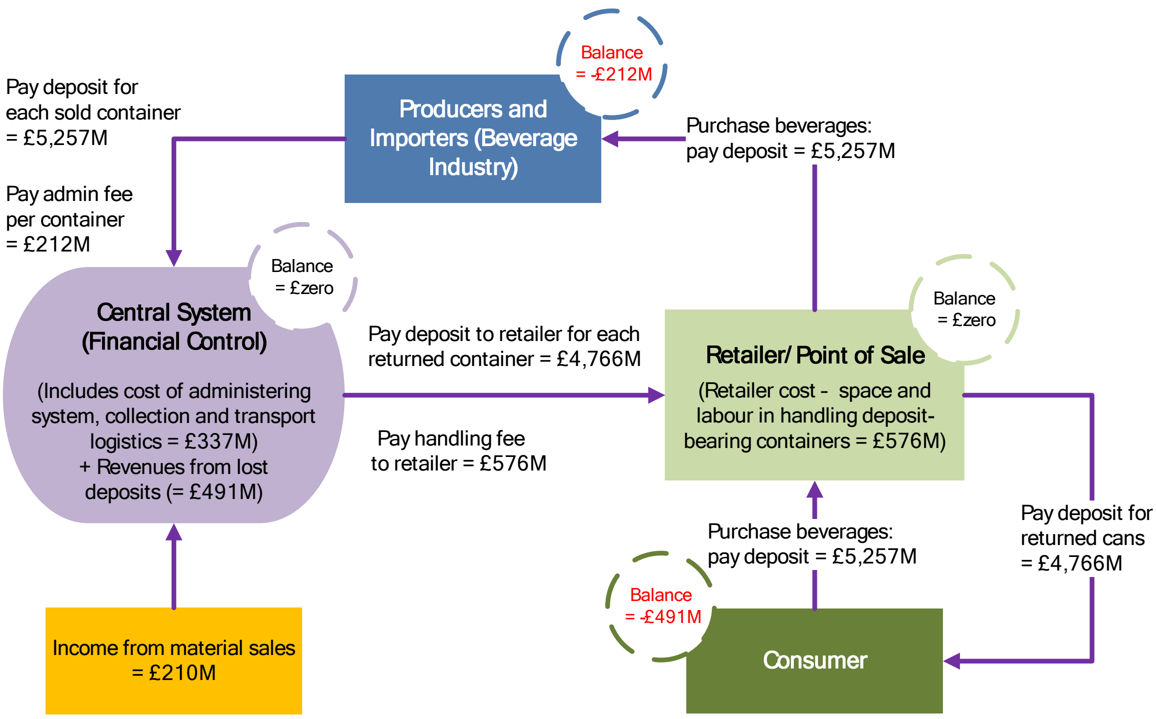


- The outstanding imbalance between the costs and revenues (including unclaimed deposits) in the central system of around £212 million are recovered through the producer administration fees. The handling fee payments to the retailers and the administration costs of the central system are offset by the revenue generated from producer administration fees, income from material sales and unclaimed deposits;

- The producer administration fee equates to around 0.7p per container placed on the market; given that the producer will be likely to pass at least some of this cost onto the consumer, this fee could be described as the 'cost' to society of implementing the DRS. However, even if the producers decided to pass 100% of this cost through to the consumer there would probably be very little change in terms of volume of sales given that the additional cost per unit is relatively low;
- The system implies a net cost to the producers i.e. producers are effectively paying for the collection of beverage containers that they place on the market.

The costs of the system are thus born by those who are responsible for the generation of the waste – the producer and the consumer.

Figure 6-2: Cash Flows in the Deposit Refund System – Complementary Scenario, £millions 2010 Real Terms



Note positive figures imply savings

The shift in the management of beverage containers from the baseline situation to the complementary scenario results in a reduction in the requirement to collect waste from a number of routes. A material reduction in the amount of waste requiring collection will thus lead to a change in the overall costs of service provision for each of these routes. Table 6-1 shows the financial savings that accrue from the introduction of the DRS under the complementary scenario.

It is clear from Table 6-1 that local authorities would save a significant amount of money on their annual waste collection costs as a result of the introduction of a DRS. In effect, the burden of waste management shifts from the 'taxpayer' to the individual person (consumer), and the industry (producer/ importer) that is responsible for generating the waste beverage containers. Thus, the 'polluter pays' principle is reinforced by the introduction of the deposit refund policy. Commercial enterprises that are currently responsible for managing their employees' wastes should also see some financial benefit. The reduction in costs of administering the PRN system also provides significant savings to businesses.

Table 6-1: Financial Savings from Existing Waste Collection Activities, £millions

Service	Local Authority/ Taxpayer	Commercial Enterprises
Change in household recycling collection costs	£129M	
Change in bring site costs	£3M	
Change in HWRC costs	£1M	
Change in litter collection costs	£27M	
Saving from reduced expenditure on PRN system		£30M
Additional cost to retail outlets outside of		-£19M
Change in commercial waste collection costs		£36M
Balance	**£159M**	**£47M**
Total Saving	**£206M**	

Source: Eunomia

In addition to the financial costs associated with the running of the system, there will also be environmental impacts that should be monetised and included in the overall analysis of costs and benefits. The environmental impacts associated with the introduction of the DRS and the resultant reduction in the collection and disposal of containers via other waste management routes is summarised in Table 6-2 and Figure 6-3. The assumptions that underpin these calculations are presented in Appendix A.5.0.

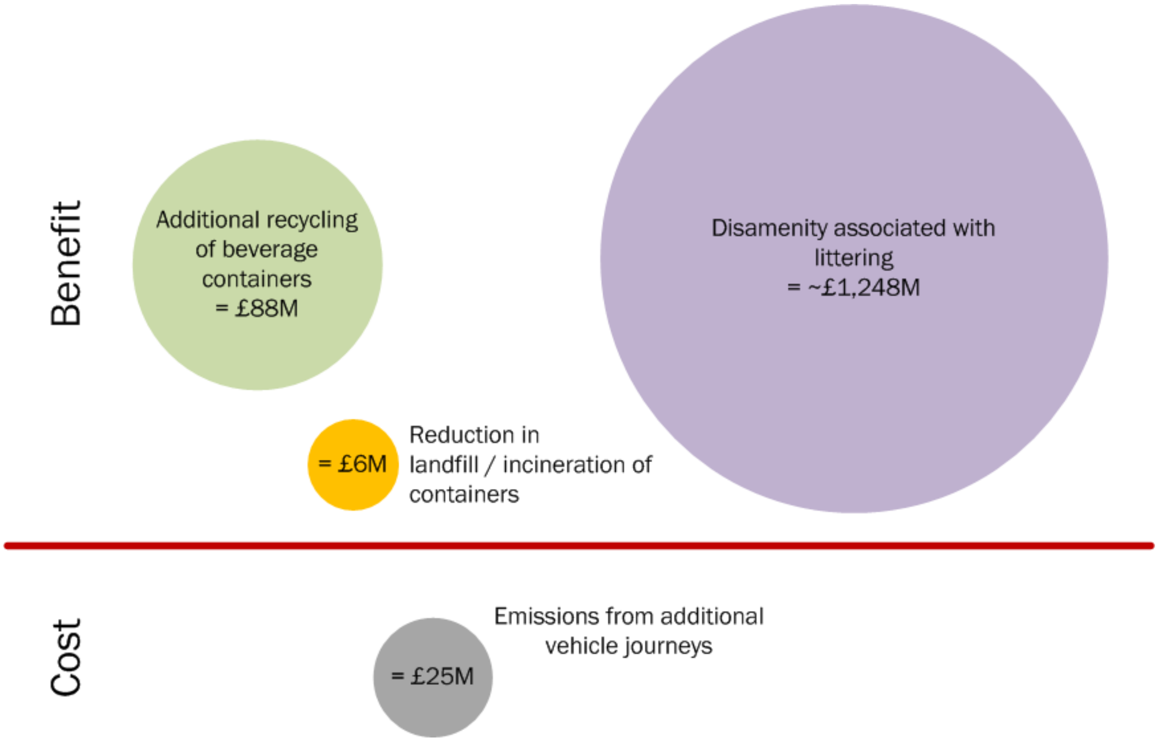
Table 6-2: Monetised Environmental Impacts, £millions

Environmental Impact	Monetised Value
Recycling (GHG + AQ)	£88M
Disposal (GHG + AQ)	£6M
Transport	-£25M

Disamenity of litter	£1,248M
Total	£1,317M

Source: Eunomia

Figure 6-3: Annual Monetised Environmental Impacts (Complementary System) £millions 2010 Real Terms

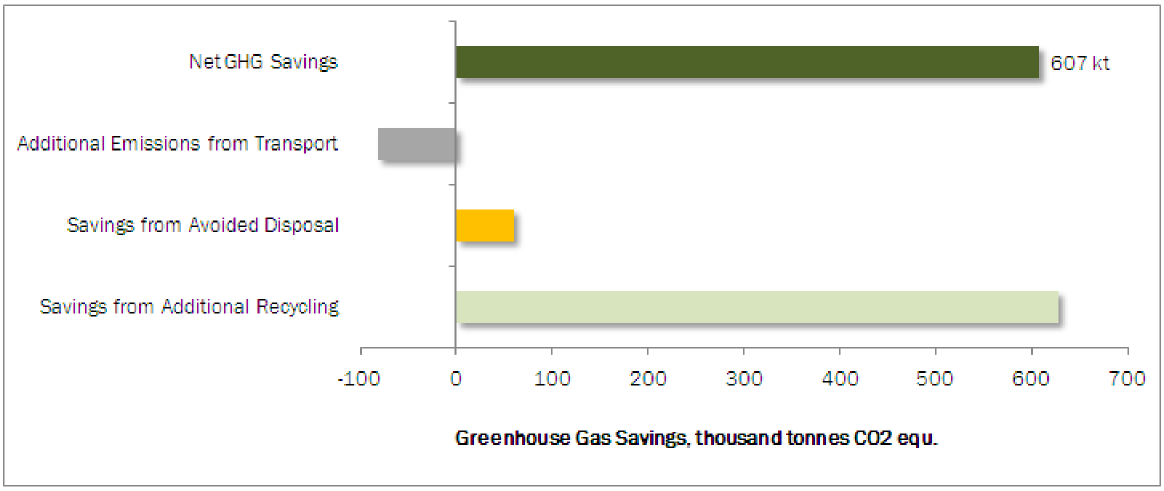


Tangible benefits accrue from the reduction in GHG emissions and air pollutants as a result of increased recycling and reduced disposal (net = £94M). Costs also occur from the net additional emissions from vehicles used to collect and process empty containers. It should be noted, however, that not all transportation impacts are negative, as there is avoided transportation from a reduction in waste collected at the kerbside and from commercial premises. Vehicles are subsequently able to travel further distances before they reach capacity and need to offload or 'tip' the collected waste, which results in a reduction in the number of longer journeys made in order to 'tip' the material and hence in the number of overall vehicles required. The overall net benefit of these tangible environmental impacts is £69M.

The figure for disamenity is as calculated in Section 5.5, based upon work by Pricewaterhouse Coopers. We illustrate overall results with and without this figure, given the absence of UK-specific studies, and the influence on results.

The greenhouse gas benefits of a particular policy, or system, are keenly pored over by policy makers. We therefore present the quantity of GHG emissions saved, above the baseline situation, in Figure 6-4.

Figure 6-4: Greenhouse Gas Savings from the Introduction of a Deposit Refund System, thousand tonnes CO_2 equivalent



Note that the emissions are presented from a 'global' perspective, as the location of marginal recycling activities is unclear, both in the UK and abroad. In essence, the value of these benefits, as reported under the UK's domestic emissions inventory, would change depending upon the location of the primary and secondary materials production.

To put this saving into a policy context, the UK Marginal Abatement Cost Curve (MACC) analysis, undertaken in 2008, estimated that by 2022 the waste sector could reduce its emissions of carbon dioxide equivalent by around 9 million tonnes, with the majority of savings (7.5 to 8 million tonnes) coming from biowaste treatment and a shift from landfill to other residual processes. Therefore, the savings generated from any level of additional dry recycling, up to the maximum of 607 thousand tonnes, would significantly help achieve the abatement required under statutory greenhouse gas targets, set out by the Committee on Climate Change.[80]

Putting it All Together - The Whole Picture

The overall costs and benefits to society from the introduction of a DRS in place of kerbside collections of containers are summarised in Table 6-3 and Figure 6-5.

It should be noted that Table 6-3 and Figure 6-5 illustrate the net benefit once the DRS is up and running. It does not include the £84 million one-off costs that would be associated with the initial setting up of the DRS, as these would only be incurred over the first year or two of the system. From society's perspective, depending on the pay-back period, these costs will be covered within the first few years of implementation, and would be met by fees payable by producers and retailers as they join up to the scheme. One-off costs are discussed in more detail in Section 6.4.

[80] This is particularly significant since our baseline assumes that kerbside collection systems of a relatively high quality exist for all households at the time the DRS is introduced.

Based on the cost benefit analysis presented in Table 6-3, the key messages from the overall cost benefit associated with the introduction of a complementary DRS in the UK are:

- DRS costs, from society's perspective, are around £703 million per annum. Not all these costs, however, are subsequently met by producers of beverages. This is because the system's finances are effectively bolstered by unclaimed deposits (to the tune of £491 million). Producers, therefore, would pay only £212 million. The unclaimed deposit is important to represent as a cost, because if the return rate does approach 100%, then the producers would have to pay an amount which approximates to the total cost of the system in the absence of unclaimed deposits (i.e. £0.7 billion);
- The *cost to producers* (net of unclaimed deposits) of operating the DRS is roughly equivalent to the *savings* produced from a) a reduction in the collection of beverage containers by local authorities and commercial enterprises, and b) a reduction in costs for operating the PRN system. Therefore the financial costs, net of savings, are close to zero. Other studies have generally focused upon the lost revenue to local authorities where materials are no longer available for collection. Quite apart from the fact that it is known that not all local authorities are securing the full benefits associated with this revenue stream, the studies have failed to appreciate that local authorities will save far more in terms of operating logistics than they lose in terms of material revenues. This is true irrespective of whether the DRS operates in a complementary or parallel fashion for the simple reason that a significant proportion of low density packaging materials no longer have to be collected though kerbside recycling / refuse systems;
- Local authorities around the UK are expected to save around £159 million per year in avoided waste management costs. This is a saving of around £7 per household per annum. In other words, for an average waste collection authority of 50,000 households, the financial saving in real terms would be around £360,000 per annum. This is a valued means of saving public sector costs at a time when cuts are being made to reduce the deficit, and consideration is being given to the transfer of services to the private sector;
- The environmental benefit is significantly different with and without the disamenity associated with littering. We have included both figures in order to show the 'worst-case' scenario cost benefit analysis, where individuals place zero value on the removal of litter from their environment, separately from perhaps a more likely scenario, where individuals are willing to pay somewhere in the region of £48 per household per annum to remove litter from the environment. There will, without question, be some disamenity value that arises through littering, and the analysis presented here shows that the reduction of containers in the environment could generate a significant benefit to society;
- In our model, a minority of consumers forego £491 million in deposits. There are interesting questions as to what might lead people to forego deposits in systems where the aim is to make returns as convenient as possible. There will be cases where it may be difficult for some individuals to make returns,

though for such individuals, there may be others who can gain the returns for them (or simply ensure no additional deposit is paid on a 'replacement' purchase). For others, the calculus may be more simple in that the marginal income to be gained is too insignificant to warrant any (additional) effort to regain the deposit, though here, the prospect remains that others will choose to benefit from the deposit. Nonetheless, this does increase the outlay from consumers, and is considered as a cost of operating the system, though the effect is to defray the costs born by the producers;

- More research into the disamenity associated with littering would be desirable in order to firm up the figures in Table 6-3 and give greater strength to determining the argument for or against the introduction of a DRS in the UK. Under the current analysis, however, the overall considerations appear favourable for introducing a complementary system where one incorporates the disamenity associated with litter; and
- For society as a whole, there is a net cost of £428 million where no allowance is made for the benefits generated from reduced littering. Once this is factored in, however, the position changes quite dramatically. Indeed, society derives a net benefit of £820 million. Indeed, the system implies a benefit:cost ratio of the order 2:1.

Another way of looking at these results is that the benefits to society will be positive as long as the disamenity associated with the reduction in litter is valued in excess of £428 million, or around £16.46 per household.

The costs of running the DRS can effectively be summarised as the cost to producers plus the revenue foregone by consumers in the form of unclaimed deposits. This is just over £700 million.

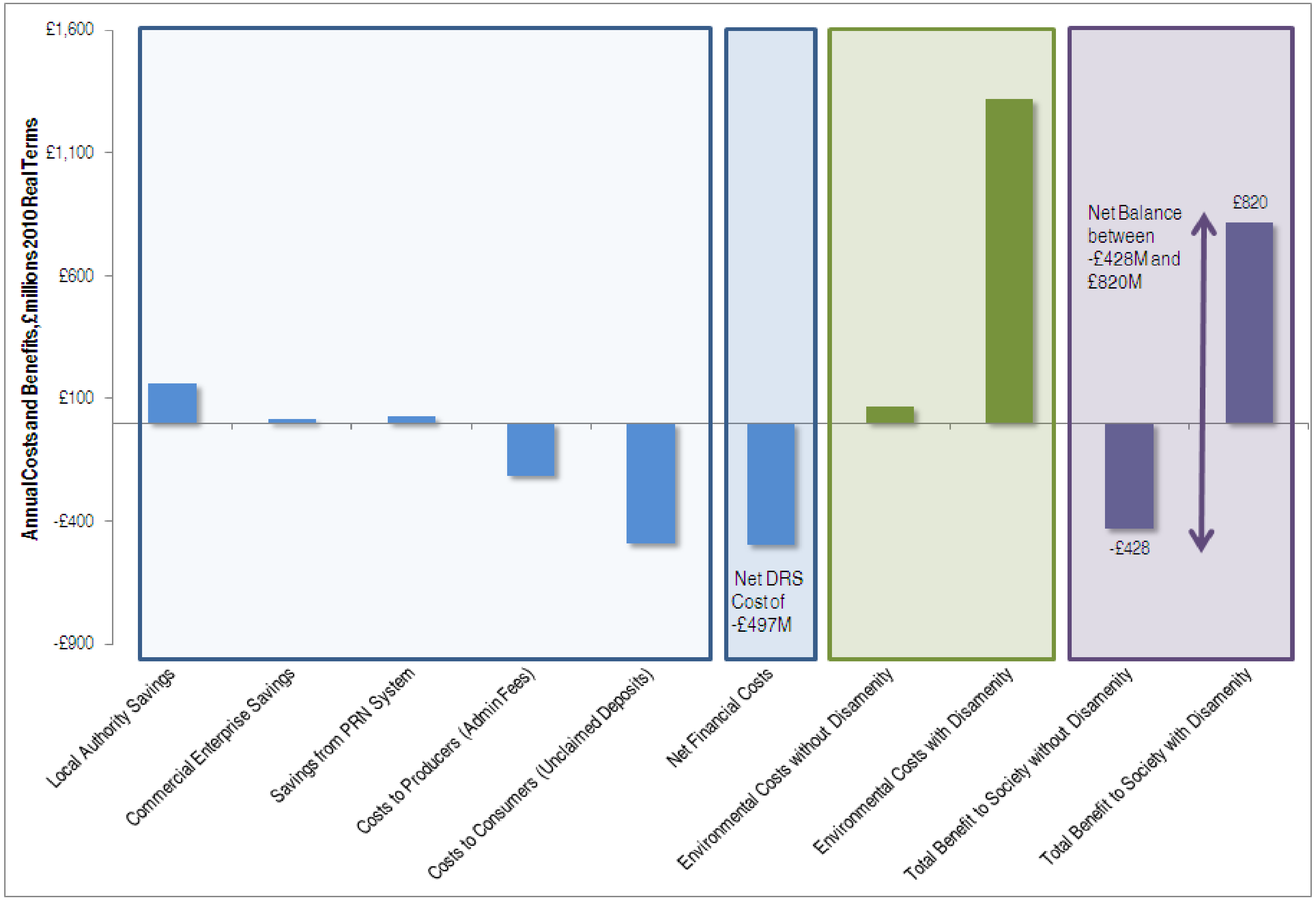
Table 6-3: Overall Costs and Benefits, £millions – Complementary Scenario

	Cost or Benefit (-ve is a cost), in £millions
Financial Effects	
Deposit Refund System (to Producers)	-£212M
Collection and Treatment/Disposal (to Local Authorities)	£159M
Change in Cost of PRNs (conservative estimate)	£30M
Collection and Treatment/Disposal (to Commerce)	£17M
Consumers (unclaimed deposits)	-£491M
Net Financial Costs	*-£497M*
Environmental Effects	
without disamenity	£69M
with disamenity	£1,317M
Total Benefit to Society	
without disamenity	-£428M
with disamenity	+£820M

Source: Eunomia

Note consumer costs are the unclaimed deposits that the consumer 'loses' as a result of not returning their containers in order to collect their deposit

Figure 6-5: Summary of Annual Ongoing Costs and Benefits from the Introduction of a 'Complementary' Deposit Refund System, £millions 2010 Real Terms



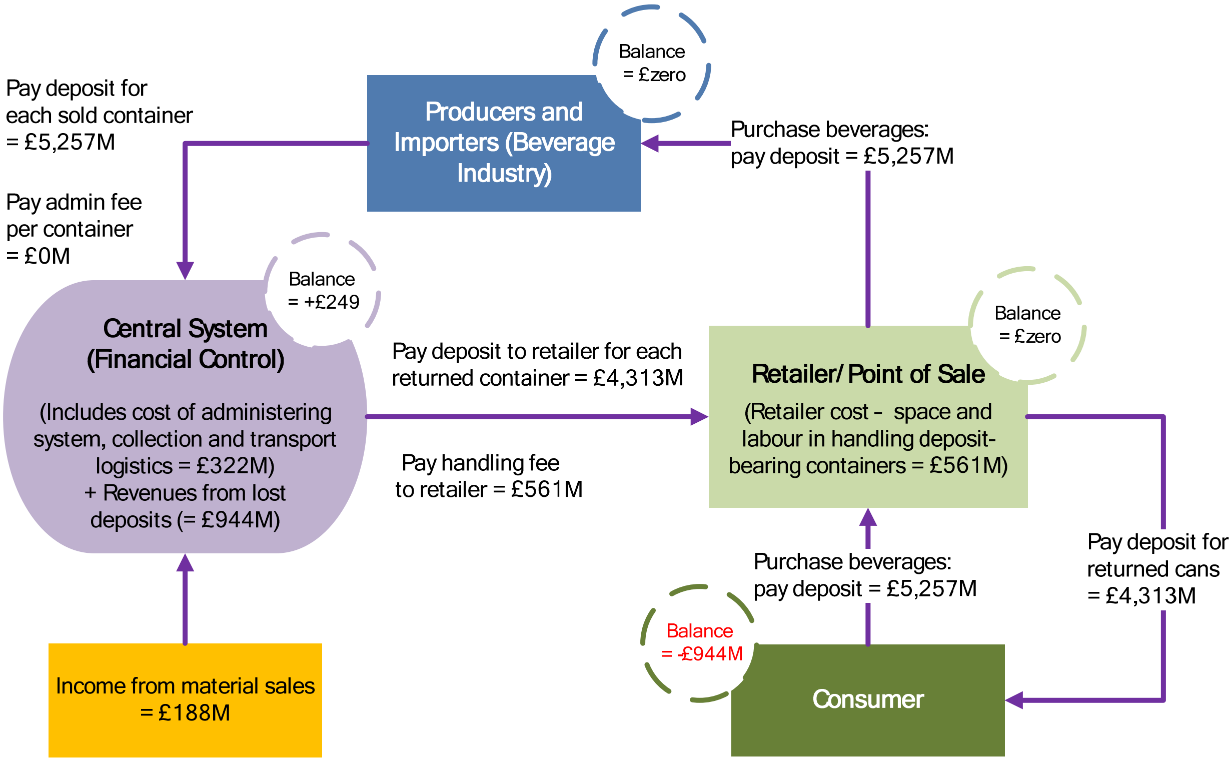
Note: Positive figures indicate benefits, negative figures indicate costs

6.2 Parallel System

Under the parallel system, the kerbside system remains in operation for beverage containers alongside the DRS. In our modelling, this has the assumed effect that some people will continue placing containers in their household recycling or refuse collection, even though they have paid the deposit, on the premise that the convenience factor outweighs the financial loss of the deposit. With this in mind the overall return rate for the system was set at 80%, 10% less than where no return can be made at the kerbside. Figure 6-6 provides an overview of the costs associated with the parallel DRS, based on an 80% return rate, and Table 6-4 summarises the overall costs and benefits derived under the parallel scenario.

Figure 6-6: Overview of Parallel Deposit Refund System Costs

80% overall return rate, £millions 2010 Real Terms



The figures presented in Table 6-4 and Figure 6-6 indicate that the net benefits to society associated with introducing a DRS alongside the existing kerbside collection are similar to those under the complementary scenario. The main differences are discussed below:

- **Given that the return rate of containers placed on the market has been assumed to be 10% less than under the complementary scenario, ie. 80%, the value of the deposit (15p or 30p depending on the size of container) results in a significant revenue being generated from lost or 'unclaimed' deposits in the parallel system. Consequently, the unclaimed deposits and material revenues negate the need for an administration fee to be paid by producers (see Figure 6-7) and generate a surplus revenue of £249 million** for the central system. As is the case in some Nordic countries, this revenue could be used to fund environmental projects, as well as to invest in further optimisation of the DRS infrastructure where applicable (for example, to increase infrastructure to achieve higher return rates);[81]

Table 6-4: Overall Costs and Benefits, £millions – Parallel Scenario

	Cost or Benefit (-ve is a cost), in £millions
Financial Effects	
Deposit Refund System (to Producers)	£249M
Collection and Treatment/Disposal (to Local Authorities)	£143M
Change in Cost of PRNs (conservative estimate)	£30M
Collection and Treatment/Disposal (to Commerce)	£15M
Consumers (unclaimed deposits)	*-£944M*
Net Financial Costs	*-£508M*
Environmental Effects	
without disamenity	£65M
with disamenity	£1,313M
Total Benefit to Society	
without disamenity	-£443M
with disamenity	+£805M

Source: Eunomia

**Note consumer costs are the unclaimed deposits that the consumer 'loses' as a result of not returning their containers in order to collect their deposit.*

81 http://www.dansk-retursystem.dk/content/us/importers_and_producers/deposits_and_fees

- The corollary of this is that consumers actually incur a greater cost, in the form of unclaimed deposits, than under the complementary system. Effectively, what is being modelled is an assumption regarding the response of consumers to the relative ease with which containers can be dealt with through the kerbside system and the DRS. This assumption is clearly open to question. It may well be that a sufficiently well resourced infrastructure would imply that the differentials in performance may be smaller, especially if the deposit is seen as 'worth having', or if the scheme is considered 'worth supporting'; and
- Given the lower amount of material being collected in the DRS, the overall logistics costs were calculated as £15 million lower in the parallel system, and the material revenues generated were also lower by the order of £22 million. In addition, given that there will be an increase in the number of containers collected at the kerbside in the parallel system, there is a resultant decrease in the overall savings available to local authorities of £15 million in comparison to the complementary system.

It should be noted that this modelling does not take into consideration the fact that, given the size of the deposit, the local authority itself would be likely to implement measures to separate out the beverage containers in the kerbside scheme, and claim back the deposits as an income stream. On a per container basis, a collection authority can gain significantly higher revenue from the redemption of the deposit than from the sale of the material only.[82] Therefore, it is quite possible that the authority would go to some effort to ensure that people place containers in the recycling system rather than in refuse, and to either separate them out in kerbside sort collections, or install an automated counting machine at a transfer station in order to redeem the deposits from the central system. Consequently, the figures for the system could converge with those calculated under the complementary scenario, with principal differences being related to the cost of installing relevant separation equipment.

We would thus suggest that both systems could be considered feasible systems for the UK. However, given that the operational costs are similar between the parallel and complementary scenarios, and they are likely to converge in any case, it seems sensible to allow householders to continue to use existing kerbside collection systems if they so desire. This might also be a more sensible approach given the existence of containers which bear no deposit (imported by consumers from abroad).

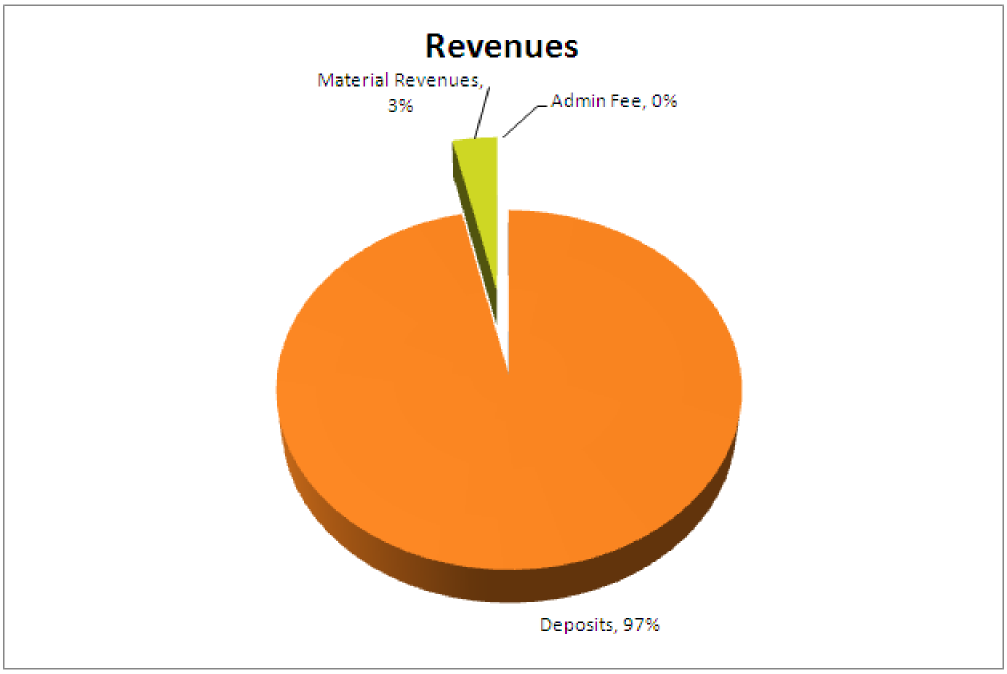
The overall costs of the DRS are, as with the parallel scheme, given by the cost to producers plus the revenue foregone by consumers in the form of unclaimed deposits. This is just under £700 million in this case. The key change between the parallel and complementary systems, driven by the assumptions regarding return rates, is the distribution of these costs between producers and consumers. Other things being equal (notably, the magnitude of the deposit), a scheme with a higher

[82] The average revenue per container is 1.7p. This is significantly less than the 15p or 30p deposit.

return rate will lead to reduced revenues in the form of unclaimed deposits and higher costs to producers.

Since DRS costs to producers are lower with lower return rates, it would appear sensible to introduce target recycling rates for these materials to encourage higher return rates from the system, and reduce the incentive for poor system design / inadequate infrastructure. This would also result in the convergence of the complementary and parallel systems, in terms of return rate. The effect of this is to lower the revenue generated from unclaimed deposits, thus leading to slightly higher administrative fees, but with the ultimate outcome that greater environmental benefits are delivered.

Figure 6-7: Revenue Source under Parallel System



Source: Eunomia

6.3 Sensitivities

In order to understand the robustness of the results and conclusions presented above, we have undertaken a series of sensitivity analyses. The results from these analyses are detailed in this Section. Given the discussion above in relation to the parallel system, all of the sensitivities presented relate to the results under the complementary scenario.

The sensitivity analyses are first undertaken as discrete elements, in order to explore the relationship between each key variable and the overall cost benefit associated with introducing the deposit scheme. Thus each sensitivity is run under the assumption of 'all other things being equal'. Testing of the overall results, using multivariable analysis, is described at the end of the section, in order to identify those variables that have the most significant influence on the results that have been obtained in this study.

6.3.1 Change in Automated vs Manual Take-back

As part of the sensitivity analysis, we explored what might happen if more retail outlets were able to install RVMs that allowed them to clear and compact containers on site, rather than requiring more regular manual collections. It is worth noting that, although as modelled here, the cost of a consumer friendly machine destined for the supermarket forecourt is around £17,000, a simple RVM designed more for smaller shops and back-rooms/ storage areas might cost as little as £4,500 to £8,500. If a greater number of retail outlets were to install these simple RVMs to streamline the take-back process, then the collection logistics would be significantly optimised due to the higher bulk densities of the material and the elimination of counting centres.

If the setup of the system is changed so that at least 80% of retailers can install on-site automated takeback systems, then 160,000 machines would be required in addition to the existing 40,000 modelled in the central case. In both cases the net benefit changes to a cost, when disamenity is not considered, but it is still a benefit when litter disamenity is included.

This shows that despite the savings from optimised collections, and less down-stream processing, the number and capital cost of RVMs play a significant role in the financial costs of the system.

Table 6-5: Overall Costs and Benefits, £millions – Take-back Methodology Sensitivity

	Central Case	€5,000 Machine	€10,000 Machine
RVM Costs	£209	£226	£419
Collection Costs	£323	£252	£252
Total Benefit to Society			
without disamenity	-£428	-£511	-£721
with disamenity	+£1.2B	+£737	+£527

Source: Eunomia

6.3.2 Change in Collection Logistics

Under the central complementary scenario, it has been assumed that most of the larger stores will be able to utilise backhauling (see Appendix A.3.2.6).[83] If this is not the case, or conversely if distribution companies are able to backhaul from much smaller premises, the overall collection requirements of the system will change significantly. In the central scenario, we have modelled that around 37% of retail outlets will be able to utilise backhauling. This is based on estimates of the

[83] Note that backhauling refers to the return trip that is made by a truck after delivering a load to a specified destination. This return trip, on which the truck would otherwise be empty, is used, where possible, to transport items back to where the truck journey commenced from.

proportion of each retail category able to backhaul. The key assumptions in the setting of these conditions were:

- All supermarkets are of a large enough size to backhaul;
- 70% of medium sized stores would be large enough to backhaul;
- 20% of convenience stores will be serviced by large-scale distribution companies which will backhaul;
- Half of pubs (whose main trade is beverages) will be supplied by a distribution company large enough to backhaul. In practice many pubs are supplied by a small number of large suppliers or breweries, so in reality the potential for backhauling using existing collection logistics could be more substantial than estimated; and
- The potential for backhauling is diminished when considering other catering sectors due to the lower volumes of containers per outlet.

37% of retail outlets equates to around 50% of the total number of containers in the system, and containers are the single most significant cost in the dedicated collection round logistics.

Table 6-6 shows the change in cost benefit if these assumptions are altered.

Table 6-6: Overall Costs and Benefits, £millions – Collection Logistics Sensitivity

	Central Case - 37% Outlets Backhauling	10% Outlets Backhauling	80% Outlets Backhauling
Collection Costs	£323	£423	£227
Total Benefit to Society			
without disamenity	-£428	-£534	-£326
with disamenity	+£1.2B	+£714	+£922

Source: Eunomia

It can be seen from Table 6-6 that the results are sensitive to the input assumptions regarding backhauling. Shifting between low and high values for backhauling changes costs, relative to the baseline, by +/-£100 million or so. Given the large number of supermarkets in the UK retail landscape, and their likely desire to want to backhaul where reverse vending machines are installed in their outlets, it seems unlikely that less than 10% of retail outlets would be engaged in backhauling.[84]

[84] Personal communication with Tesco during the TOMRA RVM trial, 2009.

6.3.3 Change in Environmental Assumptions

The way in which emissions to the environment are valued and the price that is used will both have a significant bearing on the results obtained. Details of the way in which carbon and air quality valuations have been undertaken are discussed in Appendix A.5.0. Two sets of damage costs have been considered in this study - the UK Government's Interdepartmental Group on Costs & Benefits (IGCB) damage costs and the Clean Air for Europe (Café) damage costs.[85] These datasets use slightly different values in their assessment of damage costs. The Café data set was used for the cost benefit analysis presented here in the central case. Table 6-7 illustrates that when using the UK Government's Interdepartmental Group on Costs & Benefits (IGCB) damage costs as opposed to the Clean Air for Europe (Café) damage costs, there is a reduction in environmental benefit of around £21 million in air quality benefits.

Table 6-7: Overall Costs and Benefits, £million – Change in Environmental Assumptions

	Central	Air Quality – Café to IGCB Damage Costs	Increase in additional journeys by consumer – 10% to 50%	Average Emissions Standard Euro 5 to Euro 6
Environmental Costs	£70	£49	-£8	£87
Total Benefit to Society				
without disamenity	-£428	-£449	-£506	-£411
with disamenity	+£1.2B	+£799	+£742	+£837

Source: Eunomia

Furthermore, in assuming an increase from 10% to 50% in the number of additional (dedicated) trips that the consumer might make solely to drop off their deposit-bearing containers, there would be a reduction in environmental benefit of £78million. Finally, if we assume that the vehicles required in the deposit refund collection logistics are of Euro 6 emissions standard (a more stringent standard which the UK's vehicle fleet will have to meet in the future) rather than Euro 5, there is an overall reduction in vehicle emissions, generating an additional £17 millon of environmental benefit in comparison to the central scenario.

In addition to these impacts, and as discussed previously, the disamenity associated with littering is also uncertain. Hence all results have been presented both with and

[85] Damage costs are a way of converting an environmental impact into a financial impact, by looking at the financial costs to society of some form of environmental impact. In this case, for air quality impacts, this is done through assessing the cost to society of people's ill health that results from air pollution. In the case of climate change, this is done by calculating the financial cost to society of putting in place measures to reduce climate change impacts associated with greenhouse gases.

without the potential benefit to society associated with the removal of litter from the environment.

Table 6-7 shows the change in environmental costs associated with each of the key changes in the environmental assumptions. When considering total benefit less litter disamenity, the increase in dedicated journeys by the consumer does take the overall benefit to society over the tipping point – all other things being equal. However, when disamenity is considered, none of the sensitivities challenge the robustness of the overall conclusions.

6.3.4 Potential Switch in Manufacture Away from Deposit-Bearing Containers

Though not forming part of the scope of this study, it is perhaps worth briefly discussing the potential switch in choice of container material in order to avoid the DRS. In the recent study undertaken by ERM on DRSs, it was noted that the over-riding issue in the manufacturer's choice of which material to use to contain beverages was centred on consumer acceptance, rather than on avoidance of being in a deposit scheme.[86] However, the study did note one example where the manufacturer had changed their material choice specifically because of the DRS, with one producer in Sweden switching to a bottle made from plastic that was not part of the scheme. Subsequent adjustments to the legislation brought that particular product back into the DRS. However, this might not be as easy if, for example, the producer were to turn to cartons or pouches as alternative containment methods.

Policy makers should, therefore, be aware that some equivalent form of extended producer responsibility for those beverage containers falling outside the DRS might be necessary in order to avoid the shift to materials that are not so easy to include in DRSs for technical reasons. A clear problem with the existing producer responsibility system is that the costs of complying with obligations do not fall fully upon the obligated companies. A considerable part of the cost of meeting targets for packaging waste recycling is met through central government grant and Council Tax, so that there is very little incentive for packaging waste producers to be mindful of the recyclability of the retail packaging they place on the market.

A range of instruments could be used to ensure that the incentives for product switching are reduced. Simply put, it would make sense for producers to be obliged to achieve high rates of recycling of packaging and to meet the costs of doing so (as under the DRS). Alternative mechanisms such as packaging levies could be used to influence the materials chosen by manufacturers. Denmark effectively discharges its packaging waste obligations through a combination of taxes and deposit refunds, with the tax rates varying depending upon whether the packaging falls within or outside a deposit scheme.[87]

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

[87] Eunomia (2009), *International Review of Waste Management Policy: Annexes to Main Report,* Report for the Department of the Environment, Heritage and Local Government, Ireland, p.316-321

6.3.5 Multi-Variant Analysis in Cost and Environmental Performance

A significant number of variables are included in the cost benefit model. To test all inputs and possible outcomes would require significant time, and would not necessarily provide any further understanding of the fundamental financial impacts associated with the introduction of a DRS in the UK. However, as discussed previously, to simply consider a range of discrete scenarios makes it difficult to obtain an overall idea of the 'worst' or 'best' case outcomes.

A simulation tool called Crystal Ball® was thus used to perform Monte Carlo analysis on the key inputs, and record the range of results. The goal of Monte Carlo analysis is to determine how random variation, lack of knowledge, or error affects the sensitivity, performance or reliability of the system that is being modelled. 'Monte Carlo' simulation is categorised as a sampling method, because the inputs are randomly generated from probability distributions to simulate the process of sampling from an actual population. The key variables tested in the model are given below (larger variations have been given to assumptions which are less certain):[88]

- Deposit Refund System Costs:
  - Material Revenues +/- 20%
  - Total Transport Cost +/- 50%
  - Total Container Costs +/- 50%
  - Total Counting Centre Costs +/- 20%
  - RVM Unit Costs +/- 30%
  - Labour Costs +/- 50%
  - Retail Floorspace Rateable Value +/- 50%
  - Deposit +/- 20%
  - Central System Administration Cost + 200%/ - 50%
- Existing Waste Collection Costs
  - Bring Site Costs +/- 80%
  - HWRC Costs +/- 80%
  - Litter Collection Costs +/- 80%
  - Commercial Collection Costs +/- 80%
- Environmental Costs
  - Unit Damage Costs for Air Emissions and GHGs +/- 50%
  - Littering Disamenity Benefits £10 to £50 per household
  - Transport Damages – Additional Miles +/- 80%

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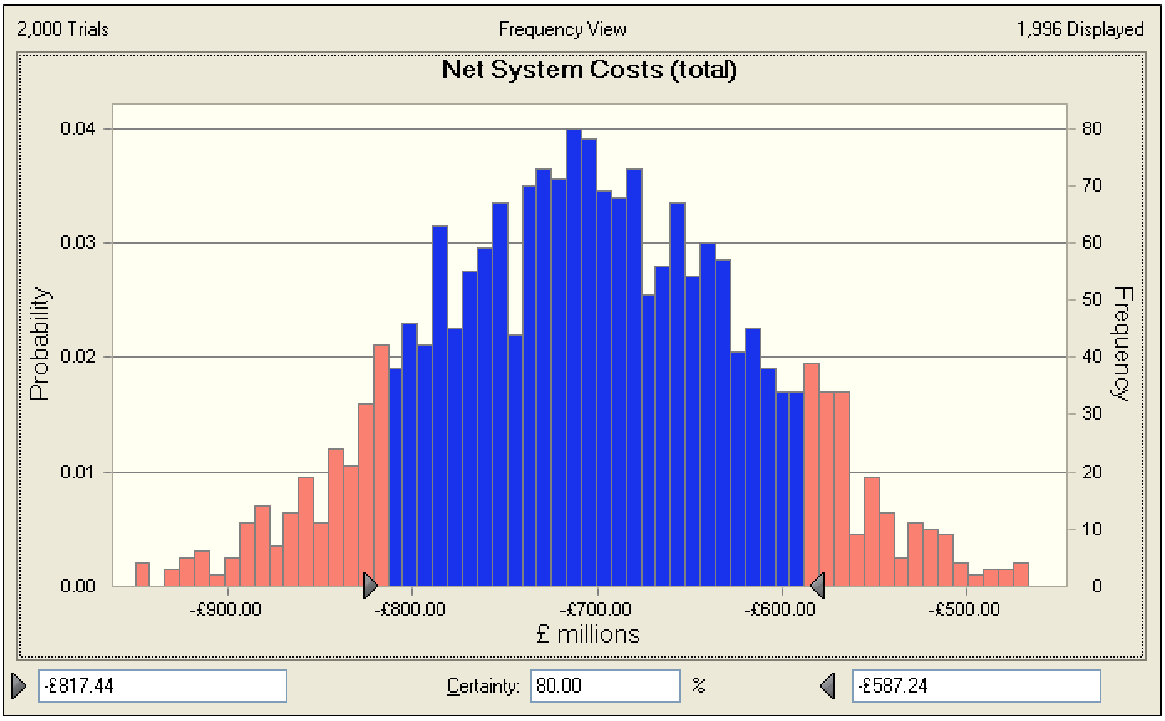
[88] All inputs are varied linearly between the limits given.

- Mass Flows:
    - Return Rates 85% to 95%

Figure 6-8 to Figure 6-12 show the outputs from the simulation. They represent a probability distribution based upon the inputs described above. The certainty of the result falling between the upper and lower bounds (the blue area) is shown at the bottom of the chart.

Figure 6-8: Monte Carlo Analysis – Net Costs for DRS



Source: Eunomia

Figure 6-8 shows that the costs of the DRS system have an 80% likelihood of lying between £587 and £817 million. These costs are, as was highlighted earlier, made up of the costs to producers and the unclaimed deposits from consumers. These two components are shown in Figure 6-9 and Figure 6-10. Producer costs show an 80% likelihood of lying between £67 and £443 million, whilst unclaimed deposits are 80% likely to lie between £303 and £605 million.

Figure 6-9: Net Costs to Producers

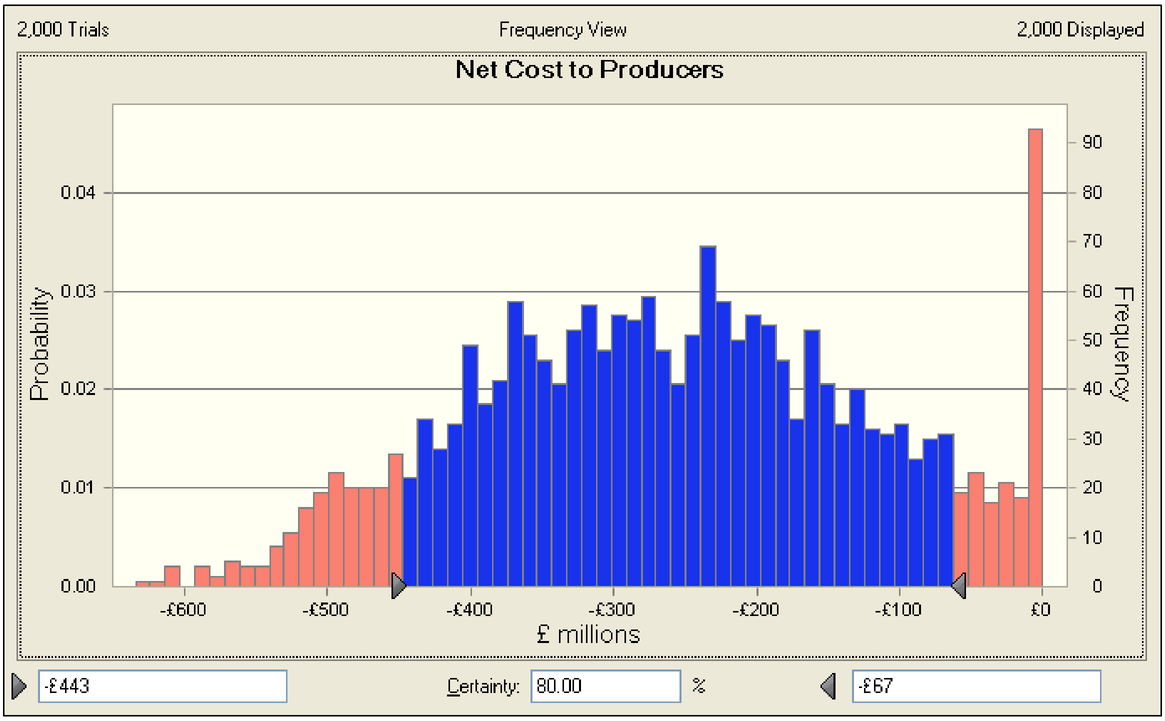
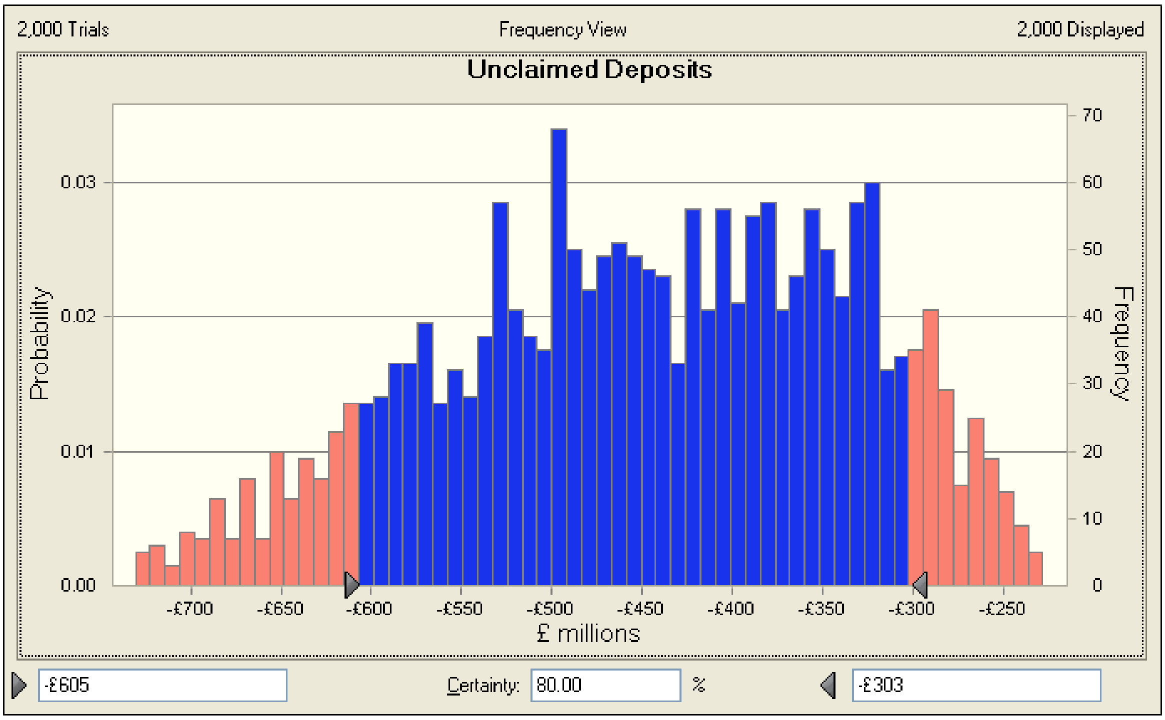
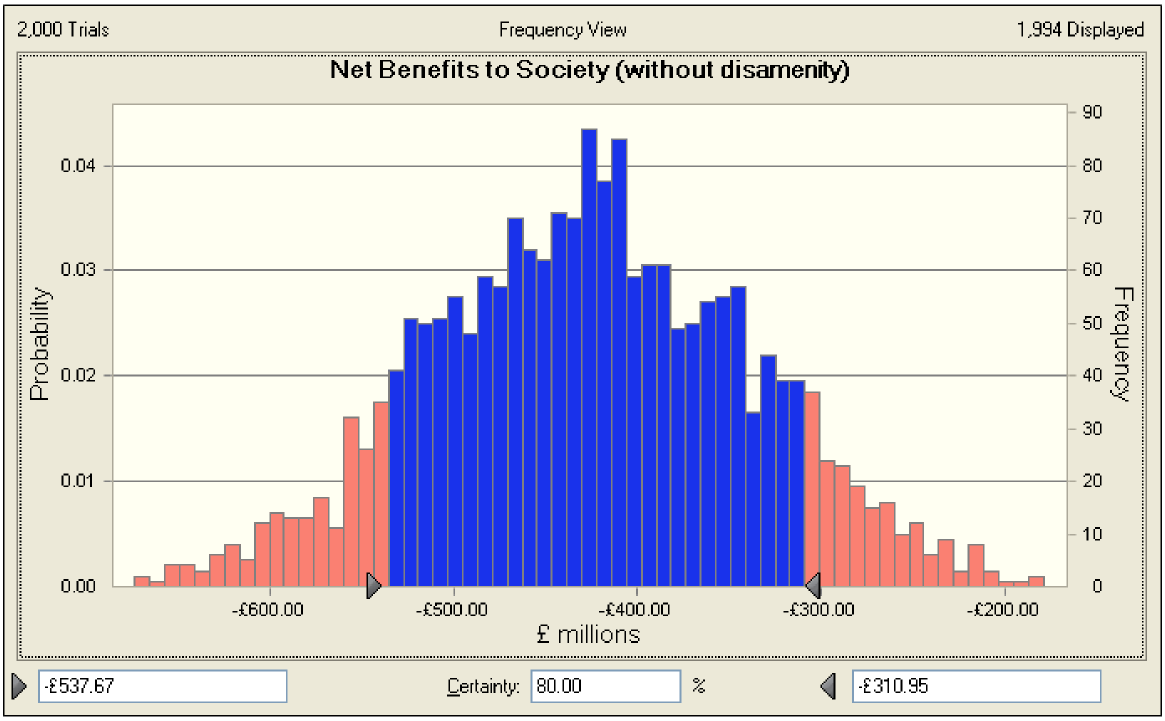


Figure 6-10: Cost to Consumers (Unclaimed Deposits)



Perhaps the most important figures are those for the net benefit to society. In the case where no benefit from disamenity is included, Figure 6-11 shows that the costs are 80% likely to lie between £311 and £537 million.

Figure 6-11: Monte Carlo Analysis – Net Benefit to Society (without Littering Disamenity)



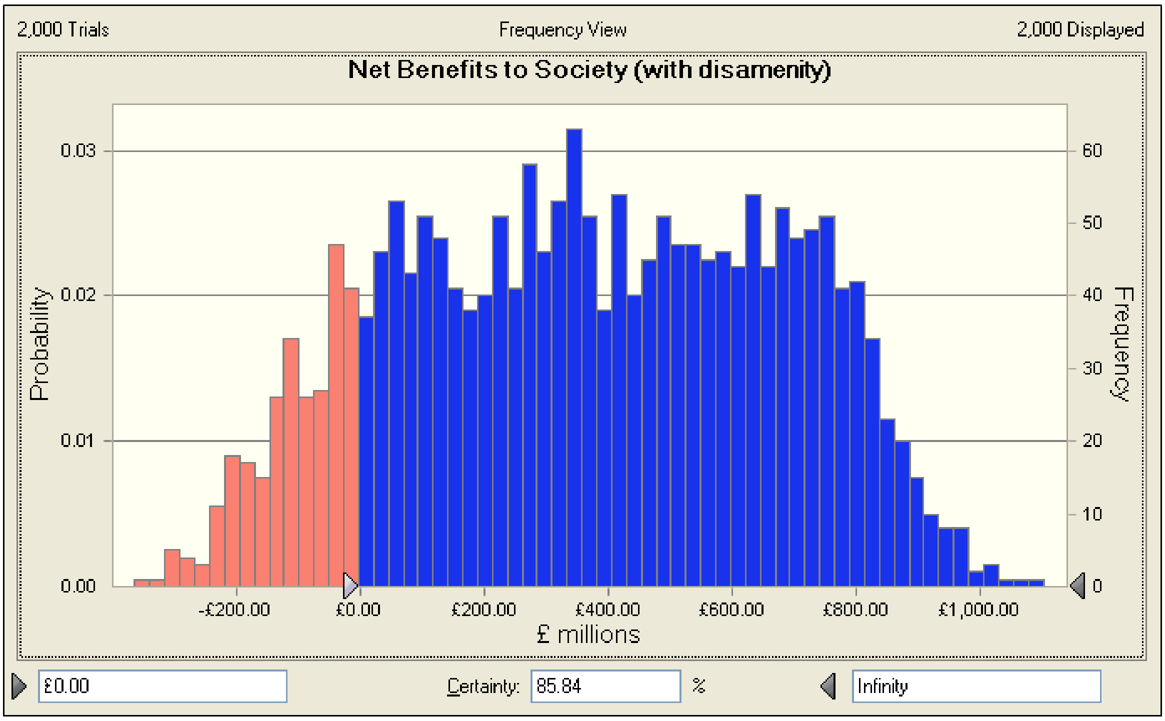
Source: Eunomia

Once disamenity is included, the picture changes radically. As Figure 6-12 shows, there is an 86% likelihood that benefits will exceed costs. In the central 80% likelihood interval, the net benefits to society range from -£43 million to +£769 million. The most likely outcome is a net benefit to society of £365 million.

The important conclusion therefore, when including the disamenity associated with litter, is that there is a strong likelihood that the benefits will exceed the costs.

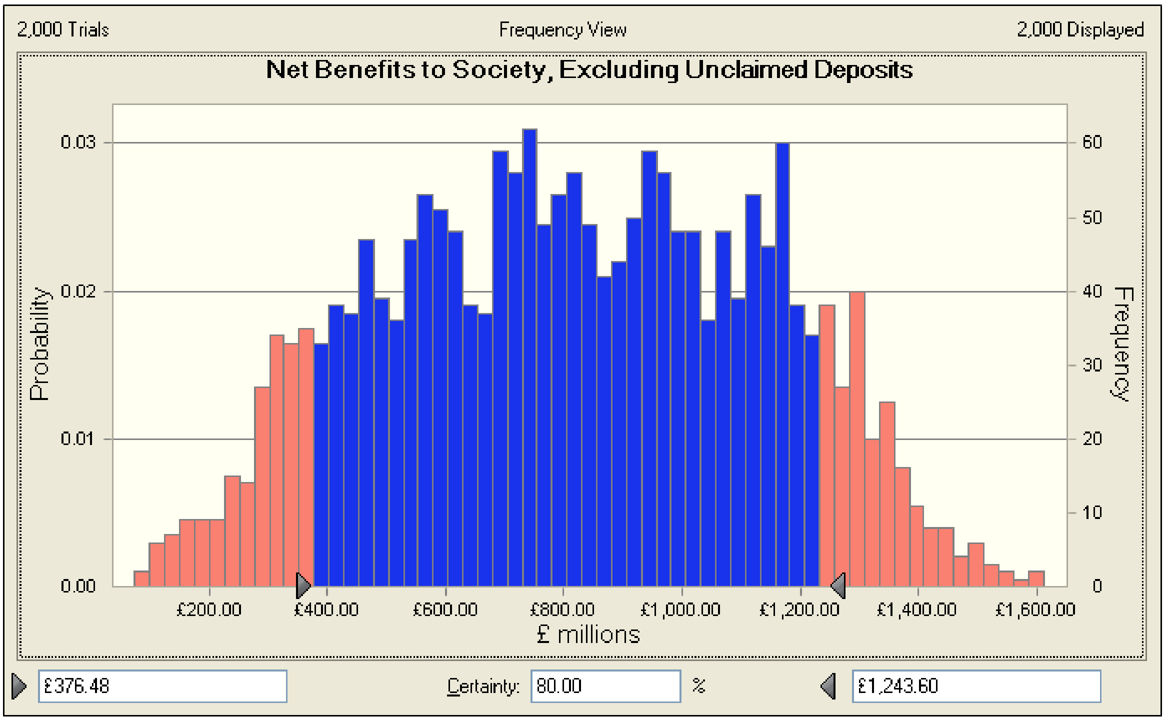
The final presentation, in Figure 6-13, shows how the figures appear if one adopts the view that unclaimed deposits are 'voluntarily' foregone, and if one excludes them from the *costs* of the DRS. This shows that under this assumption, the net benefits are always in excess of zero. The benefit figures are 80% likely to rest between £376 and £1,244 million. Strictly speaking, this ignores costs which are incurred by consumers, but it might be argued that these costs simply represent income that the consumers have *chosen to forego*. The validity of this line of argument clearly depends upon the adequacy (convenience) of the infrastructure for beverage container returns. Furthermore, if schemes are highly successful in generating returns, then clearly, the unclaimed deposits fall close to zero and Figure 6-13 appears very much as Figure 6-12 above.

Figure 6-12: Monte Carlo Analysis – Net Benefit to Society (with Littering Disamenity)



Source: Eunomia

Figure 6-13: Monte Carlo Analysis – Total Benefit to Society (with Littering Disamenity), and Excluding Costs Incurred by Consumers as Unclaimed Deposits



The key sensitivities in the model can also be extracted from within the simulation software. In examining the implementation of a DRS in the UK, it is important to note that the five most influential variables affecting the value of total benefit to society are:

1) The value of disamenity per household associated with littering (65% contribution to variance);
2) The return rate of containers into the system (14% contribution to variance);
3) The deposit applied to the containers;
4) The space costs of retail floorspace; and
5) The total costs of transporting containers during collection and processing.

This indicates that more research into the disamenity associated with littering, potential return rates and deposit value would help in providing greater robustness to the results.

6.4 One-Off Costs

Little detailed and sourced information appears to be available on the initial set up costs that would be required for a DRS in the UK. We 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 (provided by TOMRA), and the associated number of days that would be required for each task.[89] 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-27 in Appendix A.3.6.

Based on the modelling, a total cost of **£32 million** would be required to set up the central DRS, plus an additional **£1.25 million** for the producers to change their labelling, and an additional **£51 million** for the retailers to adapt their store areas to accommodate the new system requirements. In addition, significant investment would be required in order to purchase infrastructure such as RVMs and counting centres. It is unlikely, however, that these would be purchased outright; rather the typical approach in existing systems seems to be to finance this infrastructure over a number of years (modelled at around 5 years for RVMs). We have thus incorporated these annualised costs into the overall ongoing logistics costs of the system.

There is a dearth of detailed information on the overall set-up costs of existing DRSs. We could find no credible sources on the detailed calculation of joining fees for either producers or retailers which would be required to cover these one-off costs. Joining fees vary across existing deposit schemes and can also vary from year to year (to compensate for changes in return rates and material values, and hence the subsequent cost of the overall DRS). For example, in Finland, the producer can currently opt to pay either a one-off lifetime joining fee of £6,698, or an annual

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

joining fee of £1,498 over a 5 year period, and must also pay a per product additional fee of around £300 in both circumstances.[90] In Denmark, the joining fee for producers is currently set at £238 per annum, and retailers also pay an annual fee of £59 to make them eligible to receive handling fee payments.[91] In Norway, a one-off joining fee of £3,307 is currently charged for each producer, plus an additional £551 per product.[92]

For the purposes of this high level modelling, we have thus not attempted to split the one-off costs into joining fees per producer or per retailer. However, based on fees in existing deposit schemes, given the size of the one-off costs presented here and based on the number of producers and retailers, it can be expected that the average fee for producers might be somewhere around £3,000 to £5,000 (to be paid as a one-off or over several years) with a per product fee in the region of £300, and an average retailer fee of around £100 to £200.[93] 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 joining fee be a one-off membership, or an ongoing annual fee?
- Should a per product fee be charged on top of a more general fee in order to reflect the size of producer?
- Should the retailer joining fee vary according to annual turnover or some other equivalent measure?

6.5 Single Market Considerations

Care has to be taken in designing DRSs in Europe such that they are proportionate in their effect, and do not effectively become trade barriers, or obstacles to the free movement of goods within the EU Single Market, in ways which are disproportionate relative to the environmental outcome being sought.

One of the concerns within Europe has been the distributional impact across domestic and foreign producers of beverages. Several documents highlight the potential for DRSs to place foreign producers at a disadvantage relative to domestic producers, the argument being that there is a protectionist slant to DRSs, and that they fragment the Single Market. In May 2009, the European Commission issued a

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[90] http://www.palpa.fi/english,exchange rate at 0.8813

[91] http://www.dansk-retursystem.dk/content/, exchange rate at 0.1189

[92] http://www.resirk.no/Calculator-83.aspx, exchange rate at 0.1102

[93] Based on approximately 1,000 producers and 185,000 retailers; if retailers were, for example, to cover 70% of set-up costs, this would equate to joining fee of £119 per retail outlet. Remaining costs would be then be covered by producer one-off fees of £3500 plus a per product fee of £300, based on an average of 20 products per producer (Coke has approximately 300 products on the market, whereas smaller firms might have less than 10).

Communication on *Beverage packaging, deposit systems and the free movement of goods:*[94]

> *While regulatory steering measures taken at Member State level in order to introduce systems for the reuse of beverage packaging may serve environmental goals, they also have the potential to divide the internal market. For market operators engaged in activities in several Member States these systems often make it more difficult to take advantage of business opportunities within the internal market. Instead of selling the same product in the same packaging in different markets, they are required to adapt their packaging to the requirements of each individual Member State, which usually leads to additional costs.[...]*
>
> *Past experience and ongoing cases show that the adoption of unilateral measures in different Member States still poses problems. In particular, infringement procedures in the beverage sector have shown that national measures can lead to distortions of competition and, in some cases, to the partitioning of the internal market, which runs counter to the internal market aim of Directive 94/62/EC.*

Whilst there is clearly an issue associated with DRSs, there are other ways in which the Single Market remains fragmented, partly owing to the degree to which national authorities still exercise control over the workings of the domestic market. In many respects, the principle of subsidiarity (which tends to give Member States considerable freedom in the way they transpose EU legislation into domestic legislation) tends to limit the extent to which a Single Market can ever be said to exist. Notwithstanding the objectives to see this ideal realised in practice, this can only really happen if Member States simply abrogate complete responsibility for policy making to the European Parliament. This seems an unlikely outcome, and not just in the near future. Consequently, the fragmentation of the internal market remains a fact of life.

We note in passing that the UK has a strict packaging code developed and implemented relatively recently by the Food Standards Agency (FSA). This requires UK specific packaging to be produced. Therefore, there would be little additional burden to producers for developing UK specific packaging, and logistics following the implementation of a DRS, if this was already the case.

The Communication is presented as a list of 'do's' and 'don'ts' for Member States to assist them in the design of their policies in such a way that problems in respect of the internal market are minimised or eliminated. It is important to note, however, that what the Communication very clearly avoids saying is that DRSs are not legal. It merely highlights the fact that the design of such systems should be carefully considered, particularly with regard to their effect on the workings of the internal market. Moreover, it recognises that such schemes can be justified even where they may be construed as barriers to trade:

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[94] European Commission (2009) Communication from the Commission on Beverage packaging, deposit systems and the free movement of goods, C(2009) 3447 final Brussels 8th May 2009.

> *The fact that they would qualify as a trade barrier, however, does not prevent these national provisions from being justified on grounds relating to the protection of the environment. According to the Court of Justice, a deposit and return system may increase the proportion of empty packaging returned, and at the same time lead to a more targeted sorting of packaging waste. Moreover, it may help prevent littering, as it gives consumers an incentive to return empty packaging. Finally, insofar as those national provisions encourage the producers or distributors concerned to have recourse to reusable packaging, they contribute towards a general reduction in the amount of waste disposed of, which is a general goal in environmental policy. <u>In practice, this means that Member States are allowed to introduce mandatory deposit systems if, on the basis of the individual Member State's discretion, this is considered necessary for environmental reasons.</u>*

It goes on to note, however, the need for a balanced and proportionate approach:

> *If a Member State opts for a mandatory deposit and return system, it must nevertheless observe certain requirements in order to ensure that a fair balance is struck between environmental objectives and internal market needs. In view of the additional burden on imported products, such systems must take note of the specific situation and must use means which do not go beyond what is necessary for the purpose envisaged.*

It then describes approaches considered to be appropriate in the case where such schemes are introduced. This advice appears sound in the light of the considerable opposition which such schemes have engendered in respect to internal market effects.

Our analysis highlights the fact that particularly if the environmental disbenefits of littering are concerned, the overall change in costs are justified by the environmental benefits. In this respect, the approach could not be said to be disproportionate, and ought, therefore, to have much to recommend it. Much depends, of course, upon the efficiency with which the system is designed and operated.

The OECD reports that DRSs can create barriers to trade under the following circumstances:[95]

- if the initial deposits are high compared to the value of the goods;
- if foreign producers see that the costs of participating in a co-operative retrieval and recycling scheme are out of proportion to their market share;
- if non-refillable containers are an important condition for the competitiveness of imports;
- if they are applied only to certain types of containers or packaging which are primarily used for imported products; or
- if they are applied in a fashion which is discriminatory or which unduly favours domestic products.

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[95] OECD (1993) Applying Economic Instruments to Packaging Waste: Practical Issues for Product Charges and Deposit Refund Systems, Paris: OECD.

The OECD concerns reflect those which might be of concern to the World Trade Organisation. They principally concern the desire to ensure that DRSs are not disguised measures to protect national producers. Again, there seems no reason to believe that would be the case in our proposed design, as UK producers are no less likely to use the targeted materials than foreign producers.

The system we have proposed does not appear to fall foul of any of the OECD concerns. Some might argue that for some products, the deposit will be quite high relative to the value of the goods. This is a somewhat subjective matter, but the deposit levels here do not seem out of step with other systems.

Another concern in Europe has been the need to ensure sufficient infrastructural provision to cope with increased / altered collection and reprocessing requirements. This would also seem to be covered in our proposed design.[96]

In their review of the Oakdene Hollins study, Perchards suggest that the inclusion of wine bottles may be problematic:

> *We would warn against the inclusion of wine bottles in a DRS. Participation in a DRS usually requires special marking requirements (a machine readable logo or bar code that an RVM can identify) and may result in higher compliance costs. Because the UK produces hardly any wine, these burdens would fall solely on importers. This would be vehemently challenged as a barrier to trade – particularly by the French wine producers.*
>
> *It should be noted that no mandatory European deposit system includes wines or spirits bottles.*

In our model, we have included wine and spirits bottles. The aim of the system was to be as comprehensive as possible, and it could reasonably be argued that to exclude wines and spirits would be more discriminatory than their inclusion. The wording of the OECD above is instructive in that it argues that the measure would constitute a barrier to trade *only* if it affected products which are primarily imported. If all policy measures were conceived in such a way that for any product which was principally imported, exemptions were to be applied, then all policy would become ridiculously complex, with imports effectively considered as beyond the remit of domestic policy. Furthermore, wine bottles (and also spirit bottles) are included in mandatory deposit schemes in Iceland (a country in the European Economic Area (EEA)) and Israel, and South Australia and Finland are to introduce this capability soon.[97]

6.6 Cross Border Issues – Private Trade in Alcohol bringing Non-Deposit Containers into the UK

We note this issue because a) the scale of cross border trade is significant and b) it could be claimed by opponents of deposit systems to be a critical issue. The key

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[96] European Commission (2009) Communication from the Commission on Beverage packaging, deposit systems and the free movement of goods, C(2009) 3447 final Brussels 8th May 2009.

[97] Communication with Hans F. Lauszus (Anker-Andersen).

driver is the relative price of beverages. This price may fluctuate from region to region based upon local conditions, but the two most significant factors on relative pricing between countries are 1) exchange rates and 2) excise duty on alcohol. Significant differentials in price were found in a 2001 EU customs report between UK and France.[98]

Assuming the relative costs of manufacturing and transport are not significant (or, equivalently, that consumers buy in bulk to minimise these) it is clear that one of the key drivers on the price of beer is duty. One can see why consumers cross the border from the UK to France to purchase alcohol, much of it beer and wine.

The customs report also noted that:

> *"we see that the UK loses most revenue [alcohol duty], at €400 million per annum"*
>
> *"There is significant smuggling in the UK, particularly on beer"*

Additionally, the effect of exchange rates will also impact on the relative price of all beverages, not just those which attract an excise duty.

It is clearly possible that, notwithstanding the fact that the deposit is a temporary payment (and is returned when the can is returned) that some consumers might perceive it as more beneficial to shop in other countries, such as France or Ireland. PRO-Europe claims:

> *"Consumers tend to try to avoid paying deposits by shifting to deposit free products. This includes shopping in stores across borders where mandatory deposits are not applied. Consequently, retailers in the border region are faced with tremendous loses due to 'customer migration'."*
>
> *Source: PRO-EUROPE Position Paper Mandatory Deposit Systems*[99]

However, it seems that cross-border purchases between the UK and France already occur, and in the case of a deposit system in the UK consumers will be more motivated by the existing 'without deposit' differentials in price (i.e. alcohol duty), rather than the deposit itself (which will be less than the average difference in price of a can of lager, for example).

This private trade would cause a problem if, for example, containers purchased in France were not able to be accepted by the DRS return mechanisms in the UK. If RVMs or automated counting centres did not hold relevant European Article Number (EAN) codes, the systems would reject the containers and consumers would not be able to return them in this manner. This problem is easily overcome, even without the parallel operation of existing kerbside collection systems; if existing kerbside schemes remained consumers would simply return the empty containers in these

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[98] Customs Associates Ltd (2001) *Study on the competition between alcoholic drinks*, Final Report February 2001, http://ec.europa.eu/taxation_customs/resources/documents/study_comp_between_alcoholdrinks_en.pdf

[99] Pro-Europe (n/a) *PRO EUROPE Comments on: Mandatory Deposit Systems for One-Way Packaging*, http://www.pro-e.org/files/08-11_Position_Paper_Mandatory_Deposit_RBV01.pdf

schemes if they were rejected (or for travellers into the UK existing bring or 'on-the-go' recycling services could be utilised).

However, to ensure that the consumer does not lose confidence in the system, and become irritated when containers are rejected, memory cards in RVMs should be of appropriate size to enable them to hold all relevant EAN codes from France and Ireland prior to construction (a minimal incremental cost). This would mean that the system would recognise the container and it would be accepted, and transferred to reprocessors. Clearly no deposit would be paid back to the consumer, and no admin fee would be paid by the French, for example, beer producer, but the central system would benefit from the sale of the material. This would be especially beneficial in the case of aluminium cans.

7.0 Summary and Conclusions

In this report we have investigated the environmental and financial implications of the introduction of a UK-wide DRS. The research question that we were aiming to answer through this study was:

> *'How do the benefits of introducing a UK-wide DRS for certain beverage container packaging compare with the costs of implementation and operation?'*

In modelling a potential deposit refund model for the UK, we were able to examine closely the costs and revenues that might be involved in the implementation of a DRS. Based on existing examples, we calculated that a deposit of 15p and 30p would be required for beverage containers of ≤500ml and >500ml respectively in order to achieve a return rate in the region of 90% for the glass bottles, cans and PET bottles that we included in the DRS. The majority of the cost calculations for the system centred firstly on how retailers would take back the returned containers (automatic machine or manual) and the associated compensation that they would thus require, and secondly on the subsequent collection, counting and transport of those containers to re-processors. Hence a significant part of the modelling was based on building up a picture of the retail landscape across the UK. On-going administration costs for the system were also factored into the modelling.

Based on the complementary scheme as being the central scenario (where beverage containers are only collected in the DRS and not in kerbside recycling), we calculated that the DRS on its own could cost somewhere in the region of £700 million per annum. With an assumed 90% return rate, the costs are distributed across producers, in the form of a 0.7p administration fee on each container placed on the market, and consumers, to the extent that they choose to forego the possible income from the deposit. Most of the administration fee would be expected to be passed onto consumers, though even if the producers decided to pass 100% of this cost, there would probably be very little change in terms of volume of sales given that the additional cost per unit is relatively low, and the demand elasticity is not especially high.

In the parallel scenario, we assumed a return rate at 10% less than in the complementary scenario, with the rationale being that convenience would prevail if the kerbside system was still in operation. Due to the value of the deposit, significant revenue was thus generated from lost or 'unclaimed' deposits which, combined with slightly lower overall DRS costs, generated revenue from unclaimed deposits which exceeds the cost of the DRS.

Given the size of the deposits (relative to the revenue from material sales), however, the return rate would be likely to converge on that of the complementary system, be it due to individuals or the local authority itself extracting containers from the kerbside collections in order to redeem the deposit. Consequently, the costs falling on producers might move closer to those suggested under the complementary system, with local authorities / waste companies realising some of the value of the unclaimed deposits foregone by consumers.

Since both systems could be considered feasible systems for the UK, then given that the operational costs are similar between the parallel and complementary scenarios, and they are likely to converge in any case, it seems sensible to allow householders to continue to use existing kerbside collection systems if they so desire.

Importantly, we also included the resultant savings that would be achieved in other waste management routes, particularly at the kerbside, as a result of the introduction of a DRS. The removal of containers altogether from the kerbside collection system, and a slight reduction in containers at bring sites, HWRCs, in street sweepings and from on-the-go recycling results in a saving of around £159 million per year for local authorities in avoided waste management costs. This is a saving of around £7 per household per annum. The additional producer administration fee costs for the DRS are more or less offset by the savings derived from other waste management routes. In effect, the overall cost is shifted specifically onto producers and consumers rather than the population as a whole.

We also examined the environmental impacts associated with the introduction of a DRS, taking into account the positive impacts associated with increased recycling and reduced disposal of beverage containers, and the negative impacts associated with increased transportation required by consumers in returning containers to collection points, and in the collection and transport of containers from the retail outlet to the counting centres and beyond. The overall balance of environmental impacts associated with the introduction of a DRS is a benefit of around £69 million. The additional recycling from the introduction of a DRS could save up to 607 kt CO_2 equivalent per annum, which would also significantly help achieve the abatement required under statutory GHG targets, set out by the Committee on Climate Change.[100]

Finally, we have also taken the first steps towards trying to ascertain the potential environmental disamenity associated with litter in the environment, and the potential financial benefit that consequently results from a reduction in beverage containers present in the environment due to the deposit refund policy. We reasoned that this benefit could be somewhere in the region of £1.2 billion per annum.

[100] This is particularly significant since our baseline assumes that kerbside collection systems of a relatively high quality exist for all households at the time the DRS is introduced.

We also attempted to construct the one-off costs that would be associated with the set-up of a DRS in the UK. Based on the modelling, a total cost of £32 million would be required to set up the central DRS, plus an additional £1.25 million for the producers to change their labelling, and an additional £51 million for the retailers to adapt their store areas to accommodate the new system requirements. These one-off costs are certainly not insignificant amounts; however, given the large number of producers and retailers involved in the UK market, it should be possible to split the costs sensibly in order to ensure that the subsequent joining fees are both reasonable and manageable for both producers and retailers.

The combined overall cost benefit analysis indicates that, even with the additional costs incurred in the running of the DRS, there is a high likelihood of a significant net benefit to society. The influence of the reduction in disamenity associated with litter appears to be particularly strong. Although there is some uncertainty regarding the magnitude of this, the suggestion is that if households experience a level of disamenity of the order £16 or so for the removal of 80% or so of beverage related litter, then the system makes sense from the perspective of society.

To conclude, the modelling indicates that the introduction of a DRS in the UK is:

a) **Likely to cost around £84 million per annum to set up if well designed;**

b) **Likely to cost around £700 million per annum to run (net of revenues);**

c) **Unlikely to introduce very significant costs to producers. Even at 90% return rates, in our modelling, the unclaimed deposits fund around 70% of system costs;**

d) **Likely to generate savings to local authorities (and hence, to reduce the burden of taxation) by around £160 million;**

e) **Likely to deliver strong environmental benefits in terms of:**

   i. **reduced greenhouse gas emissions and air pollutants, mainly from increased recycling, in the region of £69 million; and**

   ii. **additional benefits associated with the reduction in the disamenity associated with litter, potentially in the region of £1.2 billion.**

Therefore, the case for the introduction of a DRS appears fairly compelling. Even where we use Monte Carlo analysis to vary the benefits associated with reduced litter (with the reduced disamenity varying between £10 and £50 per household on a random basis), the likelihood of net benefits accruing is 86%. This may be conservative given that our central estimate for disamenity is of the order £48 per household per year.

With this in mind, a number of key recommendations have been developed for UK policy makers. These are presented below.

A DRS can arise as a consequence of a decision to implement a mandatory scheme, or as a response, from industry, to high recycling targets. Defra has argued (albeit, we suggest, on limited evidence) that there are alternative schemes which can achieve the same outcomes as DRSs at a lower cost. The evidence in support of this view is thin, with only Belgium achieving recycling rates approaching the levels achieved in DRSs (and then, not for PET bottles, for example). Belgium has a producer responsibility scheme in place which is fully funded by obligated industry. It also sets targets well above those prevailing in the UK at present, and also has near-universal implementation of so-called pay as you throw schemes at the household level, a policy which the Coalition Government has clearly set itself against. Finally, it is not clear how levels of beverage container litter compare between, for example, Belgium and those countries where DRSs generate high return rates.

Recommendation 1: The UK Government should introduce a deposit refund system

Even if other systems could meet the recycling rates achieved by DRSs, there is scant evidence that they can achieve the same benefits in respect of litter reduction. The environmental benefits associated with litter reduction are dominant in this analysis. Therefore, it is clear the Government must consider a DRS from the perspective of achieving high return rates for recyclable beverage containers, and significantly addressing beverage container litter.

The research carried out in this report suggests a DRS can:

- Increase recycling rates of beverage containers through rewarding returns;
- Reduce litter by generating an incentive to 'not throw' away';
- Generate environmental gains both in terms of reduced litter and reduced GHG emissions

In addition, a DRS is a significant mechanism which can be used to deal with beverage containers (and other packaging) which will reduce the costs to central government, local authorities and taxpayers of dealing with packaging. This is a particularly relevant factor in the current economic climate.

DRSs are not always mandatory. They can arise from the setting of high targets for producers to meet, with DRSs becoming the means to meet those targets. There are, however, difficulties to be overcome in setting litter reduction targets, hence our recommendation in favour of a DRS. Even so, in order to ensure that the DRS is established with convenient infrastructure for returns, it makes sense to set targets for recycling of beverage containers.

Recommendation 2: High targets should be set for the recycling of all beverage containers, irrespective of material type

Targets are a pre-requisite for a well-functioning DRS since, in their absence, schemes may be designed which are inconvenient, deliver low recycling rates, and lead to high levels of unclaimed deposits, which may even become a source of revenue.[101] We also note that these targets should apply even to materials and container types which are not so easily included as part of a DRS, to prevent producers switching between container types which are, and are not, subject to targets.

Our study has suggested rates of deposit expected to generate return rates in the order of 90%. We suggest, therefore, a target rate of 85%, in the first instance, is set for the targeted beverage containers. Sanctions should be considered in the event of non-compliance.

In principle, were a DRS to be introduced, whether of mandatory nature, or in response to the existence of targets, we would recommend the following:

Recommendation 3: A central system should be established to administrate the deposit refund system.

We would recommend one central system, potentially owned by various stakeholders, such as industry groups, NGOs and retailers, which would operate to meet the recycling targets specified by the Government and administrate the DRS (see Recommendations 1 and 2). This is a similar system to the Scandinavian approach. The exact nature of the central system would probably reflect the way in which the DRS emerges (mandatory, or more voluntary in nature), with discussions to be had about the amount of outsourcing of various functions that would need to be undertaken.

Recommendation 4: PET bottles, glass bottles and aluminium and steel cans should be covered by a UK-wide deposit refund system.

We recommend that the following beverage containers should be covered within a UK-wide DRS:

- **PET bottles**
- **Glass bottles**
- **Aluminium and steel cans**

The option to include other plastic bottles should also be considered. The decision to include beverage cartons, in light of technological developments being made, should also be considered prior to full implementation of the scheme. In any case, as suggested above, such containers should also be made the subject of high recycling targets.

[101] Although in this case, it seems likely that consumers would 'internalise' lost deposits in the price of the beverage, more so than where the deposit can easily be recouped. This might, in turn, depress demand for the beverage itself.

In order to meet the targets mentioned above (see Recommendation 2), we would suggest that the level of the deposit (ultimately to be determined by the central system) should be in the region of:

- 15p for containers ≤500ml; and
- 30p for containers >500ml.

These are the average values used in our modelling – it is recognised that schemes may differentiate these by material.

Recommendation 5: In order to deal effectively with imported beverage containers, the deposit refund scheme should operate in parallel with kerbside recycling services and/or the deposit refund scheme should be designed to accept containers from France and Ireland.

A large volume of containers crosses the border with France, and to some extent the Republic of Ireland, as a result of private trade in alcoholic beverages. Neither country has a deposit system.

We have examined both 'parallel' and 'complementary' systems in this report, with a parallel scheme running alongside existing kerbside collections and a complementary scheme replacing the provision for recycling certain materials at the kerbside. We have noted that a parallel DRS may increase unclaimed deposits, but that we expect matters to converge, with some extraction of deposit-bearing containers from the kerbside recycling system. Given the minimal effect on financial flows other than the unclaimed deposits, we think it would make sense to still operate the kerbside recycling service. This enables those consumers who import beverage containers which bear no deposit to still recycle their containers.

An alternative approach would be to design the system to accept containers with European Article Number (EAN) codes from France and the Republic of Ireland to overcome the problem. This would allow reverse vending machines to accept containers which bear no deposit. Clearly, in these cases, no deposit would be redeemed, but it seems important for the system to accept containers from abroad, to ensure consumer confidence is not lost (and especially if the existence of the DRS leads some local authorities to cease collecting the targeted beverages over the medium- to long-term).

Recommendation 6: A timescale of introducing a deposit refund scheme by 2015 should be considered.

Whether in setting recycling targets, or in the context of introducing a mandatory scheme, UK Government should consider the time scales for the implementation of a DRS. Four to five years appears to be an appropriate time to allow for infrastructure development and communication with all stakeholders. In addition, this would allow for some transitional issues to be considered. For example, local authorities' collection schemes will be affected by the implementation of a DRS. In order to realise the financial benefits to authorities from the DRS's operation, time to consider contractual positions and service design would appear appropriate.

Recommendation 7: Further research into the disamenity of litter should be commissioned by the Coalition Government.

The Coalition Government has set its sights on reducing litter, yet there is no UK-based study, to our knowledge, that allows us to estimate the negative effects – the disamenity – of litter. The costs of litter and street cleaning are now a major part of local authorities' waste management budgets. They also appear to be costs which are spent in seeking to address an environmental issue which is consistently cited by residents as being a priority. There is a need for more research to be undertaken regarding the disamenity associated with littering, in order to strengthen the evidence base for estimating the impacts upon litter of a DRS in the UK. Indeed, given the Coalition Government's determination to address litter, it would seem appropriate to consider the economic benefits which might be derived from the clean-up of litter, if only to understand the level of resource which should be committed to addressing the matter.

APPENDICES

A.1.0 Review of Deposit Refund Systems

Table 7-1: Experience with Deposit Refund Schemes in Other Countries / States

Country	System	Year of Intro	Containers Covered	Capture Rate*	Deposit	Redemption Site	Driver	Reference
Austria	Law to make deposit regulatory	1992	PET bottles (non-refillables excluded)	30% PET 60% Cans	$0.40		Government	www.BottleBill.org
Belgium Ecotaxes Act of 1993	Containers taxed $0.52 per litre unless they have deposit.	1993	Beer, soda and soft drinks containers		$0.12 <50 cl $0.24 >50 cl		Government	www.BottleBill.org
Croatia	Deposit-return plus 'incentive fee' to be paid by producer if 50% refill isn't met (5% paid still, if target is met).	2005	Glass, PET and metal containers for beer, soft drinks, water, wine and spirits.				Government	EUROPEN Report 2007[102]
Denmark	Packaging Law. All beer and soft drinks must be sold in refillable bottles. Metal banned until 2002. Regulatory deposit for imported glass/plastic containers. Ecotax also.	1989 (amended 1991)	Beer and soft drinks containers. Deposits on some wine and spirit bottles dependent on retailer.	99.5 % (beer and soft drinks containers only)	€0.13 Type A – Cans, plastic and glass bottles <0.5 l €0.20 Type B – Plastic bottles @0.5 l €0.40 Type C – Cans, plastic and glass bottles >0.5 l		Government	www.BottleBill.org Ernst & Young 2009[103]
Estonia	Deposit-return	2004	Beer, low alcohol drinks, carbonated/ non-carbonated soft drinks, water, juice, cider and perry.		Glass 1.0 kroon (refill and NRB) Metal and PET < 0.5 l 0.5 kroons; PET>0.5l 1kroon	Retailers	Government	EUROPEN Report 2007; http://www.eestipandipakend.ee/eng/epp/emblem
Finland	Tax on beverage containers Exemption from tax only if	1970s (amended	One-way beer and soft drink containers	Glass bottles 99%	Non-refillables: €0.15 cans	8,000 sites	Government	http://www.palpa.fi/retail-

[102] EUROPEN (2007) *Economic Instruments in Packaging and Packaging Waste Policy*, Brussels: EUROPEN.

[103] 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.

Country	System	Year of Intro	Containers Covered	Capture Rate*	Deposit	Redemption Site	Driver	Reference
	part of refillable deposit scheme.	1990)		Cans 86%	€0.10 plastic bottles <0.35 l €0.20 plastic bottles 0.35-1 l €0.40 plastic bottles >1 l Tax $0.24 beer $0.47 plastic $0.71 glass			trade/recycling-systems
Germany	Einwegpfand Deposit on one-way a standard amount, deposit on refillables manufacturer dependent, not legally specified, though tend to be similar.	2003	Not containers for wine, fruit juice or spirits	Quota- Glass 90% Alu. 90% Plastic 80%	For one-way: ≤1.5 l €0.25 >1.5 l €0.50		Manufacturer	
Hungary	Tax linked to market share quotas.	2005	Beer, low-alcohol drinks, wine, mineral water, carbonated and non-carbonated soft drinks.	Quota- Beer 67% Low alcohol 28% Wine 20%				
Iceland	Tax on non-refillable containers.	2008	Non-refillable glass, steel, aluminium and plastic.					
Kiribati	Special Fund Act 2004	2004	Aluminium cans and PET drinks bottles		$0.05 ($0.04 returned)	Kaoki Mange operating centres.		www.BottleBill.org
Malta Deposit Return System	Previous ban of non-glass beverage containers, lifted							
Mexico	Higher tax on non-refillable bottles and cans.							
Fed. States of Micronesia Kosrae Recycling Program	(Deposit-return)	1991 (amended 2006)	Currently only aluminium cans, but glass and plastic expected to be added soon.	20,000 cans per day	$0.06 ($0.05 back)	Kosrae Island Resource Management Authority (KIRMA) sites		www.BottleBill.org
Netherlands	Agreement deposit	1993	Soft drinks and water in one-way and refillable glass and PET containers	Refillable glass 98% Refillable	PET and glass: $0.16 <0.5 l $0.72>0.5 l		Industry	www.BottleBill.org

Country	System	Year of Intro	Containers Covered	Capture Rate*	Deposit	Redemption Site	Driver	Reference
				PET 99%				
Norway	Deposit on containers and tax dependent on return rate. Refillables only exempt if 95% return rate is achieved. Retailers (on site >25m²) selling non-refillables, must also sell similar products in refillable.	1994	Most drinks excluding milk, vegetable juices and water	Wine/ spirits 60% Beer 98% Soft drinks 98%	$0.16 <0.5 l $0.40 >0.5 l (+Tax inversely proportional to return rate, but if above 95%, no tax)	Over 9000 establishments in the country, plus 3000 deposit machines where receipt is given	Tax is government driven, but recycling fee in place is retailer driven	http://www.resirk.no/Introduction-64.aspx
Peru	Deposit on some bottles		620ml size beer bottles					
Portugal	Fillers must ensure quotas met Retailers must sell refillables for all non-refillables sold.		Quotas- Beer 80% Wine (with certain exceptions) 65% Soft drinks 30%					
South Africa	Deposit return system, voluntary i.e. manufacturer driven, not Government.	Around 1948	Approx. 75% beer, 45% soft drinks and some wine and spirits bottles		Between 8-15% of product cost (or 0.5-1% if wine/spirit)		Manufacturer	
Spain				Return overall 87% Reuse beer 57%				http://www.cerveceros.org/
Sweden	Law requires rate of 90% recycling of aluminium cans, or complete ban. Industry implemented deposit system to avoid this. PET introduced later as well. deposit	Deposit on one-way containers- 1984 for cans. 1994 for PET (refillables already in place)	Aluminium cans and PET law. Deposit now on most beverage containers.	Recovery rate of 80-90% on one way containers	Voluntary Cans $0.07 Refillable PET $0.56 One-way PET $0.14-0.24		Law government driven. Standard bottle and deposit brewer/bottler driven.	www.BottleBill.org; Ernst & Young (2009)[103]
Switzerland	Deposits required on all refillable drinks containers except cans, which have a voluntary tax of $0.04.	1990	All above a certain weight (currently all!)	Refillable glass 95-98% Refillable PET 70%	Ref. glass $0.16<0.6 l $0.40 >0.6 l Ref and one-way PET $0.40>1.5 l		Government	www.BottleBill.org

Country	System	Year of Intro	Containers Covered	Capture Rate*	Deposit	Redemption Site	Driver	Reference
South Australia	Container Deposit Legislation- deposit required on almost all drinks containers, with onus on manufacturer/ wholesaler to ensure convenient system in place for deposit of container/ refunds for customers.	1975 (integrated into Environment Protection Act in 1993)	Most included except wine (unless in plastic bottle), milk, pure fruit juice or flavoured milk >1l.	85% non-refillable glass 84% cans 74% PET	$0.10 if refillable to retailer (rare) $0.05 if refillable to collection depot (99.9% done this way)	Mostly collection depots, though some store refillables.	Government legislation with manufacturer/ wholesaler responsibility	www.BottleBill.org
Canada- Alberta	All containers sold in Alberta (including imports) must be registered through the Beverage Container Management Board (BCMB).	1972	All beverage containers regulatory except milk, which is under a voluntary scheme	Glass (AB Beer) 96% Glass (import beer) 92% Alu (beer) 89% Alu (soft) 79% Overall 78%	$0.05 <1 l $0.20 >1 l Beer $0.10	215 independent depots and 78 retail outlets (for beer bottles and cans only)	Initially government, until 1997 when it was turned over to private sector	www.BottleBill.org
Canada- British Columbia	All containers must be refillable, and none collected can be landfilled or incinerated. Beer separate system, though still under legislation.	1970	All beverage containers except milk, soya milk, infant formulas, dietary or meal supplements, or other milk substitutes.	81.3%	Non-alcoholic $0.05 <1 l $0.10> 1 l Alcoholic (not incl. beer) $0.10 < 1 l $0.20 >1 l Beer $1.2 per dozen	Depots or retailers (all retailers obliged to take back as much as they sell). Beer back to retailer.	Industry	www.BottleBill.org
Canada- Manitoba	Beverage producers given option of setting up deposit-return system, or adding a 2 cent per container levy. Only beer producers choose the former.	1995	Beer containers only	Refillable beer 95.5% Dom beer 74% Glass 34% Overall residential 31%	$0.10	Retailer	Opportunity government driven, implementation producer driven	www.BottleBill.org
Canada- New Brunswick	Deposits paid on all containers (bar milk), but	1992 (revised	All except milk	Refillable beer 96%	<0.5 l $0.10 >0.5 l $0.20	89 depots around the	Industry	www.BottleBill.org; Encorp Atlantic

Country	System	Year of Intro	Containers Covered	Capture Rate*	Deposit	Redemption Site	Driver	Reference
	whilst full paid back on refillables, only half paid back on non-refillables.	1999)		Dom beer 75% Non-alcoholic 75%		province.		Inc (unpublished)[104]
Canada- Newfoundland	Half-back system, with manufacturers prohibited from selling containers other than recyclable or refillable for selected products. Beer operated separately, run by brewers. Only have to refund when customer buying (1 for 1), otherwise negotiable.	1997	Beverage containers smaller than 5l, excluding milk, dietary supplements and medicine.	Refillable beer 95% Domestic beer 55%	Non-alcoholic $0.08 ($0.04 back) Alcoholic (excluding beer) $0.20 ($0.10 back) Beer varies -full refund when same number of beer bought as empties returned.	'Green Depots' run as businesses. Beer returned to certain retail outlets.	Government, but brewers for beer system.	www.BottleBill.org
Canada- Northwest Territory	Deposit-return system, with additional handling charges for different products/ materials in container.	2005	All beverage containers except milk.	Very new system, so no certain figures yet. Approx. 72%	Wine or spirit $0.25 Other $0.10 Plus additional $0.05-0.10 handling fee	18 government depots or 26 community depots.		www.BottleBill.org
Canada- Nova Scotia	Half-back deposit system. Full refund on refillables, half on non-refillables.		All beverage containers except milk.	Refillable beer 96% Dom. beer 70%	Non-alcoholic $0.10 Alc. refillable <1 l $0.10 >1 l $0.20 Alc. non-refillable <0.5 l $0.10 >0.5 l $0.20	83 province-wide depots.	RRFB-Resource Recovery Fund Board Government and industry.	www.BottleBill.org
Canada- Ontario	Deposit-return system on alcoholic drinks containers only. Use of 'Industry Standard Bottle'.		Alcoholic drinks containers	Refillable 'industry standard bottles' beer 97%	Containers up to 630 ml, or metal containers up to 1 l $0.10 Over those sizes $0.20	Beer store only	Brewers	www.BottleBill.org
Canada- Prince Edward Island	Non-refillable drinks containers for beer or soft drinks banned since 1977.	1977 ban, 1984 deposit	Soft drinks and alcoholic drinks. Wine may be included.	Refillable beer 96% Wine/ spirit	Non-al <0.5 l $0.15 0.5 l-1 l $0.30	Mainly retailers (inc. supermarkets		www.BottleBill.org

[104] ENCORP Atlantic Ltd (*unpublished*), *Accounting for Success: EnSys – A Materials Management System to Support the Recovery of Used Beverage Containers in the Province of New Brunswick*, May 2008.

Country	System	Year of Intro	Containers Covered	Capture Rate*	Deposit	Redemption Site	Driver	Reference
	Wine may have half-back system in place.			59% Soft 98%	>1 l $0.70 Alc. $1.20 per dozen, or).07 each	and convenience stores), also 15 depots		
Canada- Quebec	Return-to-retail deposit system, with industry required to fund kerbside collection for containers not part of the system.		All beer and soft drinks containers (not juice, water and iced tea)	Refillable beer 98% Dom. beer 76%	Soft drinks and beer cans $0.05 Beer bottles $0.10 Beer bottles and soft drinks >450ml $0.20	Retailers (including depanneurs - small convenience stores not usually included in Canada).		www.BottleBill.org
Canada-Saskatchewan	Deposit-return system plus environmental handling charge (EHC) for non-refillable containers, for recycling, and beer bottle deposit system for refillables.	1973- Litter Control Regulations (unclear, appears the deposit system introduced to this in 1998)	All beverage containers apart from milk (under voluntary system).	Refillable beer 92% Dom. beer cans 95% Alu. cans 95% Glass 83% Overall 86%	Deposits vary widely for diff. materials and sizes Non-ref. glass $0.40-1.00 Metal cans $0.10-0.20	Beer bottles can only receive full refund if returned to 10 specific sites, but can be returned for less at retailers. Other returns at 71 SARCON site	Government	www.BottleBill.org http://www.sarcsarcan.ca/sarcan/faqs.php
Canada-Yukon	No kerbside collection. Deposit-return system, with 'recycling club' for children offering 'prizes' as well as refund if certain numbers reached. Refillables not charged recycling fund fee, all others are.	1998	All beverage containers except milk.	Refillable bottles 103% Non-refill. bottles 113% (?) Liquor containers <200ml 99% 1L 90% >1L 79% (includes refillables)	D=deposit, R=refund Liquor ref. D=$0.10 R=$0.10 Liquor non <0.5 l D=$0.15 R=$0.10 >0.5 l D=$0.35 R=$0.25	22 depots or four Liquor Commission outlets	Government	www.BottleBill.org
USA-California	California Beverage Container Recycling and Litter Reduction Act	1987 (Expanded 2000 to	Non-refillable drinks containers, inc. beer, spirits, carbonated, fruit	Alu 73% Glass 58% PET 46%	Under 24oz $0.05 Over 24oz $0.10	Redemption centres (not retailers)		www.BottleBill.org

Country	System	Year of Intro	Containers Covered	Capture Rate*	Deposit	Redemption Site	Driver	Reference
	Deposit-return system on non-refillable containers	include all non-carbonated and non-alcoholic drinks excluding milk.)	drinks and some vegetable juices. Not milk.	HDPE 51% Overall 61%				
USA-Connecticut	Beverage Container Deposit and Redemption Law Deposit-return system.	1980	Beer, malt, soft drinks and mineral water.	Not recorded. In 2004 CRI estimated recycling rate to be similar to Massachusetts of 69%	$0.05	Redemption centres, or retailers (but only for brands /products they sell).		www.BottleBill.org http://www.cga.ct.gov/2005/rpt/2005-R-0836.htm
USA- Delaware	Beverage Container Legislation Deposit-return system	1982 Wholesale 1983 Retail	All non-aluminium beer, malt, carbonated, mineral water and soda water containers less than 2 quarts (approx. 1.9l).	Not recorded.	$0.05	Retail stores, but only for brands they sell.		www.BottleBill.org
USA-Hawaii	Deposit Beverage Container Law Deposit-return system	2002	All beverage containers excluding milk and dairy derived products, except tea and coffee or liquor containers.	72% for 2008	$0.05	Redemption centres or retailers (if not within 2miles of red. centre in highly pop. areas, or if under 5,000sq ft of retail space	Government	www.BottleBill.org
USA-Iowa	Beverage Container Deposit Law Deposit-return system. Deposit containers banned from landfill in 1990.	1979	Beer, soft drinks, soda water, mineral water, wine, liquor and wine coolers.	93%	Not less than $0.05	Redemption centres or retailers (who can refuse if they have an agreement with former).		www.BottleBill.org
USA- Maine	Refillable Beverage	1978	Beer, soft drink, wine	Not recorded.	Wine and liquor	Redemption		www.BottleBill.or

Country	System	Year of Intro	Containers Covered	Capture Rate*	Deposit	Redemption Site	Driver	Reference
Maine	Container Law Deposit-return system		cooler, mineral water. Expanded to include wine, liquor, water and non-alcoholic drinks in 1989.		$0.15 Other $0.05	centres or retailers (who can refuse if they have an agreement with former).		g
USA- Massachusetts	Beverage Container Recovery Law Deposit-return system	1983	Beer, soft drinks and carbonated water.	69%	$0.05	Any retail establishment that sells the container.		www.BottleBill.org
USA- Michigan	Michigan Beverage Container Act Deposit-return system	1978	Beer, soft drinks, carbonated and mineral water. Wine coolers and canned cocktails in 1988.	97%	$0.10	Retail stores		wwiw.BottleBill.org
USA- New York	New York State Refillable Container Law Deposit-return system	1983	Beer and other malt drinks, carbonated soft drinks, wine coolers, mineral and soda waters.	Soft drink 62% Beer 77% Wine coolers 65% Overall 70%	Minimum of $0.05	Retail stores and redemption centres.		www.BottleBill.org
USA- Oregon	The Beverage Container Act Deposit-return system Only US deposit law with no handling fee.	1972	Beer, malt, carbonated soft drinks, mineral and soda water and (as of 2009) water and flavoured water. Bottles and cans under 3L	Overall 84%	Standardized refill bottles $0.02 Non-standardized and non-refillable $0.05	Retail stores.		www.BottleBill.org
USA- Vermont	Beverage Container Law Deposit-return system	1973	Beer, soft drinks, malt, soda and mineral water, mixed wine and liquor (added 1987).	Overall 90-95%	Liquor above 50ml $0.15 Other $0.05	Retail stores and redemption centres.		www.BottleBill.org

Source: data based on report by Oakdene Hollins (2008) Refillable Glass Beverage Container Systems in the UK, Report for WRAP, 26 June 2008.

**The report notes that capture rate includes containers returned for recycling as well as refilling. Separate figures were not so readily available. Unless specifically listed as something else, the monetary unit is American dollars. The only exception is Canada where the Canadian dollar is used.*

Percentages given for US capture rates are taken from various sources, often telephone conversations by the Bottle Bill researchers. For more detailed references see www.BottleBill.org

A.2.0 Cost Benefit Analysis Model

The cost benefit analysis (CBA) model has been developed by Eunomia as a bespoke model that also utilises Eunomia's existing municipal waste collection model, Hermes.[105]

The overall structure of the model is given in Figure A-7-1.The key elements are:

1) A waste baseline for each of the key materials, which will include modelling of kerbside collection of household waste;
2) Scenario waste flow modelling;
3) Deposit refund (DR) system modelling;
4) Environmental impacts of recycling and disposal (including the disamenity of litter); and
5) 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 the UK.

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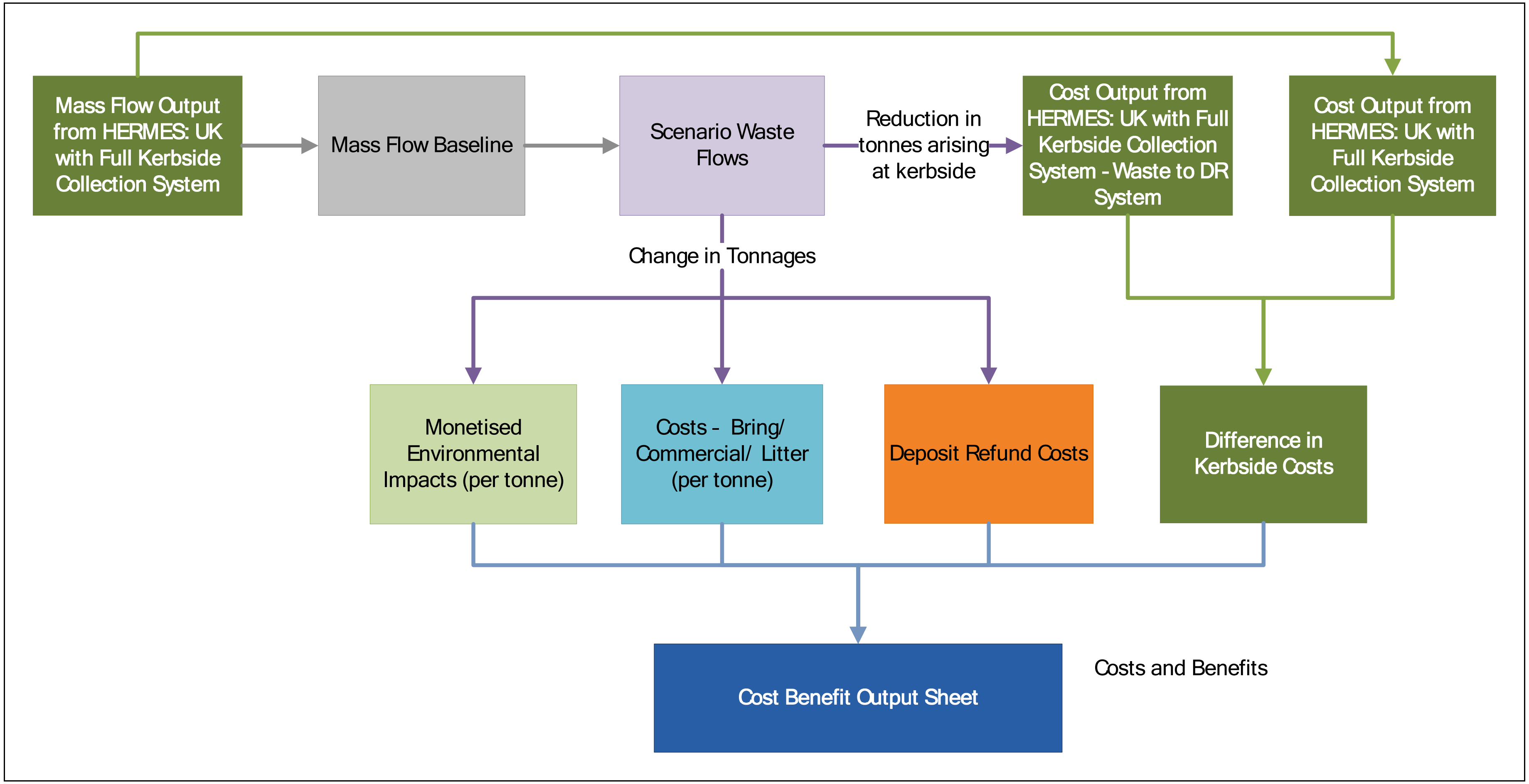
[105] Hermes has been used in projects for WRAP, Defra, Welsh Assembly Government, and by many local authorities around the UK. It has also been used in developing shadow bids in procurement processes for waste collection services.

Figure A-7-1: Cost Benefit Analysis Model Schematic



A.2.1 Materials to be Included in Deposit Refund System

The materials that we have included in the deposit refund system are one-way (non-refillable) beverage containers as follows:

1) Plastic bottles made from PET (Polyethylene Terepthalate) e.g. fizzy drinks, mineral water, squash bottles. The recycling symbol on these products is:

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, wine bottles, soft drink bottles etc.

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;[106]
- 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 high-density polyethylene (HDPE) in existing deposit refund systems.[107]

The modelled system targets non-refillable containers, because the market for refillables in the UK is much smaller than that for non-refillables, and 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. Some deposit refund systems (DRSs) do remain in the UK, but they are the exception rather than the rule, and target the smaller market of refillable glass bottles (e.g. A. G. Barr scheme in Scotland, milk rounds across the UK), rather than the growing market of disposable containers.[108] Targeting non-refillables exploits the potential

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

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

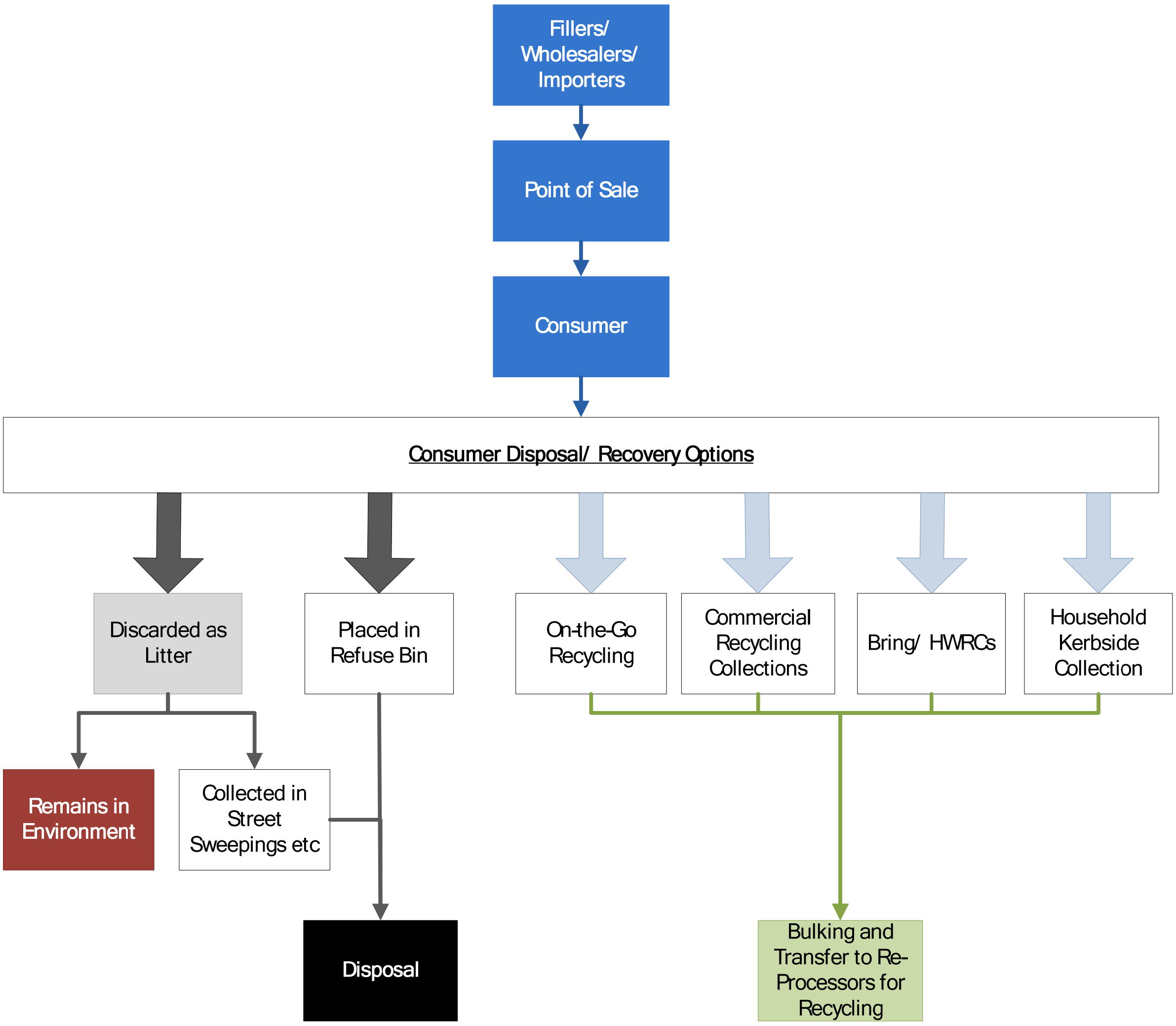
[108] See http://www.agbarr.co.uk/agbarr/newsite/ces_general.nsf/wpg/corporate_responsibility-courtauld_commitment_2!OpenDocument

for increased recycling rates, a reduction in litter levels and an increase in the quality of material that is collected for recycling through the deposit mechanism.

A.2.2 Baseline

The first step in building the cost benefit analysis model was to consider the material flows in the UK, where the waste arises and how much of the waste is sent for recycling compared to how much ends up requiring disposal. Figure A-7-2 indicates the possible material flows in our container universe (before the DR System).

Figure A-7-2: Possible Container Material Flows (Pre-DRS)



The second step was to consider which year to model as the baseline year. In this study we have assumed the baseline year is around 2015; the landfill tax escalator will have increased to £80 per tonne by 2014/15, and by this time, it is also likely that fully comprehensive kerbside collection services will have been rolled out to all households in the UK.[109] In order to provide direct comparison, the ensuing changes to the baseline as a result of the introduction of a deposit refund system have also been modelled based on the same year.

A.2.2.1 Household Kerbside Collection Modelling

Eunomia's proprietary waste collection model, Hermes, has been used to investigate the effect of implementing a deposit refund system in the UK on kerbside collection schemes. Hermes is a sophisticated spreadsheet-based tool that allows a wide range of authority specific and collection scheme specific variables to be modelled. The optimisation of these variables allows us to build scenarios to accurately reflect local circumstances. The main outputs of the model are recycling performance and cost.

Eunomia is confident that Hermes is as reliable a tool as any of its kind. It has been used to model systems for authorities that collectively manage around 25% of the UK's total municipal waste. It is used to support contract procurement advice and contract dispute resolution by building 'shadow' bids against which contractors' tender submissions can be tested. Hermes has also been used in the context of studies of relevance to national policy, and to undertake a cost benefit analysis for the kerbside collection of food waste across the UK.[110]

The first step in building up a model of UK-wide kerbside collection schemes was to develop a number of scenarios based on combinations of urban/rural classifications and dry recycling collection systems currently employed across the UK. Classification of local authorities across the United Kingdom into rural and urban varies from nation to nation. For England, Wales and Northern Ireland, we were able to obtain already-classified data on local authorities based on a broadly similar six-fold classification as follows:[111,112,113]

- Major Urban (districts with either 100,000 people or 50 percent of their population in urban areas with a population of more than 750,000).
- Large Urban (districts with either 50,000 people or 50 percent of their population in one of 17 urban areas with a population between 250,000 and 750,000).

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109 Fully comprehensive means a system that would collect all of the containers in scope in this study.

110 Eunomia (2007) *Dealing with Food Waste in the UK,* report for WRAP, March 2007

111 Defra (2008) Classification of Local Authority Districts and Unitary Authorities in England: An Introductory Guide, Updated September 2008 http://www.defra.gov.uk/evidence/statistics/rural/documents/rural-defn/LAClassifications-introguide.pdf

112 ONS (2005) *Rural and Urban Area Definition for Middle Layer Super Output Areas*, available at http://www.ons.gov.uk/about-statistics/geography/products/area-classifications/rural-urban-definition-and-la-classification/rural-urban-definition/index.html

113 NISRA (2005) *Urban Rural Classification 2005*, provided by NINIS, May 2010

- Other Urban (districts with fewer than 37,000 people or less than 26 percent of their population in rural settlements and larger market towns).
- Significant Rural (districts with more than 37,000 people or more than 26 percent of their population in rural settlements and larger market towns).
- Rural-50 (districts with at least 50 percent but less than 80 percent of their population in rural settlements and larger market towns).
- Rural-80 (districts with at least 80 percent of their population in rural settlements and larger market towns).

For Scotland, the data available was not already classified on an overall local authority basis; data was, however, available on the percentage of the population in each local authority that can be found in each of six different urban/rural categories given above.[114] We therefore used these percentages to classify each authority into one of the six listed categories.

These classifications were then grouped to create a three-fold classification for all authorities:

- Urban (Major Urban and Large Urban);
- Towns (Other Urban and Significant Rural); and
- Rural (Rural-50 and Rural-80).

In addition to the urban/rural classification, the number of households in each district and the recycling collection scheme were collated for each district in the UK. The dry recycling kerbside collection schemes were categorised into three types as follows:

- Fortnightly single stream commingled (where the material is collected unsorted and subsequently sorted at a Materials Recovery Facility (MRF)), referred to as 'Commingled';
- Fortnightly two-stream (residents are asked to separate material into two different collection containers, typically fibres in one (i.e. paper, card) and containers in the other (i.e. cans, plastics, sometimes glass), with some subsequent further separation required at a MRF), referred to as 'Two-stream';
- Weekly sorting of materials at the kerbside, referred to as 'Kerbside Sort'.

Alongside each of the dry recycling schemes, we modelled fortnightly residual waste collections and weekly food waste collections (with the latter modelled as a being collected on a separate vehicle for the commingled and two-stream systems, and as being collected at the same time as the dry recyclables on the same vehicle in the kerbside sort system). Garden waste collections were excluded from the analysis, given that garden waste is typically collected in a separate pass and that the

[114] Scottish Executive (2004) *Urban Rural Classification 2003-2004*, available at http://www.scotland.gov.uk/Resource/Doc/47251/0028898.pdf

logistics for this waste stream would not subsequently be affected by any change in beverage containers in the kerbside system.

This data was based primarily on our extensive knowledge of kerbside systems across the United Kingdom, with any missing information provided by the Online Recycling Information System (ORIS) sourced from WRAP.[115]

The three rural/urban classifications were combined with the three collection systems to create nine baseline categories. A summary of the number of authorities in each of the nine categories, the average number of households and the average population are provided in Table A-2, Table A-3 and Table A-4 respectively.

For the purposes of modelling in Hermes, the overall averages given in Table A-3 and Table A-4 for the number of households and population were subsequently used for the basic configuration of the three "districts" to be modelled, named Urban, Towns and Rural. For each of these three districts, the three collection systems were then modelled separately.

Table A-2: Number of Authorities in Our Nine Categories.

	Urban	Towns	Rural	Total
Commingled	60	48	47	**155**
Kerbside Sort	61	58	63	**182**
Two-Stream	29	23	14	**66**
Total	**150**	**129**	**124**	**403**

Table A-3: Average Number of Households in Each Authority for Each Category, Rounded for Use in Modelling.

	Urban	Towns	Rural	Overall Average
Commingled	91,200	51,600	50,300	**66,600**
Kerbside Sort	79,500	51,800	46,900	**59,400**
Two-Stream	105,700	66,800	49,700	**80,200**
Overall Average	**89,300**	**54,400**	**48,500**	

[115] WRAP (2010) Recycling Information, Accessed May 2010. http://www.wrap.org.uk/local_authorities/research_guidance/online_recycling_information_system_oris/mapping.html

Table A-4: Average Population in Each Authority for Each Category, Rounded for Use in Modelling.

	Urban	Towns	Rural	Overall Average
Commingled	179,000	121,000	110,000	**138,000**
Kerbside Sort	185,000	115,000	113,000	**136,000**
Two-Stream	247,000	151,000	109,000	**182,000**
Overall Average	**195,000**	**123,000**	**111,000**	

One of the most important inputs to the kerbside modelling is the quantity of material collected for recycling. For this model, the tonnages were based upon the WRAP report on kerbside recycling performance in England.[116] This report gives recycling in kg per household per year for the six-fold rural/urban classification above, as well as for the different recycling systems. The results for the six rural/urban classifications were averaged in pairs to create three classifications.

The results printed in blue in Table A-5, Table A-6 and Table A-7 are the upper quartile data for captures of the three materials (cans, glass and plastics) which would be covered by the deposit refund system. We used the upper quartile because we assume that recycling systems in 2015 would be performing better than the median in 2007/8. Using a mathematical analysis technique (least squares method), we were able to calculate the tonnage data for the nine scenarios given in each table based on the data provided by WRAP.

Table A-5: Cans Dry Recycling Performance in kg/hhld/yr Calculated using Least Squares from WRAP Kerbside Recycling Performance Data

	Urban	Towns	Rural	WRAP Data
Commingled	9.2	9.9	10.4	10
Kerbside Sort	12.2	12.8	13.4	13
Two-Stream	10.3	9.7	9.7	10
WRAP data	10.5	11	11.5	

[116] WRAP in association with Icaro Consulting (2009) Analysis of kerbside dry recycling performance in England 2007/8, Summary report for WRAP, December 2009

Table A-6: Glass Dry Recycling Performance in kg/hhld/yr Calculated using Least Squares from WRAP Kerbside Recycling Performance Data

	Urban	Towns	Rural	WRAP data
Commingled	49.4	53.2	58.4	54
Kerbside Sort	42.3	57.3	63.4	58
Two-Stream	45.5	43.6	45.1	45
WRAP Data	49.5	53	58	

Table A-7: Plastic Dry Recycling Performance in kg/hhld/yr Calculated using Least Squares from WRAP Kerbside Recycling Performance Data

	Urban	Towns	Rural	WRAP data
Commingled	11.8	12.2	12.2	12
Kerbside Sort	10.4	11.4	11.4	11
Two-Stream	10.4	9.9	9.7	10
WRAP Data	11	11.5	11.5	

In addition the model also accounts for the tonnages of paper, card and food waste being collected in the kerbside recycling systems; these were kept constant throughout all modelling and therefore do not affect the results, but were simply used to calibrate baseline performance based on known authorities.

In order to then drill down further into the actual tonnages of material that would feed into the deposit refund model, we made the following additional assumptions (in % by weight). These were based around detailed household compositions and our knowledge of operational collection systems; furthermore they were validated when outputs were sense checked against existing sources of packaging waste generation and recycling, and found to be comparable:

- 75% of glass captured is beverage (as opposed to other) container glass;
- 50% of the plastic captured at the kerbside (mainly comprised of bottles) is PET, with 50% being HDPE;
- 20% of cans are aluminium, most of which are beverage containers;
- 80% of cans are ferrous metals, with 30% of these being beverage containers. The remaining ferrous cans being food containers, etc.

The total quantity of waste left in the residual stream is calculated as:

Waste in Refuse = Total Waste Collected at Kerbside – Waste Captured for

Other important assumptions for the Hermes modelling were the participation rate (the percentage of households that participate in the recycling scheme at least once every two weeks) and the set-out rate (the percentage of households that set out a box in any given week, which will be less than the participation rate because not everyone is setting out recyclables at every opportunity). For consistency across all three types of collection scheme, both of these values were kept constant for all options modelled, and were set at high-performing values of 85% and 72% respectively for the dry recycling, and 100% and 90% for residual waste collection. However, in reality, the set out and participation rates would be likely to be closer for fortnightly commingled collections than for weekly kerbside sort.

A.2.2.2 Bring Sites / Household Waste Recycling Centres (HWRCs)

WasteDataFlow (WDF) was interrogated and data for all waste collection authorities (WCAs) and Unitary authorities was compiled for the whole of the UK. The relevant questions in WDF are:

> **Question 16:** Civic Amenity (CA) sites: Tonnes of material collected for recycling/reuse at CA Sites operated by local authority or its contractors
>
> **Question 17:** Bring sites: Tonnes of material collected for recycling/reuse at bring sites operated by local authority or its contractors

The following assumptions, based upon the rationale described above, were required to estimate the quantities of beverage containers currently being recycled through these sources:

- All of ‘brown glass’ is beverage containers;
- All of ‘green glass’ is beverage containers;
- 35% of ‘clear glass’ is beverage containers (the remaining 65% is jars and a small quantity of other clear glass such as broken pint glasses);
- 75% of ‘mixed glass’ is beverage containers;
- 50% of Plastics are PET beverage containers;
- 80% of mixed cans are ferrous metals / 20% are aluminium; and
- Commingled materials are disaggregated using the proportions of source segregated materials captured for recycling.

See Table A-9 for estimates of the tonnages of beverage containers from bring sites and HWRCs.

A.2.2.3 Commercial Wastes

The definition of commercial 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.

Estimates of the total quantity of glass, dense plastics and metals in the commercial waste stream for recycling or requiring disposal were taken from the recent landfill bans cost benefit analysis.[117] Assumptions were then made to estimate the proportion of beverage containers in each waste fraction, e.g. glass bottles in 'glass.' These estimates were then adjusted where required to ensure that a reasonable and logical baseline was achieved.

See Table A-9 for estimates of the tonnages of beverage containers from businesses.

A.2.2.4 On-the-Go Recycling and Street Sweepings

WasteDataFlow was interrogated and data for all waste collection authorities (WCAs) and Unitary authorities for on-the-go recycling was compiled for the whole of the UK. The relevant question in WDF is:

> **Question 34:** Street recycling: Tonnes of material collected for recycling at street recycling bins.

It should be noted that a caveat is included with the tonnages reported in WDF for street recycling. There appeared to be large variations in the data reported between authorities. Upon investigation, it was determined that the reporting of waste collected in on-street recycling bins is not rigorous, and there are improvements to be made in this area of reporting.

The same assumptions used for bring sites and HWRCs to estimate the quantity of beverage containers captured for recycling (Appendix A.2.2.2) were also applied to the tonnages reported for on-the-go recycling.

WDF was also interrogated to gather information on the total quantity of waste collected from street sweepings for disposal (ie. litter that is collected from the environment for disposal, at the expense of the taxpayer). This far outstrips the total quantity of waste collected through on-the-go recycling bins. The relevant question is given below:

> **Question 23:** Details of other wastes collected for disposal (residual waste not collected for recycling) - *Collected household waste: Street Cleaning*

The total quantity of street sweepings collected for disposal was disaggregated, on a material basis, using the composition obtained by AEA Technology from the Welsh

[117] Eunomia (2010) *Landfill Bans Feasibility Research*, Final Report for WRAP, March 2010, http://www.wrap.org.uk/downloads/FINAL_Landfill_Bans_Feasibility_Research.f5cf24f9.8796.pdf

Assembly Government study.[118] Additional assumptions were required to estimate the likely quantities of beverage containers in each waste fraction. These assumptions are as follows:

- 75% of the 'Packaging glass' fraction are Glass Bottles;
- 50% of the 'Dense plastic bottles' fraction are PET Bottles ;
- 20% of the 'Ferrous food and beverage cans' fraction are Steel Beverage Cans; and
- 60% of the 'Non-ferrous food and beverage cans' fraction are Aluminium Beverage Cans.[119]

See Table A-9 for estimates of the tonnages of beverage containers from on-the-go recycling and street sweepings.

A.2.2.5 Total Products Placed on the Market / Total Waste Arisings / Containers Remaining in Environment

In order to estimate the quantity of beverage containers left in the environment as litter, we have combined a top down approach with the 'bottom up' approaches considered in the Sections above. Our simple approach estimates that:

Containers Remaining in the Environment as Litter	=	Total Containers Placed on Market – Containers Captured for Recycling and Treatment / Disposal*

**note there will also be a small amount of re-use for other purposes (eg. home-brewing, plant pots, re-using plastic bottles). The amount of re-use is unknown, but we would expect it to be relatively small compared to the recycling and disposal figures used in this study.*

The figure for 'Total Containers Placed on Market' is the top down approach, 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 UK market in 2009.

The weights of beverage containers were determined through actual measurements of sample products, from existing studies, and from websites such as The Environmental Register of Packaging PYR Ltd.[120,121] The average weights for different container types used in the study are given in Table A-21. This data allowed

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[118] AEA Technology, MEL Research, Waste Research and WRc (2003) *The Composition of Municipal Solid Waste in Wales*, Report to the Welsh Assembly Government, December 2003

[119] More food containers (soup tins etc) are made from ferrous metals, hence why the proportions of beverage containers are higher for the non-ferrous fraction.

[120] WRAP (2008) *Bulk Shipping of Wine and its Implications for Product Quality*, Final Report: GlassRite: Wine, May 2008, http://www.wrap.org.uk/downloads/Bulk_shipping_wine_quality_May_08.1be9881a.5386.pdf

[121] PYR (n/a) *Packaging Weight Units*, Accessed 1st May 2010, http://www.pyr.fi/eng/forms/packaging-date-questionaire/packaging-weight-units.html

us to calculate the total weight of containers placed on the UK market every year. By subtracting the tonnages of beverage container waste collected for recycling and disposal from the total weight of containers placed on the UK market, the resultant figure indicates the tonnage of beverage containers that would remain in the environment as litter. 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-9.

Table A-21: Average Weight per Container Type

Container	Kgs
Soft/Beer & Cider Bottles	0.3
Wine bottles	0.5
PET Bottles	0.033
Ferrous Cans	0.035
Aluminium Cans	0.017

Source: Eunomia

The weight and number of containers predicted by our bottom up analysis was greater than that estimated using the Canadean® data. This is due to the fact that the Canadean data does not include imports from 'private trade' with other EU countries (such as France and Ireland). The volume of beer, and wine, for example is considered to be significant (see Section 6.6 for more detail).

A.2.2.6 Summary Baseline Figures

Table A-9 shows the mass flow baseline upon which subsequent calculations were undertaken on the costs and benefits 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-9 to be reasonable, being, as they are, based on reasoned argument, and rationalised to the greatest extent possible. Furthermore, the tonnages were cross-checked with packaging data available from various sources.[122,123] The figures were within acceptable error margins, especially when considering data in the waste sector (often of low quality).

From the figures provided in Table A-9, it can be seen that:

- A significant quantity of containers will be sold in the UK every year (around 28 billion);

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[122] David Davies Associates (2009) *PackFlow 2012: UK Compliance with the European Packaging & Packaging Waste Directive, Volume 1: Summary Report & Recommendations*, November 2009.

[123] Advisory Committee on Packaging (2008) *Packaging in Perspective,* November 2008.

- The implied commercial recycling rate is high. Note, however, that the baseline is modelled based on 2015, when the landfill tax has escalated to £80 per tonne, which would promote the uptake of commercial recycling services above and beyond the levels seen today; and
- A significant quantity of waste is left in the environment every year (~300 million bottles / cans etc). It is important to re-iterate the limitations of this study in estimating the amount of beverage container litter that is present in the environment. Unfortunately, we could find no studies or research that have previously tried to estimate this figure with which to compare our estimates. Our modelling does make an estimate of the potential disamenity benefit possible from the removal of beverage container litter from the environment.

The overall recovery rate for the containers in scope in this study, under the baseline system (pre-DRS), is calculated at 68% (this is significantly higher than what is currently being achieved, being based around a baseline where it is assumed that a comprehensive set of kerbside recycling services has been rolled out across all local authorities). There is, therefore, scope to increase the environmental benefits associated with greater recovery of these materials.

A.2.3 Scenarios

This section describes the two central scenarios that have been modelled for the introduction of a deposit refund system in the UK. These scenarios are as follows:

1. **Complementary** – where no beverage containers are collected at the kerbside i.e. the deposit refund system is complementary to the existing kerbside schemes; and
2. **Parallel** – where the household kerbside systems for beverage containers operate in parallel to the deposit refund system.

The scenarios result in changes in mass flow compared to the baseline described in Appendix A.2.2. To determine the magnitude of the change, we estimated the likely situation following implementation of the DR system, and then calculated the difference compared to the baseline.

Note that we have assumed the total quantity of containers placed on the market remains constant across the scenarios. In reality the quantity may fall slightly as the price of the container increases, though discussion with Canadean® suggests that an increase in cost of 1-2p (ie. the admin charge calculated from the deposit refund model) would be unlikely to instigate any significant changes in demand, with demand being primarily driven by other factors such as the weather (determining how thirsty we are) and promotional deals.[124] Demand is generally believed to be relatively inelastic.

[124] *Personal communication with Canadean®.*

In both cases the mass flows were adjusted so that the overall return rate for the deposit refund system was set at reasonable levels. The rationale for the likely return rates follows.

Table A-9: Mass Flow Baseline for CBA Modelling

	No. of Containers (millions)	Tonnages (thousand tonnes)										
Products	Placed on Market	Placed on Market	hhld Kerbside		Bring	HWRCs		Commercial		Litter		
			Recycling	Refuse	Recycling	Recycling	Refuse	Recycling	Refuse	Recycling	Refuse	Environment
Glass Bottles	5,905	2,288	1,002	312	234	33	5	505	89	17	68	23
PET Bottles	8,846	314	71	164	5	4	1	15	14	1	37	3
Cans (Fe.)	5,717	200	45	84	7	3	0.1	31	8	2	18	2
Cans (Al.)	7,271	124	34	46	2	1	0.1	10	3	0	26	1
Total	**27,740**	**2,926**	**1,152**	**605**	**249**	**41**	**6**	**562**	**114**	**20**	**148**	**29**

We start with the maximum return rate likely from a standalone system (scenario 1 – the 'complementary' system). Through looking at existing systems, it is estimated that a likely return rate for all beverage containers would be 90%.[125,126,127,128] This is by no means the maximum (or minimum) value, but likely to be a reasonable estimate, especially if containers cannot be collected at the kerbside.

For the parallel system (scenario 2), consumers whose behaviour is not influenced by the loss of deposits will continue to leave containers within the DR system in kerbside boxes or in their residual waste bin. It could be argued that those for whom the deposit is valuable might remove the containers from kerbside boxes and bins. This could also include kerbside collection crews / MRF operators. However, the capture via these methods will be unlikely to be as high as through the deposit refund system itself. We therefore assume that the overall return rate for containers in the system will be less than the '*complementary*' scenario, and we estimate the return rate might be 80% under the '*parallel*' scenario.

The general approach to determining the waste flows for the two scenarios is given in the sections below. This is followed by summary tables showing, in quantitative terms, the effects of the two scenarios.

A.2.3.1 Scenario 1 (Complementary System) Waste Flow Principles

The general principles used to estimate the likely future waste flows as a result of a complementary deposit refund system are:

- There is a 100% reduction in the quantity of beverage containers collected for recycling through household kerbside collection systems;
- The quantity of containers in refuse will not be zero, as some people simply will not take the containers back to a collection point. We have assumed 5% of containers remain in household refuse (clearly this is an unknown factor, no data supports this figures specifically. But if return rates of >90% are possible, and some containers, of which the householder is the greatest generator, are disposed of, 5% disposal in household refuse seems a reasonable estimate. The main point being that this activity would occur so it is important to make some estimation of if in the modelling work); and
- 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%.

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125 http://www.dansk-retursystem.dk/

126 http://www.palpa.fi/

127 http://www.resirk.no/Frontpage-63.aspx

128 Eunomia et al. (2009) *International Review of Waste Management Policy: Annexes to Main Report*, Report for Department of the Environment, Heritage and Local Government, Ireland, September 2009.

A.2.3.2 Scenario 2 (Parallel System) Waste Flow Principles

The general principles used to estimate the likely future waste flows as a result of a parallel deposit refund system are:

- There is an 80% reduction in the quantity of beverage containers collected through household kerbside collection systems
- 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 80%.

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.

A.2.3.3 Summary Scenario Waste Flows

Table A-23 shows the change in waste mass flows as a result of the implementation of a complementary or parallel deposit refund system in the UK.

As illustrated in Table A-23 the magnitude of the shift from existing collection routes increases under the complementary scenario – this is due to the fact that the possibility of collection from household kerbside collection schemes is removed.

Table A-23: Change in Mass Flows Resulting From Introduction of Complementary and Parallel Deposit Refund Systems

Products	No. of Containers	Tonnages (thousand tonnes)											
	Placed on Market	Total Arisings	hhld Kerbside		Bring	HWRCs		Commercial		Litter			via DR System
			Recycling	Refuse	Recycling	Recycling	Refuse	Recycling	Refuse	Recycling	Refuse	Env.	
Complementary Deposit System (Scenario 2)													
Glass Bottles	0	0	-805	-249	-183	-26	-4	-394	-69	-13	-53	-18	1,814
PET Bottles	0	0	-57	-146	-4	-3	-1	-12	-11	-1	-29	-2	265
Cans (Fe.)	0	0	-40	-74	-6	-2	0	-25	-6	-2	-14	-2	170
Cans (Al.)	0	0	-24	-39	-1	-1	0	-8	-3	0	-20	-1	98
Parallel Deposit System (Scenario 1)													
Glass Bottles	0	0	-1,002	-246	-192	-27	-4	-414	-73	-14	-56	-19	2,047
PET Bottles	0	0	-71	-152	-4	-3	-1	-12	-11	-1	-30	-3	288
Cans (Fe.)	0	0	-45	-77	-6	-2	0	-26	-6	-2	-15	-2	181
Cans (Al.)	0	0	-34	-42	-1	-1	0	-8	-3	0	-21	-1	112

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 (NGOs), 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 the UK;
- All consumers which purchase beverages in the UK; 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 UK's deposit refund system model developed for this study is given in Figure A-7-3.

The system developed for this study is based on similar principles (though the details reflect the UK's structure of retailing) to the systems which exist in Denmark (Dansk Retursystem) the Scandinavian countries (Norsk Resirk, Returpack and 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:

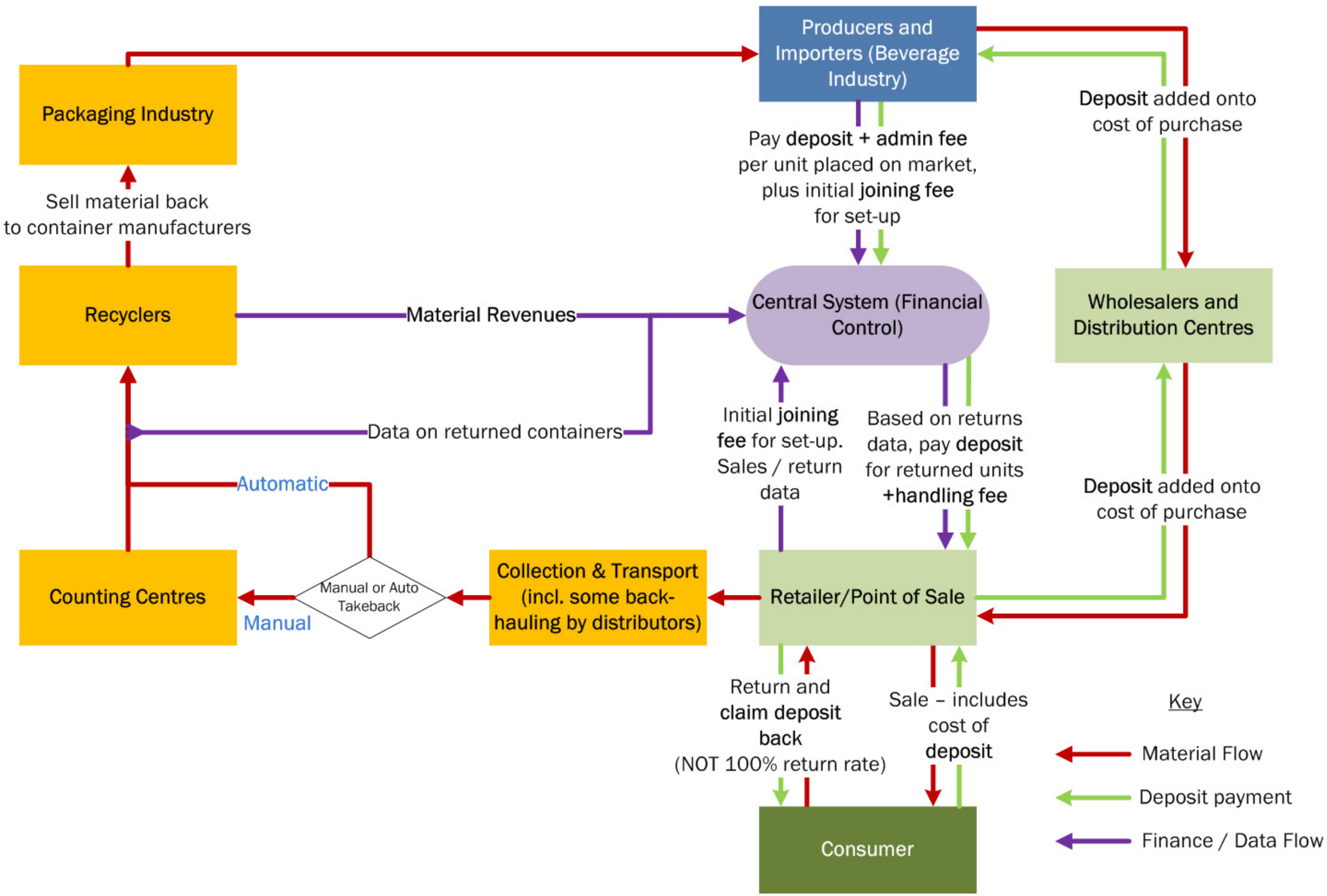
- As beverages are produced and sold to wholesalers, or directly to retailers, producers send sales data to a central system along with a payment matching the total value of the deposits on all items sold. The cost of the deposits is then paid back to the producers, by wholesalers or retailers, upon 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 set each year 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 once more. Thus the circle of deposit payments is closed. As the return rate for containers in 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). Handling fees are reviewed and adjusted each year;

- Returned empty containers are collected in a number of ways. Automated systems of collection use reverse vending machines or automated counting machines. 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;[129]
- Where the containers are collected via an automated machine, the sorted (and predominantly compacted) material can be transported directly to a recycler, with material revenues being paid back into the central system. Material revenues will also be paid on those containers that are collected manually, though this material will first have to be transported to a dedicated centre for counting, sorting and compacting, before it can be hauled on to a recycling facility. These 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 and handling fees. In other words, the administration fee guarantees the DRS is 'cost neutral' overall.

[129] This differs to the typical systems employed in countries such as Sweden and Canada, where collections occur at a small number of redemption centres rather than at every retail outlet. We believe that in order to maximize 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 the UK, 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.

Figure A-7-3: Deposit Refund System Model



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, rather than going through a central system.[130] Given the array of problems that have been highlighted in association with the German system, that this system has been recognised as an expensive scheme and that the scheme was originally partly set up to try to encourage the refillables market, we chose to model the UK 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.[131,132] It is also worth noting the recent communication from the European Commission, which states that:

> *"In practice, this means that Member States are allowed to introduce mandatory deposit systems if, on the basis of an individual Member State's discretion, this is considered necessary for environmental reasons."*[133]

The communication goes on to state several safeguards that need to be respected in relation to how the system is designed in order to ensure a fair, open and transparent system, including:

4) *A countrywide system (which could be run either via a non-government organisation (NGO), a government body or via the producers/distributors concerned, and which may consist of more than one system operator so long as the systems are compatible with each other). This will:*
    - A) *Ensure a sufficient number of return points for consumers to encourage participation in the system.*
    - B) *Avoid '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.*
5) *A system which is open to all economic participators in the sector concerned – including imported products under non-discriminatory conditions. This will avoid creating an unjustified barrier to trade or distorting competition.*
6) *A system which ensures that there is no discrimination between those products that are exempt and those that are subject to a deposit and that any differentiation is based on objective criteria i.e. in principle, focus on material*

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130 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.
131 Perchards (2007) *Study on Factual Implementation of a Nationwide Take-back System in Germany After 1 May 2006*, Final Report, 14 February 2007.
132 G. Bevington (2008) *A Deposit and Refund Scheme in Ireland*, Report commissioned by Repak Ltd., September 2008.
133 EC (2009), *Communication from the Commission: Beverage Packaging, Deposit Systems and Free Movement of Goods*, May 2009

and not on content of beverages as it is the former which drives the environmental performance of the system.

In order to ensure in our modeling that a sufficient number of return points are subsequently available to consumers in the UK 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 automated counting centre) 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. This differs from the typical systems employed in countries such as Sweden 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, 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', a denser network of collection points would be more appropriate for the UK. 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.

Further details of the modeling assumptions used for the collection, transport and processing logistics are given in Appendix A.3.2.

A.3.1 The Deposit and Return Rates

The value of the deposit for the UK is calculated based on deposits and return rates from other systems around the world. Figure A-7-4 shows the return rate as a function of the deposit. The deposit is converted from the local currency of the deposit refund system to GB Pounds (GBP) using OECD Purchasing Power Parities from 2008.[134] This gives a better estimate of the value of the deposit than simply using the current exchange rate.

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

$$\textit{Return Rate} = 0.0592 * \ln(\textit{deposit}) + 0.9876$$

In order to get a return rate of 90% for the UK, we set our deposit to be £0.20 (in line with the relationship represented by this equation).

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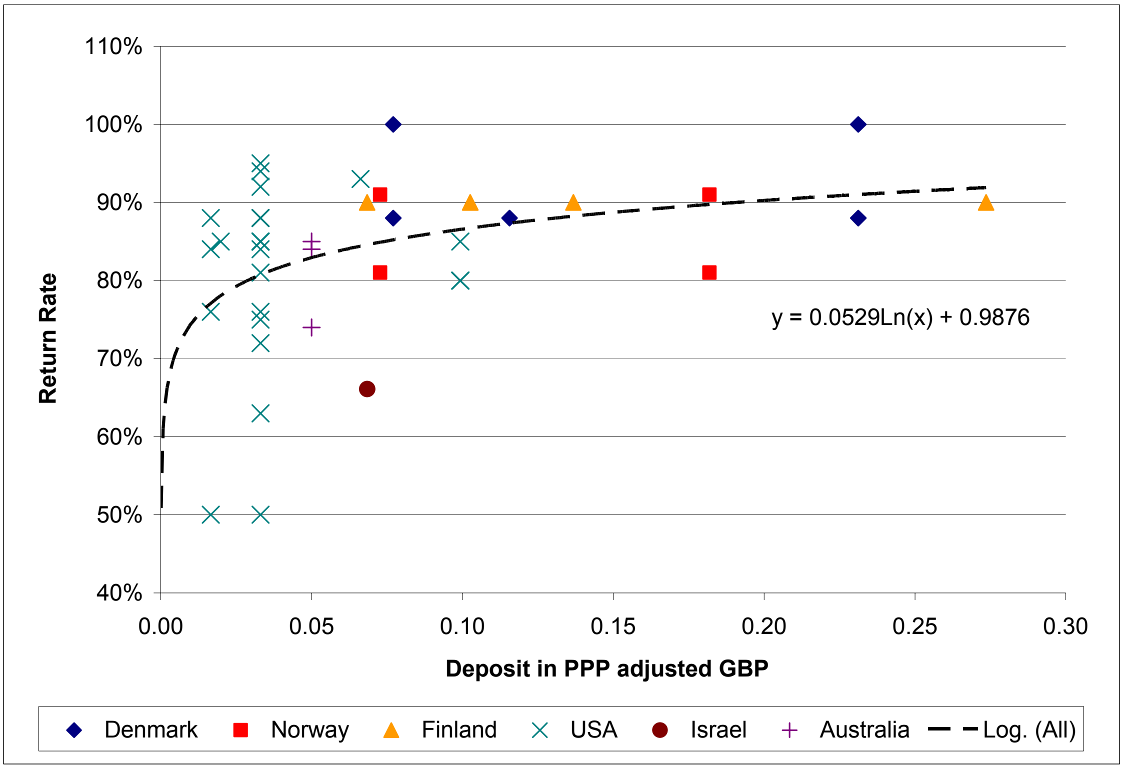
134 OECD (2010) Purchasing Power Parities (PPP), Accessed May 2010, http://www.oecd.org/department/0,3355,en_2649_34357_1_1_1_1_1,00.html

Figure A-7-4: Return Rates as a Function of Deposits in PPP-Adjusted GB Pounds.



Smaller containers generally have a smaller deposit than larger containers, so in line with other countries, we have set a threshold at 500ml. UK market research shows that approximately 65% of potential deposit refund containers sold have a volume less than or equal to 500ml, while 35% have a volume greater than 500ml.[135] Using this split, we set the deposit at £0.15 for small containers and £0.30 for large containers (see Table A-24).

Table A-24: Proposed Deposits for Containers in UK Deposit Refund System

Container size	% of UK market	Deposit
≤ 500ml	65%	£0.15
> 500ml	35%	£0.30
Overall		£0.20

[135] Personal communication with Canadean®, May 2010, http://www.canadean.com/

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. The handling costs were calculated based upon realistic assumptions. The approach was mindful of how the system would operate in the UK and what costs retailers were likely to incur. We were careful not to be optimistic in the setting of assumptions, so therefore believe the collection, handling and processing costs to be a good estimate of what they would be in practice.

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 transferred back to the retailer during the redemption of the deposit? Both these aspects 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.[136] The handling fee appears to be negotiated on an annual basis. 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 cost benefit analysis.

It is important to note that the deposit system in the UK will be different from those in other countries because:

a) There are very few deposit systems left operating in the UK (especially for alcoholic beverages, beer bottles etc), so most containers are one-way and will be eligible for inclusion in the system;

b) Modern behavioural attitudes appear to place a premium on waste collection activities which make minimal demands on personal time - thus drop-off ought to be quick and locations easily accessible;

c) There is a relatively high population density; and

d) The historic nature of retail outlets has led to a structure which is essentially characterised by large numbers of small outlets operating in a decentralised manner (clearly many have now been replaced by larger supermarkets, but a considerable number remain).

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[136] Personal communications with TOMRA, May 2010

All of these points mean that the system must have the ability to collect 1) large quantities of glass, especially from pubs and bars; 2) a high proportion of containers from a large number of dispersed outlets, and on a frequent basis; and 3) ensure that take back is possible through easily accessible locations, thereby increasing the likelihood of return.

Following establishment of the retail landscape, the handling fee was calculated by ensuring the following elements were included in the cost calculations:

- RVMs (reverse vending machines);
- Retail Space Infringements;
- Labour;
    - Pickup / Unloading;
    - Take Back; and
- Bags and crates for containment.

These elements are costed in the sections below.

Following this, the determination of *logistics and processing* costs, financed by the central system, are provided.

Finally the elements of the handling fee are brought together and the per unit fee calculated.

A.3.2.1 Retail Landscape and System Design

In order to determine the types and total numbers of retail outlets in the UK that might accept returned containers, data was amalgamated from numerous sources.[137,138,139,140,141,142,143] It is estimated that there are over 350,000 outlets

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[137] Wetherill, Paul (2009) UK Business: Activity, Size and Location – 2009, An Office for National Statistics Publication, September 2009, http://www.statistics.gov.uk/downloads/theme_commerce/PA1003_2009/UK_Business_2009.pdf

[138] Prosser, Londsay (editor) (2009) UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007), An Office for National Statistics Publication, December 2009, http://www.statistics.gov.uk/methods_quality/sic/downloads/SIC2007explanatorynotes.pdf

[139] Defra Surveys, Statistics and Food Economics Division (2007) Food Service and Eating Out: An Economic Survey, January 2007, https://statistics.defra.gov.uk/esg/reports/Food%20service%20paper%20Jan%202007.pdf

[140] NCBS (2005) Chapter 2: The UK food and drink industry, in Ethical trading in the UK food and drink industry, a final report for Defra, August 2005, https://statistics.defra.gov.uk/esg/reports/Ethical%20trading/chapter2.pdf

[141] Frewin, Angela (2010) Number of Hospitality and Catering outlets – Industry Data, Accessed May 2010, http://www.catersearch.com/Articles/2010/05/07/317292/number-of-hospitality-and-catering-outlets-industry-data.htm

[142] Institute of Grocery Distribution (2009) UK Grocery Retailing, Accessed May 2010, http://www.igd.com/index.asp?id=1&fid=1&sid=7&tid=26&cid=94

currently operating in the UK that are likely to sell beverages (excluding kiosks).[144] The types of retail outlet considered were:

- Superstores;
- Medium Stores (including cash and carrys);
- Convenience Stores;
- Pubs;
- Restaurants;
- Hotels/B&Bs;
- Food Retailer;
- Leisure; and
- Canteens/cafes in workplace.

Information on market distribution for the main beverage sectors was taken from relevant DataMonitor reports.[145] The material composition of the containers sold in each sector was then estimated.

From this data, the proportion of glass bottles, plastic bottles and cans returned to each type of retail outlet was estimated (Table A-25). The key assumption being that the majority of containers will be returned to the same type of retail establishment as they were sold.

Table A-25: Total Containers Returned to Retail Outlets

Scenario	Glass Bottles	Plastics Bottles	Cans	Total (millions)
Parallel	4,682	7,457	10,589	**22,727**
Complementary	5,283	8,114	11,736	**25,133**

Source: Canadean / Eunomia

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*. It should be noted that, in this model, it is assumed that any type of container can be taken back to any of the participating retailers. Although this is eminently possible via RVMs or manual take back of commingled plastics and cans, glass bottles accepted manually would need to be placed in dedicated boxes.

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143 Rogers, Simon (2010) Labour's manifesto: Where have all the pubs gone?, Accessed May 2010, http://www.guardian.co.uk/news/datablog/2010/apr/12/general-election-labour-manifesto-pub-closures

144 No data on the number of small retail kiosks operating in the UK was available.

145 DataMonitor provides industry profile data, www.datamonitor.com

In practice, it would not be recommended that all retailers store all sizes of boxes 'just in case' a take back is required. However, in small volumes, glass would not restrict the retailer from accepting the container. We would expect the bottle would probably be placed in the bag with commingled plastics and cans – this is the current procedure in Germany and Denmark.[146]

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
Superstores	100%	Large sales / return volumes, so all will join.
Medium Stores	100%	Large sales / return volumes, so all will join.
Convenience Stores	50%	Half with small number of employees, and lower beverage sales.
Pubs	90%	High sales volume relates to nature of business. Most will have too many containers to take to a supermarket etc.
Restaurants	60%	Beverage sales will be lower, enabling smaller restaurants to opt out of the system.
Hotels/B&Bs	70%	Split based on hotels with >10 employees.
Food Retailer	10%	Small sales volumes and small size will mean many retailers will opt out of the system and take stored containers to local return points.
Leisure	50%	Less information known about the large variation in 'Leisure' activities / sites. 50% split deemed a neutral assumption.
Canteens/cafes in workplace	10%	Most have low numbers of employees (<10).
Kiosks	0%	All kiosks will be too small to join the system, and therefore will take containers to local convenience stores and supermarkets etc.

Source: Eunomia

Furthermore, we assumed that all small kiosks would opt not to participate in the system, and would instead take returned containers to the nearest convenience

[146] Personal communication with TOMRA.

store, supermarket or counting depot –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:[147]

> *"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."*

The next step to consider was how the containers would be collected by retailers. In Appendix A.3.0 it was argued that automatic take back of containers through placing of machines in stores would be necessary to provide easily accessible take back points for consumers in the UK.

For the purposes of this modelling, we have assumed that the automated machines would be reverse vending machines (RVMs), though other methods of automated collection exist, including high-speed counting machines which may be chosen by some as a preferred collection option. Automated machines will be pragmatic for a large number of shops across the UK, being already used in stores such as Tescos, but will not be pragmatic for bars and restaurants. Table A-27 shows the proportions of each retail category which we have assumed would have an RVM in their store and the average number of RVMs per store, with the remaining proportion of each retail category undertaking 'manual' container take-back. It should be noted that, for a small proportion of those retailers classed as 'manual' take-backs, particularly for bars and restaurants, the deposit may never be passed onto the consumer in the first place as it may be relatively easy for the retailer to retain the beverage container and serve the beverage in a glass, thereby reducing staff time required for the manual process. However, for the purposes of ensuring that the estimation of handling fees is not too low, we have classed all non-RVM retail outlets as requiring the same amount of resource time for manual collection.

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

Table A-27: Retail Outlets Requiring RVMs and Number per Store

Type of Retailer	% of Retailers Requiring an RVM	No. of RVMs per store
Superstores	100%	2
Medium Stores	70%	1
Convenience Stores	10%	1
Pubs	0%	
Restaurants	0%	
Hotels/B&Bs	0%	
Food Retailer	5%	1
Leisure	0%	
Canteens/cafes in workplace	0%	
Kiosks	0%	

Source: Eunomia

From this analysis the total number of retail outlets requiring an RVM in the UK is calculated as around 36,000. The total number of *RVM machines* is just over 42,500. In Germany (a country with a higher population) the equilibrium number of RVMs is circa 30,000.[148] However, Germany's retail landscape is different. In the UK there appear to be a larger number of stores of a size which would justify an RVM. The total number of RVMs maybe an over estimate, but should ensure the modelling does not under-cost the required infrastructure.

In order to check the validity of these assumptions, the average take back rate per RVM was subsequently calculated. Assuming a 7 day opening week and two hour peak time frame, the return rate is around five to six containers per minute. This is eminently possible. The operating capacity of machines is around 30 to 45; however, in practice the actual number of containers returned per minute will be lower, relating to intensity of use and the number of users at any one time.

The number of businesses opting to join the system but not requiring an RVM is estimated at around 150,000.

[148] Personal communication with TOMRA, May 2010.

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-28.

Table A-28: Number of Containers Requiring Collection via RVMs of through Manual Take Back, millions

Product	Complementary		Parallel	
	RVMs	Manual	RVMs	Manual
Glass ≤0.5 l	894	1,646	1,009	1,858
Glass >0.5 l	754	1,387	850	1,566
PET ≤0.5 l	1,599	1,974	1,740	2,148
PET >0.5 l	1,738	2,145	1,891	2,334
Cans (Fe.)	1,664	2,997	1,844	3,321
Cans (Al.)	2,116	3,812	2,346	4,225

Source: Eunomia

Note the higher quantity of aluminium cans compared to ferrous. Household composition suggest that the weight ratio is 20:80 (Alu. to Fe.), however, the weight of an aluminium can is around half, so the modelling suggests the figures above. No sources of data could be found to provide further evidence as to the split of material used for cans placed on the market. However, as we note in Section A.2.2 the tonnage data matches up to existing sources, so the number of units should not be significantly over or underestimated.

A.3.2.2 Reverse Vending Machine (RVM) Costs

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

<u>Capital Costs</u>

In terms of capital costs, average figures of €20,000 for the machine, and €1,250 for the installation were provided by TOMRA. This equates to around £17,000 for one RVM, and just over £1,000 for the installation.[149] 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 machine to the central system.

[149] Using an exchange rate of 0.849083.

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.[150] The interest rate is assumed to be 7%.

Operating Costs

Operating and maintenance costs are assumed to be 9% of the total capital cost of the machine.[151] 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. This cost of replacing the compactors is €2,000. This has to be carried out on average after every 800,000 containers have been compacted.

Total Cost

The total annual cost to retailers for purchasing and operating RVMs is estimated to be around **£209 million** under both scenarios.

A.3.2.3 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 loss of floor space is described below.

RVM Store Costs

The costs for retailers who install RVMs will be the actual cost to lease the floor space in the sales area, the additional storage area required for the containers, and the lost opportunity cost resulting from a reduction in floor space in the sales area.

It is estimated that an average retailer will require an area of 9 m^2 (4 m^2 sales area + 5 m^2 storage space). The opportunity cost of retail floor space and operator margin (i.e. the profit the retailer would receive) are also estimated at £3,000 per m^2 per annum and 5% respectively.[152]

The rateable value of commercial and industrial properties in the UK varies from <£25 to around £450 per m^2.[153] The average rateable value for retail floorspace in England was £129 in 2007.[154] Using the latest GDP deflator from HMT, the rateable

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[150] 7 years is also expected to be the lifetime of the machine.

[151] Personal communication with TOMRA, May 2010.

[152] GLA (2005) *Retail in London: Working Paper C Grocery Retailing*, October 2005, http://www.london.gov.uk/mayor/economic_unit/docs/retail_in_london_wpc_grocery_retailing.pdf

[153] CLG (2008) *Floorspace and rateable value of commercial and industrial properties 1 April 2008, (England & Wales)*, Accessed 13th May 2010, http://www.communities.gov.uk/publications/corporate/statistics/floorspace2008

[154] Lancashire County Council (2008) Retail Floorspace 2007, Accesed 13th May 2010, http://www.lancashire.gov.uk/office_of_the_chief_executive/lancashireprofile/monitors/retailfloorspace.asp

value used in the modelling, in 2009 terms, is calculated as £135 per m^2 per annum.[155]

There are just over 36,000 retail outlets that are likely to install RVMs. The cost to these retailers for loss of floor space and opportunity cost is around **£65 million** per annum for both scenarios.

<u>Manual Take Back Store Costs</u>

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. The same rateable value for floor space presented above is also used for this calculation.

If it is assumed that a containment bag (see Appendix A.3.2.5) can store, on average, 200 beverage containers, then one retail outlet will amalgamate eight containment bags per week. In the collection modelling, a weekly pickup rate for each retail outlet is assumed (see Appendix A.3.2.6 below). The *average* collection frequency is just under twice per week. Therefore the average retailer will have to store 4 bags in between pickups. An area of 5 m^2 has been given to each retailer for storing these bags.

There are just under 150,000 retail outlets who are likely to be 'manually handling' containers. The cost to these retailers for loss in floor space is around **£101 million** per annum for both scenarios.

A.3.2.4 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 below.

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

The outline plan for the German deposit system estimated that the time required to process receipts from stores with RVMs was 0.3 hours per day.[156] Based on a seven day working week and a labour cost at above the minimum wage (currently £5.93/hr). With on-costs of 25% the hourly costs of labour used in the model is around £8.80. The total labour cost to retailers is estimated at **£30 million** per annum.

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[155] HM-Treasury (2010) *GDP deflators at market prices, and money GDP, Last updated 31 March 2010*, http://www.hm-treasury.gov.uk/data_gdp_fig.htm

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

To add weight to the cost calculations in this section, two approaches have been taken and an average figure used in the model. By making the following assumptions, it is possible to derive a different cost of labour as follows:

- Each customer returns an average of 15 containers in one go;
- It takes 10 seconds for the retailer to process the receipt and reimburse the customer with the monetary value of the accumulated deposits;
- Each 'average sized' RVM has a storage capacity of 300 containers;
- The time taken to empty the RVM when it is full and store the containers at the back of the store is 5 minutes; and
- Staff are unskilled and paid the minimum wage.

This secondary approach values the time taken for the shop assistant to both process receipts and empty machines. The total cost estimated using this approach is around **£39 million** per annum.

An average of the two approaches is around **£34 million** for both scenarios. This is the figure used in the modelling.

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

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/ waiter to accept an average of 15 containers and store them is estimated at 45 seconds.

With the labour costs valued at above the basic wage, the total cost to retailers who implement a manual take back policy is estimated at **£113 million** and **£102 million** for the complementary and parallel systems respectively.

<u>Labour Costs for Customer Take Back from Retailers Outside of Deposit System</u>

Some of the smaller retailers, such as corner shops, kiosks, and cafes, will not receive a high enough volume of containers to warrant paying the joining fee. This is, in one way, a valued side effect, enabling the efficiency of the overall collection logistics to be greatly improved by concentrating the volume of containers in a smaller number of locations. However, on the negative side, an additional cost will be incurred by these retailers in having to store a small number of containers and subsequently deposit the containers at local take-back points to redeem the deposits. Rather than being included in the running costs of the deposit system, this cost should be included in the overall cost benefit analysis. It is discussed in this section of the report only because the methodology is closely linked to that used in the calculation of the labour costs presented above.

In this calculation it is assumed that the small retailer will be able to store containers for around 14 days. This could be much less for some retailers, particularly if they were to take containers back to, for example, a cash and carry whilst purchasing new goods for sale. However, in order to take a conservative approach, we have assumed a storage period of 14 days for all small retailers. Furthermore, it will take half an hour of labour time to visit a local take back point and redeem the deposits. Again the cost of labour is valued as above.

Assuming that 70% of the total number of retail outlets categorised at the start of this section stock beverages (even though some leisure outlets and canteens will just serve food), the total cost to these businesses will be around **£19 million**.

<u>Labour Costs for Container Collection</u>

In implementing a deposit refund system, there would potentially need to be three main avenues of collection services for the retailer: one for refuse, one for beverage containers, and one for other recyclable materials. Although it is assumed that the volume and hence frequency of refuse and 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 was also made (see Table A-29). Labour is valued at higher than an unskilled rate, as more senior staff may need to facilitate this process. A rate of £9 per hour has been used (plus 25% on-costs).

Table A-29: Retailers Requiring Collection and Pickups per Week

Type of Retailer	Number of Retailers Requiring a Collection	Pickups per Week
Superstores	0	7
Medium Stores	11,550	4
Convenience Stores	12,125	3
Pubs	23,400	2
Restaurants	13,500	2
Hotels/B&Bs	30,240	2
Food Retailer	2,610	1
Leisure	8,550	0.5
Canteens/cafes in workplace	8,455	2
Kiosks	0	0

Source: Eunomia

The total cost of labour time to retailers for facilitating the collection of containers is estimated at **£13 million** per annum.

A.3.2.5 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.

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 can be compacted and an applicable containment device used. Experience from other countries suggests that collapsible plastic bins are a useful mechanism for transportation of compacted containers received through RVMs (see Figure A-7-5). When backhauling, these bins could be stored folded up in the vehicle and given to the retailer to replace the full bin.

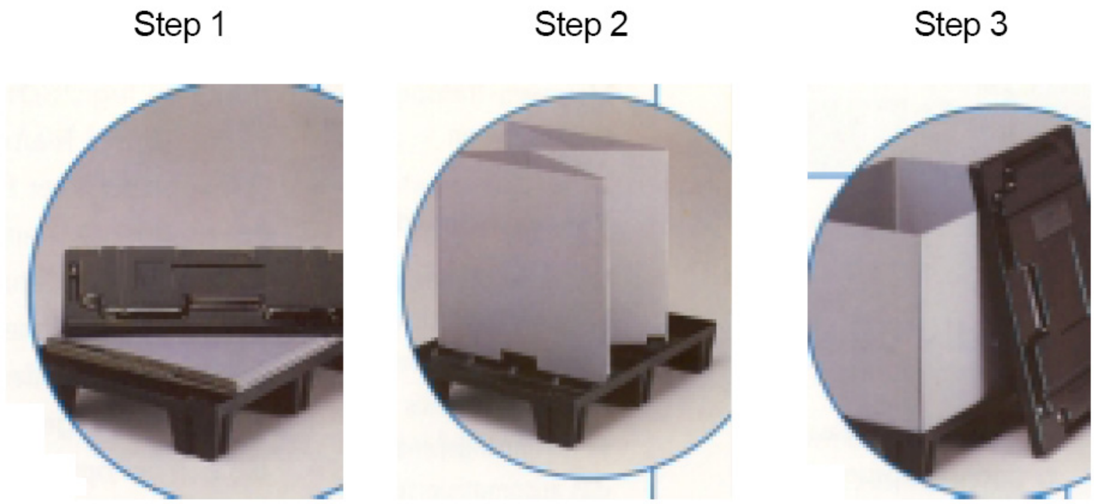
Alternatively, logistics companies could use existing delivery devices. Common practice is to use wheeled storage cages. However, placing the compacted containers in the cages may be time consuming. Furthermore, additional containment would be required to manage the loose items. Taking a conservative approach, it has been assumed that new 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:

- An average capacity figure, for all container types, of 1,400 per bin;
- Each bin will be in use or storage for a period of 14 days before being refilled;
- The cost for one bin is £125;[157]
- A nominal charge or £5 per bin for cleaning has been included;
- The lifetime of the bin is three years; and
- The value of the bins has been annualised over a period of three years at an interest rate of 7%.

Subsequent calculation of an average of five bins per store was considered a reasonable number in providing a sense-check for this section of the modelling.

[157] Personal communication with TOMRA, May 2010

Figure A-7-5: 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 and cans 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 sufficient for containment of plastic bottles and cans. This is similar to many kerbside collections of plastic bottles already in place in the UK.[158] 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-7-6).

Figure A-7-6: Plastic Bags with Empty Beverage Containers for Transportation

[158] WRAP (2007), *Annual Local Authorities Plastics Collection Survey 2007*, June 2007, available at http://www.wrap.org.uk/downloads/Wrap_ReportDisclaimerSmaller.513fb4e1.3869.pdf

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 bottles or 250 cans.[159] The cost of a bag and a tag is modelled at 67p. In reality, this cost could go down if bags are reused, or the purchasing power of the central system comes into play, and all 52 million 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-7-7). The total number of crates required and the total cost was calculated using the following assumptions:

- 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;
- Each crate will be in use or storage for a period of 3 days before being refilled;
- The cost for one crate is £10;[160,161]
- A nominal charge or £1 per crate has been included for cleaning;
- The lifetime of the crate is 3 years; and
- The value of the bins has been annualised over a period of 3 years at an interest rate of 7%.

Figure A-7-7: Plastic Crate for Transporting Glass Bottles

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

[160] 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/

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

Based on the assumptions outlined above, the total cost of containment devices is estimated at **£54 million** and **£49 million** for the complementary and parallel systems respectively.

A.3.2.6 Transport Costs

The transport costs have been modelled with the UK situation in mind, not simply copied from existing systems in other countries – although these were used to understand some general principles. The main principles were:

- Backhauling using existing logistics networks is 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 7.5 to 18 tonnes;
- Containers are transported directly to recyclers, or to counting centres for clearing.

The area which will provide the greatest potential for financial savings is backhauling. This is where delivery vehicles that distribute products to shops, bars etc, will fill the empty space with returned deposit containers, rather than the current practice which is to return to the depot empty. Therefore, we have modelled the collection logistics using both backhauling and collection rounds direct to the retail outlet. The system is summarised in Figure A-7-8 and described under each of the subsequent headings.

<u>Backhauling</u>

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, which are supplied by a larger number of independent traders, backhauling would be less beneficial for the supplier, as transporting the smaller volume of containers to a recycler or counting centre would be less efficient. What the fulcrum of cost to benefit would be is unclear from this high level analysis. However, what can be assumed 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 able to backhaul are shown in Table A-30. The key assumptions in the setting of these conditions were:

- All supermarkets are of a large enough size to warrant backhauling;
- Far fewer medium sized stores would be large enough to warrant backhauling;
- 20% of convenience stores will be serviced by large-scale distribution companies which will backhaul;
- Half of pubs (whose main trade is beverages) will be supplied by a distribution company large enough to backhaul. In practice many pubs are supplied by a small number of large suppliers or breweries, so in reality the

potential for backhauling using existing collection logistics could be more substantial than estimated; and

- The potential for backhauling is diminished when considering other catering sectors due to the lower volumes of containers per outlet.

The marginal cost to the distribution company for backhauling to their centralised 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. In fact some of the capacity in the cages will already being used to backhaul card and plastic packaging to central depots for recycling. Change in fuel costs are not easy to estimate at the macro level, hence this has been excluded from the analysis. We recognise this limitation in the modelling, but would suggest that the total impact would be low when compared to the overall costs of the system.

As can be seen from Figure A-7-8 the backhauled containers from the retail outlets are transported back to a central collection depot.[162] 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, such as an RVM or counting centre. This means that nearly 80% of the backhauled containers will already be 'cleared' in the central system and compacted ready for transport.[163] Consequently, loading and unloading of the collection vehicles will be more efficient. Nonetheless, some clearing and compacting of containers will still be required. This will either take place at the centralised depots, using automated high-speed counting devices (the costs of which are discussed in Appendix A.3.2.7), or via transportation to one of the many centrally operated counting centres (again, discussed in Appendix A.3.2.7); the additional transportation is assumed not to be significant in this case (because they would have to return to depots anyway which could be just as far in reality).

Plastic bottles and cans will be baled ready for transportation to reprocessing centres in the UK, or to nearby docks for export abroad. This will happen using the retailers existing fleet of large scale transporters (articulated lorries etc). Bales will simply be fork-lifted on and off the vehicle. Under this approach the potential for backhauling is also high. However, we have included this as a real cost to either the retailer or distributor.

Glass, however, must be treated differently. When compacted, the density and nature of the material means that a containment device is required for transportation. Existing systems use skips (which could be of any size) to store the cullet, either colour segregated or mixed. It is not thought that there would be much appetite for the retailers to expand their vehicle fleet to facilitate the transportation of skips. Therefore, we have modelled the collection of colour separated glass being contracted to local waste management companies. These companies may then transport the material to the North East for re-melting, local docks for export, or to other reprocessing activities.

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

[163] '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.

Figure A-7-8: Transport Requirements for Container Collection

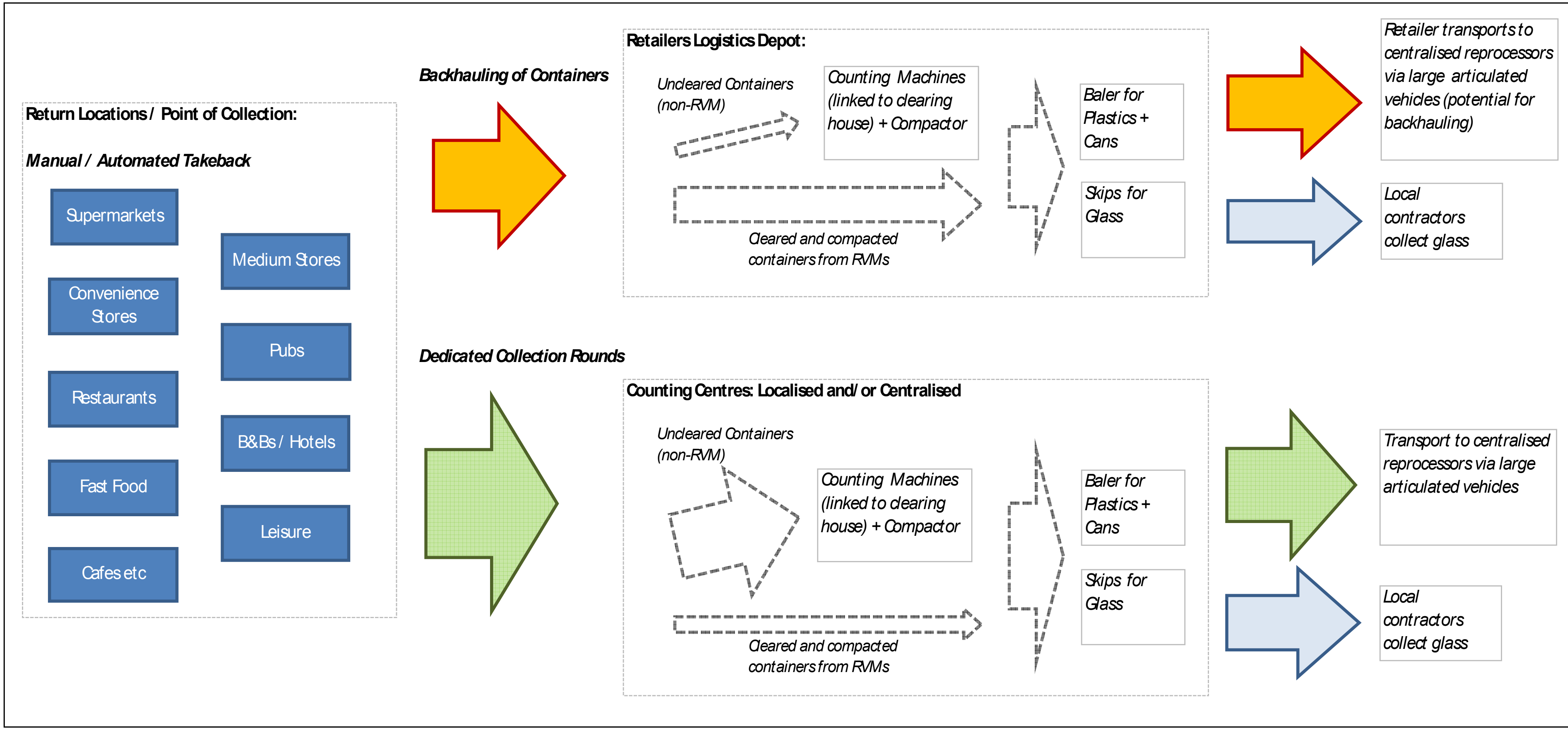

Table A-30: Backhauling from Retailers

Type of Retailer	% of Retailers able to Backhaul
Superstores	100%
Medium Stores	70%
Convenience Stores	20%
Pubs	50%
Restaurants	10%
Hotels/B&Bs	10%
Food Retailer	10%
Leisure	10%
Canteens/cafes in workplace	5%
Kiosks	0%

Source: Eunomia

The *transportation* costs for enterprises backhauling containers from retail outlets is therefore calculated as the combination of the cost to transport baled plastic and cans to a central reprocessor or exporter, and the cost of contracting out the collection of glass stored in skips. These calculations follow.

For the transport of baled plastics and cans from central depots to a reprocessor, the following assumptions were made:

- The average load capacity of the transporting vehicle is 22 tonnes;
- The average distance from depot to reprocessor is 300 km; and
- The average haulage cost, per km, is 84p.[164]

The total cost of backhauling plastics and cans is estimated at **£3.3 million** and **£3.0 million** for the complementary and parallel systems respectively.

For the transport of glass via local collection contractors, the following assumptions were made:

- The average skip capacity is 10 tonnes;
- The average distance from depot to local reprocessor is 70 km; and

[164] Calculation based upon a haulage cost of £1 per mile (average current prices) and 20% of return journeys not enabling backhauling i.e. a real cost.

- The average haulage cost, per km, is £1.40.[165]

The total cost of collecting backhauled glass is estimated at **£9.9 million** and **£8.8 million** for the complementary and parallel systems respectively.

Dedicated Collection Rounds

For many smaller businesses the possibility of backhauling will be limited due to the multiple suppliers servicing the outlet. Organising the loads of vehicles delivering mixed products (including non-beverages) to a large number of different locations would be challenging. Without further dedicated research into supply logistics, it is difficult to ascertain whether any additional backhauling might be possible via some of the suppliers. As the scope of this study does not cover such research, we have assumed that *less* rather than *more* backhauling will occur.

Table A-31 shows the proportion of each retail category which would require a dedicated collection of containers.

Table A-31: Dedicated Collection from Retailers

Type of Retailer	% of Retailers Requiring a Dedicated Collection
Superstores	0%
Medium Stores	30%
Convenience Stores	80%
Pubs	50%
Restaurants	90%
Hotels/B&Bs	90%
Food Retailer	90%
Leisure	90%
Canteens/cafes in workplace	95%
Kiosks	0%

Source: Eunomia

Under these assumptions, just over 15 billion containers would require collecting from around 150,000 locations throughout the UK every year. Figure A-7-8 shows

[165] Calculation based upon a haulage cost of £1 per mile (average current prices), for both legs of the journey.

that the collected containers would be transported to dedicated counting and processing centres (see Appendix A.3.2.7). The setup would be similar to that described above at the centralised collection depots of retailers – requiring counting of un-cleared containers, baling of plastics and cans, and storage of glass cullet in skips. The down-stream transport arrangements will also be the same – baled plastic and cans taken to a central reprocessor and glass collected by local contractors. The main elements in the cost calculations, therefore, are a) transport to counting centres and b) subsequent transport to reprocessing.

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. Plastic bottles and cans will be comingled in heavy-duty bags, potentially including glass where the quantities are small. Where volumes of glass are significant, reusable plastics crates will be employed (see Appendix A.3.2.5). In Germany, for example, containers collected on dedicated rounds are transported in plastics boxes of Europallet size, and on vehicles with tail-lift, or the like.[166] However, the nature of the collections will be different in a UK system.

Taking the existing type of waste collection vehicles in the UK into consideration and the requirement to collect mostly bagged low density containers, the following vehicle setup has been assumed for this study:

- 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 comingled plastic bottles 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 UK-wide level.

A simple collection model was developed to estimate the number of vehicle days required per annum to collect the containers, and the cost of operation per vehicle. The key assumptions are listed below:

- Number of pickups per week (see Table A-29);
- Bulk densities of the containers, estimated based upon likely number per Europallet, and knowledge of wastes collected in the UK for recycling:[167]
    - Glass bottles – 93 kgs/m^3 compacted and 111 kgs/m^3 un-compacted;

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

[167] Personal communications with TOMRA and Andy Grant, Eunomia

    - Plastic bottles – 27 kgs/m^3 compacted and 17 kgs/m^3 un-compacted;
    - Cans – 455 kgs/m^3 compacted and 83 kgs/m^3 un-compacted;
- 70% of retail outlets requiring a collection will be urban, 30% will be rural;[168]
- There are 18 cages (2 m^3 each) on a larger urban vehicle, and 9 on a smaller rural vehicle;
- Drivers work a 9.5 hour day;
- Time is required to drive to and from the round and tip when the vehicle is full;
- It takes an average of five minutes to pickup containers from each store;
- It takes eight minutes to travel between stores in urban areas and 15 minutes in rural areas;
- The cost to operate a vehicle per day (including capital costs, driver wage, fuel cost, maintenance etc, and a large overhead) is estimated at around £310.

The following 'sense-checks' were made to make sure the model was not generating spurious results:

- The average volume of containers picked up per store is 2 m^3. This seems reasonable, being at around 2/3 of a large bag load;
- Individual vehicles collect between 2 and 4 tonnes when full, depending on size. Again, this low weight is reasonable considering the low bulk density of un-compacted plastics and cans;
- The cost of collecting the containers is around £127 per tonne. This is not inconsiderable, but the nature of the collections– small quantities, from a large number of locations, and requiring frequent collections – suggests that this would not be unexpected.

The total cost of collecting containers through dedicated collection rounds is estimated at **£152 million** for both the complementary and parallel systems.

Finally, and following the same assumptions as described previously, the total cost of transporting the cleared and compacted containers to reprocessors was calculated as **£16 million** and **£14 million** for the complementary and parallel systems respectively. This equates to around £13 per tonne of waste collected.

A.3.2.7 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 commingled stream

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[168] Note this may not represent the split of all stores in urban / rural areas. It is likely that very rural stores will opt out of the system so the consumer has to return containers to large centralised supermarkets in more urban areas.

of beverage containers as their input. Any container included in the system, be it plastic, glass or metal can 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 which retailers.

A small number of counting machines will probably be required at some retailer and supplier logistics depots, in order to clear any containers not received via RVMs or other automated systems. However, the majority of counting machines required would be those used by the central system. It is not within the scope of the study to consider spatial distribution of counting centres. However, it could perhaps be assumed that counting centres would follow the distribution of population across the UK.

The system design and costs have been constructed by Anker-Andersen – a supplier of high-speed counting machines (HLZ) - which is based in Denmark.[169] The specification of the system was simply to be able to process the 15 billion containers returned manually to stores around the UK. The collection and transportation costs from the retailer to the counting centres are calculated in Appendix A.3.2.6. The key assumptions involved in the setup of the counting centres system are described as follows:

- There will be around 95 centralised counting centres each with two high-speed machines located around the UK. These will most likely service areas of higher population, around cities and large towns;
- There will also be around 328 smaller scale local counting centres distributed around areas of lower population density, such as towns;
- This setup will ensure collection vehicles do not have to travel a significant distance from the end of a round to a counting centre;
- Labour costs for operating the centres are equivalent to the UK minimum wage (£5.93 in 2010, plus 25% on-costs);
- Centralised counting centres are operated on a two shift basis, and regional centres on a one shift basis;[170]
- Industrial floorspace costs have been estimated at £80 per m^2 per annum;[171]
- Installation and service costs are included in the calculations;
- Each counting centre includes a separate compactor and baler for clear PET, coloured PET, ferrous cans and aluminium cans; and

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[169] http://www.anker-andersen.com/

[170] This allows a greater capacity at the introduction of the system, as centres will be able to operate on a higher shift pattern. The experience from Germany was that many stores initially operated manual take back whilst RVMs were being installed.

[171] King Sturge (2010) Industrial / Distribution Floorspace Today, March 2010, Accessed 18th May 2010, http://www.kingsturge.co.uk/research/industrial-distribution-floorspace-today-IDFT-march-2010.aspx

- An additional factor to account for the counting centres required to process un-cleared containers collected via backhauling is also included. An additional 20% increase in the number of machines is required to manage these containers.

Consequently, the total cost of clearing and processing containers returned manually is estimated as **£74 million** and **£67 million** for the complementary and parallel systems respectively.

A.3.2.8 Calculated Handling Fees

Given the detail provided above regarding the differences between the automated and manual takeback systems, the total handling fee payable to the retailers was calculated separately for those retailers that will be likely to use an automated machine compared to those undertaking manual takeback. For the former, the total handling fee is calculated at **£362 million** and **£359 million** per annum for the complementary and parallel systems respectively. This equates to around **4p per container** handled via an automatic machine. For the latter manual takeback system, the handling fee is calculated at **£214 million** and **£203 million** per annum for the complementary and parallel systems respectively, equating to around **1p per container** handled.

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 UK situation in our modelling. We have, however, been able to establish the numbers of staff involved in administration in the Palpa system in Finland (12 staff), a system which is similar to that which we have modelled for the UK, 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.[172] 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 UK situation based on population, with a small amount of economies of scale factored in (though even without such consideration, the overall admin cost for the system would only be £1.8 million higher than modelled here). The overall on-going costs for the central system are presented in Table A-32.

Given the importance of a fully integrated product database and financial accounting system in the smooth running of the central system administration function, we have tried to be conservative in terms of the on-going IT costs that the

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

system might face, and have thus factored in a total of £4.1 million IT costs per annum, to cover both the database and accounting system, and any additional system requirements for customer services.

Table A-32: 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	£30k per licence	£3.6m
	Total IT costs		£4.1m
Staff costs	Number of database/accounting staff	100	
	Average salary + on-costs (@25 %)	£37.5k	
	Number of customer services advisors	20	
	Average salary + on-costs (@25 %)	£25k	
	Total staff costs		£4.25m
Office space costs	Average leasing cost for fully equipped/furnished office	£500 per person per month	£0.24m
	Total office space costs		£0.72m
	Total support services costs (e.g. Legal, HR)		£0.6m
	Total communications/marketing		£5m
		TOTAL £m PER ANNUM	£14.7m

For staffing costs, we have based the potential number of staff on discussions with Palpa (Finland), and we have assumed a total headcount of 120 people, with higher average salaries for the more technical staff than for the customer services advisors.[173]

For office space, we have also taken a conservative approach and have used the top-end cost of leasing a fully-equipped and furnished office in a city centre such as Bristol which would accommodate 120 members of staff.[174] We have also included an additional £600k of support service costs to cover any legal or HR costs that might be incurred by the central system.

Finally, we have added in £5 million per annum of communications/ marketing costs, to ensure that the system continues to be well publicised. The overall cost of

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173 *Personal communication with Pasi Nurminen from Palpa, Finland, August 2010.*

174 *Personal communication with Regus Office Solutions, 4th June 2010,* http://www.regus.co.uk/

administering the system is thus calculated at **£14.7 million** per annum for both the complementary and parallel deposit systems.

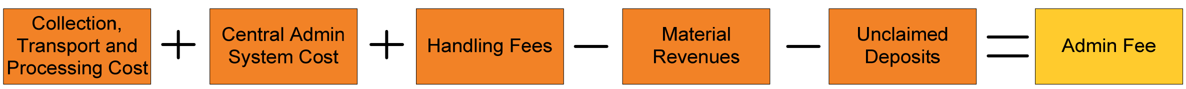
A.3.4 Material Revenues

The material revenues that have been allocated to the material that is collected through the kerbside collection system and deposit refund system are based on a combination of information from LetsRecycle, and from our own knowledge of materials markets in the UK.[175] For the commingled kerbside recycling system, it is assumed that, rather than receiving material revenues for this material, a gate fee of £38 per tonne would be payable in order to sort the material before it can be sent on to reprocessors. For the two-stream kerbside recycling system, it is assumed that material revenues would be obtainable from the collection of paper and card as a single stream, but that a materials recovery facility (MRF) gate fee would be payable in order to sort the containers which would offset the benefits derived from the fibres, leading to an overall zero net benefit from the sale of material in this system. Hence the only two systems modelled as generating an overall income from the sale of materials are the kerbside sort system and the deposit refund system. The material revenues used for these two systems are given as follows:

- PET bottles - £220 per tonne for material collected through the deposit refund system, compared to £150 per tonne for kerbside-sort collected material;
- Glass bottles - £12 per tonne through the deposit refund system. The potential income from glass bottles is assumed to be lower than that which can be achieved from collection at the kerbside (£22 per tonne), as we have assumed that the material will require collection by local contractors who then transport to Yorkshire for remelting or to dockyards for shipment abroad, hence reducing the overall revenue that can be obtained;
- Steel cans - £66 per tonne for material collected through the deposit refund system, compared to £60 per tonne for kerbside-sort collected material;
- Aluminium cans - £900 per tonne. This is higher than the income that we would expect to be obtained at the kerbside (£600 per tonne), as we have assumed that the high quality compacted and baled used beverage containers will be delivered direct to outlets such as Novelis, Warrington (an aluminium roller and can recycler plant).

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:



175 http://www.letsrecycle.com/materials/

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 deposit refund system.

The administration fee payable by the producers for every unit placed on the market has been calculated at 0.7p for the complementary deposit system. This falls close to the range of administration fees set by a number of existing deposit refund systems e.g. 1 to 4p per unit in Finland (dependent on material), just over 2p per unit in Estonia, 1.6p per unit in Maine, USA.[176,177,178] For the parallel system, the administration fee has been set at zero; in this case, based on our assumption that the return rate would be lower in the parallel system and that the deposit would be 15p/30p for smaller/larger containers in both systems, the unclaimed deposit more than offsets the costs of administration that the producer would otherwise be expected to cover. It is important to note that the administration fee will be sensitive to both the return rate and the deposit, 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 over time following introduction of a deposit scheme to ensure that the fee continues to cover the cost of the system.

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 deposit refund system. 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 (provided by TOMRA), and the associated number of days that would be required for each task.[179] 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-27. Based on the modelling, a total cost of **£32 million** would be required to set up the central deposit refund system, plus an additional **£1.25 million** for the producers to change their labelling, and an additional **£51 million** for the retailers to adapt their store areas to accommodate the new system requirements.

It is worth noting that although some producers may need to change their printing procedures in order to ensure that the correct barcode is applied to containers destined for the UK market, the actual changing over of labels will more than likely coincide with the periodical changes that the producers already have to make in

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[176] http://www.palpa.fi/english,exchange rate at 0.8813

[177] http://www.eestipandipakend.ee/eng/epp, exchange rate at 0.0553

[178] http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0216B-06.pdf/$file/EE-0216B-06.pdf, exchange rate at 0.6909

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

their printing process; hence, as long as sufficient lead-in time is given to producers, then the cost of changes to labelling should be able to be kept to a minimum.[179]

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 of £6,698, or an annual joining fee of £1,498 over a 5 year period, and must also pay a per product additional fee of around £300 in both circumstances.[180] In Denmark, the joining fee for producers is £238 per annum, and retailers also pay an annual fee of £59 to make them eligible to receive handling fee payments.[181] In Norway, a one-off joining fee of £3,307 is charged for each producer, plus an additional £551 per product.[182]

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?
- Should a per product fee be charged on top of a more general fee in order to reflect the size of producer/ retail outlet?

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180 http://www.palpa.fi/english,exchange rate at 0.8813

181 http://www.dansk-retursystem.dk/content/, exchange rate at 0.1189

182 http://www.resirk.no/Calculator-83.aspx, exchange rate at 0.1102

Table A-27: 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	£45k		
Fee structures	10	10											20	£30k		
Decide on new central organisation	10	5											15	£22.5k		
Finalise stakeholder requirements	10	5											15	£22.5k		
Work out the clearing house model	20	20											40	£60k		
System security policy	5	5											10	£15k		
Logistics approach	5	5											10	£15k		
Nominate supervisory board		5											5	£7.5k		
Review and approve model			10										10	£15k		
Build Interim Organisation																
Appoint executive team		25											25	£37k		
Create legal entity			30										30	£45k		
Complete start-up budget			30										30	£45k		
Procure and secure financing			25										25	£37.5k		
System Construction																
Procure logistics transport pool and associated IT solutions (in-cab, hand-held etc)				50									50	£75k	£5,750k	
Find office for clearinghouse				10	10	10							30	£45k		
Stakeholder communications				5	5	5	5	5	5	5	5	5	45	£67.5k		
Wider public advertising				20	20	20	20	20	20	20	30	30	200	£300k	£15,000k	

	Total Resources (Days) Required per Month to Deliver Task															
Build container database					3	3	3	3	3				15	£22.5k	£3,450k	
Stakeholder enrollment					5	5	5	5					20	£30k		
Clearinghouse solution					5	5	5	5	5				25	£37.5k		
Acquire or build processing centres					5	5	5	5	5	5	10	10	50	£75k		
Recruit staff				10	10	10	10	10	10	10	10	10	90	£135k		
Populate database										5	5	5	15	£22.5k		
Set up call centre				5	5	5	5	5	5	5	5	5	45	£67.5k	£2,000k	
Legal and consultancy fees (management of)	2	2	2	2	2	2	2	2	2	2	2	2	24	£36k	£4,000k	£31,510k
Producer Impacts																
Change labeling to meet requirements (based on additional 5 day resource to change label printing per producer, total 1,000 producers/ importers[183])**									5000				5000	£750k	£500k	£1,250k
Retailer Impacts																
Optimising outlet floor space to accommodate takeback of containers (manual only)***										1	1	1	472,890	£35,466k	£15,800k	£51,266k

**Day rates are set at £1,500 for all tasks except the producer and retailer impacts. A day rate of £75 has been used for the retailer impacts, based on staff in each outlet undertaking the store adjustments. A slightly higher day rate of £150 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.*

****Note the number of days is per retailer i.e. three days per retailer that would need to make these adjustments.*

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[183] Wetherill, Paul (2009) UK Business: Activity, Size and Location – 2009, An Office for National Statistics Publication, September 2009, http://www.statistics.gov.uk/downloads/theme_commerce/PA1003_2009/UK_Business_2009.pdf

A.4.0 Additional Cost Modelling

Appendix A.4.0 describes the methodology for calculating the change in collection tonnages and hence the associated costs from a reduction in household kerbside arisings. Appendix A.3.0 explains the determination of the costs of operating the deposit system under both scenarios.

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 bring sites;
- Collection of containers through Household Waste Recycling Centres (HWRCs) – both recycling and disposal;
- 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 thus described in the Sections below. These figures will undoubtedly vary across the regions and sub-regions of the UK. However, for the purposes of the modelling presented here, we have mainly drawn from existing Eunomia studies completed in the first few months of 2010 in order to obtain average costs for each collection route.[184,185] Again, the level of detail was limited in these macro level studies. However, the figures used are considered to be good estimates for realistic potential savings associated with a reduction in the need to collect beverage containers through each method. Furthermore, given the uncertainties, we have chosen conservative figures in all cases throughout this study, especially when estimating cost savings.

A.4.1.1 Bring Sites

An average figure for the incremental cost of collecting materials through bring sites (those that collect cans and bottles) was estimated to be £15 per tonne of waste collected. Whether this cost would indeed be the saving achieved from the incremental *reduction* in waste collected is unknown. In principle, the most likely financial saving associated with a reduction in beverage containers at bring sites would be from the reduced *frequency* of collections required, rather than from a reduction in the number of bring sites.

Given that a high proportion of the small quantities of waste that are deposited at bring sites are typically beverage containers, the introduction of a deposit refund system could lead to a noticeable fall in the frequency of collections required at

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[184] Eunomia (2010) *Landfill Bans Feasibility Research*, Final Report for WRAP, March 2010, http://www.wrap.org.uk/downloads/FINAL_Landfill_Bans_Feasibility_Research.f5cf24f9.8796.pdf

[185] Eunomia (2010) *Economics of Waste Management in London*, Report produced for the GLA

bring sites. This could significantly reduce the number of collection vehicles required by an authority, further increasing the 'per tonne' saving. Given our wish not to understate costs, and the relatively low overall tonnages collected through this route, the figure chosen is not considered to overstate the benefits achieved in this study.

Note that the figure given above includes revenue costs from the sale of material. The collection only costs would be higher, but in this case the net figure is correct.

A.4.1.2 Household Waste Recycling Centres (HWRCs)

The costs of operating an HWRC vary considerably depending upon the setup of the centre. Again we aim to estimate a single conservative figure for use in the cost benefit analysis.

The incremental cost of recycling waste at HWRCs has been estimated at £70 per tonne.[186] 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 HWRC 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; hence the avoided costs of recycling would be lower than the figure given, and we have therefore used a lower figure of £15 per tonne to represent savings in handling and staff time for a reduction in containers deposited at HWRCs.

Handling costs for refuse at HWRCs will be low. We estimate these at £15 per tonne of waste delivered to the centre. On the other hand, the cost of disposal of the refuse (landfill gate fees and landfill tax) will comprise a significant proportion of the total costs (see Appendix A.5.1.4).

Regarding disposal, we have assumed an avoided disposal cost of £100 per tonne in this modelling. The justification is as follows:

1. From WRAP's latest survey of gate fees, the median pre-tax gate fee for landfilling reported by local authorities is around £23 per tonne. The landfill tax will be at £80 per tonne in the period which we are modelling (from 2014). The tax rate is set in nominal terms and will be eroded somewhat by the effects of inflation. The level of tax in real terms is expected to be of the order £72.50 per tonne (we have assumed a 2.5% deflator). Hence, the costs of landfilling are likely to be around £95.50 per tonne if the pre-tax gate fees remain constant in real terms (and this has proven a relatively robust assumption over the last 15 years).
2. At the same time, an increasing amount of residual waste will be sent to treatments other than landfill. The gate fee for such treatments, at a scale of around 200,000 tonnes, is currently of the order £90-£120 per tonne. These figures have risen much faster than inflation, and are affected by a range of factors, including (for equipment sourced from overseas) the exchange rate.

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

3. The figure of £100 per tonne thus represents an estimate of the real costs of disposal in 2014 and beyond, effectively 'blending' landfill and other residual waste treatment costs. It should be noted that for some authorities with treatment facilities built in the 1990s, the avoided costs of disposal will be much lower than this. However, many of these will need to be retrofitted / replaced over the coming decade, and the costs seem likely to increase significantly as a result.

Hence the saving associated with a reduction of beverage containers deposited in the refuse skip at HWRCs is estimated to be £115 per tonne. Due to the very low quantities of containers being managed through this route, the cost benefit of the system will not be sensitive to changes in this price.

A.4.1.3 Commercial Collection

The costs of collecting beverage containers from commercial premises, for recycling or disposal, were taken from a study looking at the costs and benefits of landfill bans in the UK.[187] The general principles being a) metals and plastics are likely to be collected together (as separation costs are low), b) glass is collected separately and c) the same cost of refuse collection applies to all material streams.

The costs of waste collection were derived using a simple cost model, which included the following elements:

- Vehicle capital and operating costs;
- Driver / crew costs;
- Estimated number of pickups per day;
- Revenues from the sale of materials; and
- Sorting costs (where applicable).

The resulting costs of collection (and therefore savings avoided with a reduction in the demand for collection services) are as follows:

- Plastics and metals - £136 per tonne;
- Glass - £41 per tonne; and
- Refuse - £35 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 argued in Appendix A.4.1.2 that this cost is around £100 per tonne. Therefore, this saving is also included for each tonne of commercial refuse waste that is diverted into the deposit refund system.

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[187] Eunomia (2010) *Landfill Bans Feasibility Research*, Final Report for WRAP, March 2010, http://www.wrap.org.uk/downloads/FINAL_Landfill_Bans_Feasibility_Research.f5cf24f9.8796.pdf

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, the costs are high, especially for street sweeping services.

The figures extracted from WasteDataFlow provide an estimation of the total quantity of waste collected via both routes. 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. It should be noted that waste collected via street sweeping is significantly more costly than that collected via litter bins.

A small literature review was conducted by Eunomia on behalf of the GLA regarding costs of street sweeping.[188] The data available was found to be very limited - mainly as local authorities do not want to share details of contract prices. Based on this limited research, we estimate the savings from avoided street sweeping could be as high as £1,500 per tonne, and for collection from litter bins (or on-the-go recycling bins), around £200 per tonne of avoided waste.

It could be argued that some of the savings on collection posited in the central case 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).

We have therefore modelled a conservative 20% saving on the collection, but have credited all the savings associated with the reduction in disposal.

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

A.5.0 Environmental Impacts

Environmental impacts associated with the introduction of a deposit refund system will occur from the following processes:

1) Recycling of beverage containers;

2) Disposal of beverage containers;

3) Collection and transportation of containers to recyclers' and

4) Disamenity associated with litter.

Each of these processes is described in further detail in the Sections below.

The two main elements considered for processes 1) to 3) are greenhouse gas (GHG) emissions and air quality impacts. The approach to valuing these two elements is set out in Appendix A.5.1.1 and Appendix A.5.1.2. However, there is also an environmental impact to be considered. This is related to the disamenity associated with litter. There is a dearth of relevant studies allowing the valuation of this, but it is simply too important, in our view, to be assigned (implicitly) a zero value. Our approach is set out in Appendix A.5.1.6.

A.5.1.1 Greenhouse Gas (GHG) Valuation

The approach detailed in the latest guidance from the Department of Energy and Climate Change (DECC) on the valuation of carbon in policy appraisal forms the basis of the valuation of GHG-related impacts.[189] The approach is the same used in the cost benefit analysis of landfill bans undertaken by Eunomia; full details of the calculations used can be found in the appendices of the document.[190]

Under the DECC approach, the precise valuation methodology differs according to the specific policy question being addressed:

- For appraising policies that reduce/increase emissions in sectors covered by the EU Emissions Trading System (ETS), and in the future other trading schemes, a 'traded price of carbon' will be used. This will be based on estimates of the future price of EU Allowances (EUAs) and, in the longer term, estimates of future global carbon market prices;
- For appraising policies that reduce/increase emissions in sectors not covered by the EU ETS (the' non-Traded Sector'), the 'non-traded price of carbon' will be used, based on estimates of the marginal abatement cost (MAC) required to meet a specific emission reduction target;

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[189] DECC (2009) Carbon Valuation in UK Policy Appraisal: A Revised Approach. Climate Change Economics, Department of Energy and Climate Change, July 2009.

[190] Eunomia (2010) *Landfill Bans Feasibility Research*, Final Report for WRAP, March 2010, http://www.wrap.org.uk/downloads/FINAL_Landfill_Bans_Feasibility_Research.f5cf24f9.8796.pdf

- In the longer term (2030 onwards), consistent with the development of a more comprehensive global carbon market, the traded and non-traded prices of carbon converge into a single traded price of carbon.

The value of carbon is deemed to vary over time. For recycling, where both recycling and the manufacture of containers using virgin materials are assumed to occur overseas, the emissions savings will be valued at the Shadow Price of Carbon (SPC), although for modelling purposes, from 2020 to 2030 the SPC prices would be amended, converging linearly with the traded price.[191]

Given that the benefits associated with GHG emissions reduction are posited to increase in the future, the year in which the modelling is set will affect the overall monetised value of emissions. Ideally we would model waste flows over time, apply the correct value year-by-year, and calculate the net present value of the total benefits. Given that the study is forward looking, it seems sensible to choose a year, not too close, but not too far ahead. The values for 2020 have thus been used in the calculation of greenhouse gas associated damage costs.

A.5.1.2 Air Quality Valuation

We have considered the impacts upon air quality that are expected to result from the treatment processes, including both direct and indirect impacts (the latter relating to avoided impacts associated with energy generation and the recycling of materials).

Our approach is to apply external damage costs to emissions of a range of air pollutants, allowing for the quantification of impacts in monetary terms.

The analysis that follows is focussed upon emissions to air. Whilst waste treatment processes may also in some cases affect soil and water quality, data regarding the precise nature of these impacts is less robust, and valuation data is more scarce still.

Two sets of damage costs were initially considered for this study, based on the cost benefit analysis of landfill bans undertaken by Eunomia, and with full details again provided in the Appendices of this document. [192] In summary, the two sets of damage costs considered were:

- The first set is from the UK Government's Interdepartmental Group on Costs & Benefits (IGCB) Guidance on Air Quality Damage Costs. This covers damage costs for particulate matter (PM10), oxides of nitrogen (NOx), sulphur dioxide (SO2) and ammonia (NH3). Emission damage costs are broken down by sector and, for transport emissions, by location;

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[191] The IPCC approach considers GHG emissions only insofar as they affect the UK's inventory as reported to the IPPC. In this case, any increase or reduction in GHG emissions overseas as a result of UK waste management is ignored. Under the Global approach, all emissions would be considered, irrespective of the location of their generation.

[192] Eunomia (2010) *Landfill Bans Feasibility Research*, Final Report for WRAP, March 2010, http://www.wrap.org.uk/downloads/FINAL_Landfill_Bans_Feasibility_Research.f5cf24f9.8796.pdf

- The second set, covering a wider range of pollutants, uses UK-specific damage costs for non-GHGs taken from the Clean Air for Europe (CAFÉ) programme, and the Benefits Table (BeTa) database. The figures are given in Euros in year 2000 prices, so they are converted to £ and inflated to 2009 prices. Damage costs for carbon monoxide are taken from a Danish study. The 'medium high' dataset has been used for valuing impacts.

However, ongoing work around the valuation of air emissions under the IGCB dataset (currently being undertaken by Eunomia) is showing that these figures are underestimates of the likely damages associated with air emissions. Taking the precautionary approach, the Café data set, has been used as these are generally higher than the IGCB figures – the medium low values were used for this study.

A.5.1.3 Recycling of Beverage Containers

A significant quantity of recycling is already taking place, as presented in the baseline in Appendix A.2.2. The aim of this study is not to value the material that is already being collected for recycling, but to establish the value of the additional recycling that will occur as a result of higher return rates from the parallel and complementary deposit refund systems. Recovery rates for the baseline and the two scenarios are shown in Table A-34.

Table A-34: Recovery Rates and Additional Material Recycled (thousand tonnes)

Products	Recovery Rate			Additional Material Recycled (thousand tonnes)	
	Baseline	Complementary	Parallel	Complementary	Parallel
Glass Bottles	77%	95%	95%	425	420
PET Bottles	29%	93%	90%	200	192
Cans (Fe.)	43%	94%	92%	102	98
Cans (Al.)	37%	92%	89%	68	64
Total	68%	95%	94%	795	773

Source: Eunomia

Emissions factors for recyclates were taken from the Landfill Bans study.[193] Under the approach to valuing GHGs (see above) a different value is used depending on whether the emissions are saved in the UK, or abroad. For this model, it is assumed that 50% of the recycling of each material would occur in the UK and 50% overseas.

[193] Eunomia (2010) *Landfill Bans Feasibility Research*, Final Report for WRAP, March 2010, http://www.wrap.org.uk/downloads/FINAL_Landfill_Bans_Feasibility_Research.f5cf24f9.8796.pdf

Therefore, half of the GHG emissions are valued at the non-traded price, and half at the shadow price of carbon.

Air quality impacts are calculated using the values discussed in the section above; however, it is recognised that emissions may attract a lower value in countries where recycling activities take place. The GHG and air quality impacts are given per tonne of material recycled in Table A-35.

Table A-35: Recycling Impacts for GHGs and Air Emissions, per tonne

Material	GHGs	Air Quality
Glass	-£13	-£10
Ferrous metal	-£62	-£53
Non ferrous metal	-£430	-£333
Dense plastics	-£64	-£51

Source: Eunomia (2010) Landfill Bans Feasibility Research (AQ – Café only)

From the assumptions laid out above, the total monetised benefit of the additional recycling generated from introducing a deposit refund system is calculated as **£88 million** and **£84 million** for the complementary and parallel systems respectively.

A.5.1.4 Disposal of Beverage Containers

The total change in tonnages requiring disposal was calculated when determining the scenario waste flows (see Appendix A.2.3.3).

For the potential savings associated with reduction in containers going to landfill, it is important to determine whether the potential environmental benefit calculated via the above means (GHGs and air quality) is less than or greater than the actual financial benefit associated with a reduction in landfill tax.

The landfill tax is applied as a means to internalise the externalities associated with landfilling waste ie. it accounts for environmental benefits as a 'private' cost. Given that, in this instance, the landfill tax is greater than the calculated environmental benefits associated with a reduction in containers going to landfill, the landfill tax has subsequently been used to calculate the benefit associated with avoided landfill, as detailed in Appendix A.4.0.

Similarly, we have not included damage costs associated with disamenity of waste treatment facilities, as estimates of disamenity costs vary considerably between the different sources, and are not yet available for processes other than incineration and landfill.

Excluding the savings that are associated with avoided payment of landfill tax, which have already been discussed in Appendix A.4.0, the only other environmental benefit would occur if containers are displaced from other forms of residual treatment. In this model it is assumed that 25% of the UK's waste is managed though thermal facilities in the future. We therefore use the figures for energy from waste (EfW) calculated in the landfill bans study as unit impacts for GHGs and Air Quality. The approach to valuing these impacts is described in detail in the appendices for this report.[184]

The total monetised benefit of containers being diverted from disposal is thus calculated at around **£6 million** for both scenarios.

A.5.1.5 Collection of Beverage Containers

Beverage containers are collected and transported large distances to reach reprocessing facilities using trucks and lorries. These vehicles emit greenhouse gases, and a number of other compounds and particles, which cause damage to the environment. It is important to include these impacts in the cost benefit analysis. However, it is also important to include the avoided transportation from a reduction in waste collected at the kerbside or from commercial premises.

Table A-36 thus shows the estimated distance travelled for the various elements of the overall modelling, including changes to the kerbside collection system and the direct impact of the introduction of specific beverage-container collection rounds for both scenarios.

Table A-36: Distance Travelled in Collecting Containers, thousand km

Transportation Requirement	Miles Driven	
	Parallel	Complementary
Household - Recycling	-4,293	-4,890
Household - Refuse	-1,302	-1,332
Commercial - Recycling	-1,838	-1,932
Commercial - Refuse	-889	-935
Street Collections	-233	-245
HWRCs	-184	-193
Bring Site	-646	-679
Backhauling	0	0
Collection Rounds	132,490	132,490
Additional Consumer Journeys	286,000	286,000
Net Change	409,104	408,284

Source: Eunomia

Using the Euro 5 emissions limits for HGVs and Café air quality damage costs, the total environmental damages from the increase in vehicles collecting waste is estimated at around **£25 million** for both scenarios.[194] If the Euro 6 emissions limits are used (those to be in place for new vehicles by 2014), the damages fall to around **£9 million.**

A.5.1.6 Disamenity of Uncollected Litter

There is a negative environmental impact, or disamenity, associated with uncollected litter. A study by Cambridge Economic Associates indicates that the average household would be willing to pay £25 per annum to live in a neighbourhood where the streets are kept clean.[195] Unfortunately, however, this value does not cover the potential willingness to pay to remove litter from rural areas, and, as far as we are aware, there are no studies attempting to place a value on the disamenity experienced in such circumstances in the UK.

The only significant study of this nature of which we are aware was carried out in Australia by Pricewaterhouse Coopers. This indicated that households are willing to pay, on average, AUS $4.15 per 1% reduction in litter. The quantification of 'reduction' is not clear, but if, in line with the work of Stein and Syrek, we take the view that size (volume) is a proxy for visual impact, and that visual impact is what residents most notice, then we might assume that households interpreted this in terms of volume reduction.[196]

Assuming this to be the case, then if one also assumes:

- Beverage cans occupying 25% by volume of litter (which may be conservative);[197] and
- 80% reduction in beverage-related litter as a result of a DRS[198]

then the effective reduction in litter volume would be equivalent to 20% of the total. Using the Pricewaterhouse Coopers figures, converted to UK exchange rates (we

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[194] http://europa.eu/legislation_summaries/environment/air_pollution/l28186_en.htm

[195] Cambridge Economic Associates et al (2010) Developmental Work to Value the Impact of Regeneration, Technical Report: Environmental Quality and Amenity, May 2010

[196] Steven Stein and Daniel Syrek (2005) New Jersey Litter Survey: 2004, A Baseline Survey of Litter at 94 Street and Highway Locations, Report for the New Jersey Clean Communities Council, January 28, 2005. http://www.njclean.org/2004-New-Jersey-Litter-Report.pdf

[197] The analysis in Section 4.2 above suggests that the effect of DRSs on the volume reduction in litter in the US may be well above this figure, and in systems which are achieving lower return rates than the one modelled here. In addition, the analysis of the composition of litter in the UK is at least suggestive of a relatively high proportion of the volume being occupied by beverage containers.

[198] These figures are typical of the levels of reduction reported under DRSs for beverage containers (see, for example, 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).

have used the rate UK£ 1 = AUS $1.73), the value of this would be £48 per household.

This gives a net figure, across 26 million households in the UK, of £1,248 million per annum.