The impact of the carbon agenda on the waste management business

Grant Thornton

Oakdene Hollins

Carbon emissions RECYCLING
Waste management
WASTE TARGETS
Landfill
SUSTAINABLE INVESTMENT Regulatory control
Closed loop
CO_2 benefits lost carbon
Glass recycling policy
Negative environmental effects
economic trade-offs Landfill
Glass recycling policy
RESOURCE MANAGEMENT

Part of the Grant Thornton thinking series

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Glossary

BREW – Business Resource Efficiency and Waste programme
A provider of funding derived from the landfill tax to organisations such as Envirowise and NISP. It aims to give resource efficiency support to UK businesses.

BVI – Best Value Indicators
Performance measurements mandated by the Government upon public bodies to characterise the value of services.

Closed Loop Recycling
Where the collected material is put back into use in the same applications as originally intended. See Open Loop.

CO_2 – Carbon Dioxide
The most common greenhouse gas produced as a result of combustion processes.

6th EAP – 6th Environmental Action Plan
Adopted by the European Parliament and Council in 2002 and running until 2012. It requires the European Commission to prepare Thematic Strategies covering seven areas such as air pollution and the prevention and recycling of waste.

Envirowise
Government body offering free and confidential advice to help companies become more resource efficient by identifying where waste production can be minimised and cost savings made.

GHG – Greenhouse Gas
Gases with significant global warming potential, commonly expressed as the mass of carbon dioxide (CO_2) having an equivalent warming effect.

LATS – Landfill Allowance Trading Scheme
A scheme where local authorities are allowed to trade their landfill allowance permits. The number of permits decreases with time to achieve the Government's targets for diversion of waste from landfill.

Light-weighting
Designing a product such as an aluminium can or glass bottle to the thinnest and lightest specification in weight terms.

MTP – Market Transformation Programme
Supports the development of UK Government policy on sustainable products. MTP were awarded £3.3 million in 2006/7 to develop forward-thinking market projections and action plans on technological, market and policy developments.

MBT – Mechanical Biological Treatment
Latest generation of technologies for handling mixed wastes incorporating sorting, processing, digestion, combustion or SRF manufacturing steps.

NISP – National Industrial Symbiosis Programme
Government body that facilitates links between industries from different sectors to create sustainable commercial opportunities.

Open Loop Recycling
Where the collected material is put back into use in different applications from originally intended. See Closed Loop.

PRN – Packaging Recovery Note
A regulated system of obligations on producers and users of packaging to ensure materials recovery, whilst financing reprocessors of such materials.

Renewables
A collective term for energy-producing technologies and systems based on naturally replenished sources: wind, solar, tidal, wave, biomass etc.

ROCs – Renewable Obligation Certificates
Eligible renewable energy operators receive certificates for each MWh of electricity they generate. These certificates can then be sold to suppliers, in order to fulfil their obligation. Suppliers can either present sufficient certificates to cover the required percentage of their output or they can pay a "buyout" price for any shortfall. All the proceeds from this payment are given back to suppliers in proportion to the number of ROCs they present.

RDF – Refuse-Derived Fuel
See SRF.

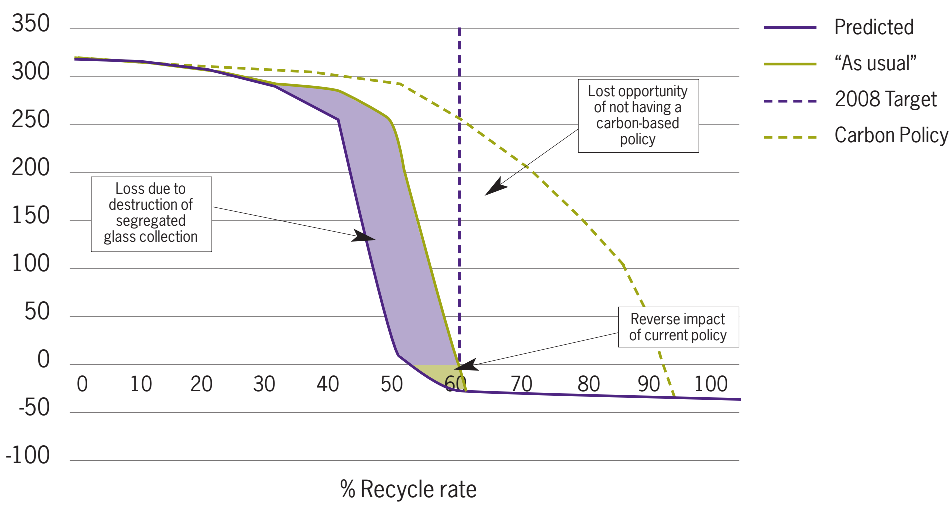
SRF – Solid Recovered Fuel
Often known as RDF, fuel derived from wastes, typically through an MBT process.

WRAP – Waste Resources Action Programme
Established by the Government in 2001 to promote sustainable waste management.

1. Executive summary

Over recent years the renewables sector has seen a substantial increase in investment activity. Clear signals in the policy landscape and regulatory framework, coupled with outcome-oriented economic incentives seem to be driving the evolution of novel solutions to energy issues, with a commensurate demand for finance, both internal and external. The alignment of theses factors is a key factor in the step change seen in the investment activity.

Figure 1: Marginal CO_2 benefit from glass recycling



Source: Oakdene Hollins Ltd/Grant Thornton

However, the landscape, regulatory regime and technologies of the waste management domain are not well aligned. Although they reflect a desire to address the expanding waste mountain – an issue of major concern – they lack the focus required for a simple unifying outcome.

The drive to find economic recycling options for large tonnages is having negative side effects. For example, recycling large quantities of glass is being done at the cost of destroying the process of segregated collection – a prime requirement for recycling efficiency. So, although agencies involved in promoting glass recycling markets have raised recycling volumes, current materials recovery targets will result in significant lost CO_2 benefits of around 100,000 tonnes per year.

The Government's 60% recycling target for glass will be achieved by encouraging the grinding of the product in order to manufacture a substitute for architectural and filtration sand. However, this energy-intensive recycling process generates more CO_2 than if the glass was sent to landfill.

Such outcomes occur because financial instruments and policy interventions have been designed to encourage tonnage diversion from landfill, regardless of CO_2 implications.

The 60% recycling target for glass will save around 300,000 tonnes of CO_2 per year. However, the same target could save a further 100,000 tonnes if policies were better directed. In addition, targets could be feasibly extended well beyond 60% to produce even further benefits for very little cost (under £3 million based on typical Carbon Trust cost-benefits).

As the drive towards increased levels of recycling continues, there is a very real danger that hard-won gains in the renewables sector may be eroded unless the relative carbon effect of different recycling strategies is properly understood and acted on.

- Some types of recycling can have a negative impact. The good work performed to date with regards to materials recovery and re-use will be offset by decreasing and even negative environmental effects in the future. This is likely to be the case across many material streams.
- The current basis for establishing landfill diversion and recycling targets is incorrect – motivations provided by weight-based recovery targets will have increasingly negative carbon benefits. Grant Thornton and Oakdene Hollins believe that waste management policy should be realigned with the carbon agenda.

- This report proposes that the current basis for establishing landfill diversion targets, and the balance within the resource recovery agenda could be supplanted by a better driver of sustainability based on GHGs or carbon impact measures.
- This could be achieved by rationalising existing fiscal and market-based systems using relatively simple mechanisms. In some materials, an international exchange of recyclates could address local supply and demand imbalances and produce consequential carbon benefits. These moves could remove the need to adopt inferior recycling technologies. Incentives such as the creation of international carbon-trading permits may serve to help matters.
- In the context of the new framework, deriving energy from waste is a valid, CO_2 beneficial option for some waste disposal, particularly in consideration of the treatment of organics.
- We expect the Government will recognise the carbon effects of current recycling policies and it is likely that changes in the waste management framework will result. Potential investors in this field should therefore be cautious about technologies that are not aligned with the carbon agenda.

2. Introduction

Under the microscope

There has never been greater Government interest in environmental issues than at present. For the general public, the issue of global warming is perhaps the most visible aspect of legislative concern; it sees a variety of initiatives encouraging energy saving in the home and fuel economy in personal transport. Even if the public feels its own responses to environmental challenges are voluntary, it believes the Government is justified in applying statutory pressures to businesses, especially large energy users, to reduce their burden (in the form of CO_2 emissions) on the environment.

In this climate, financial incentives ranging from research to investment in plant and carbon credits are driving the development and implementation of "low carbon" products. These products, aimed at the centralised energy supply markets, are also spilling into the public domain as consumers become aware of the possibility of taking control of their own energy costs. While this trend is tentative, it is clear that economic drivers, linked to desired environmental outcomes via an evolving public policy shift, have the potential to transform the shape of the energy grid. As a result, significant changes in the roles of centralised and decentralised energy generation and transport could occur.

On the back of these policies and incentives, there has been a significant upswing in investment activity in the renewables sector. The Carbon Trust recently commissioned a review[1] of activity associated with Clean Technology (which is broadly understood to embrace low carbon technology). It estimated that the investment community has significantly changed its attitude to businesses involved in Clean Technology – triggering an increase of £1 billion in investment during the period 2000-2004. While such figures are estimates, there is strong indication that investors have confidence in a sector that is driven by long-term social objectives.

2.1 Spotlight on waste

Waste management has received similar levels of policy attention. Numerous agencies are charged with promoting resource efficiency. For example, Defra's Business Resource Efficiency & Waste (BREW) fund supports the activities of bodies targeting largely industrial waste reduction, recovery and re-use. DTI, WRAP, NISP, Envirowise, Environment Agency, Market Transformation Programme, Carbon Trust and Regional Development Agencies all promote or support one or other aspect of resource efficiency.

Public involvement is largely concerned with activities aimed at recycling post-consumption waste materials. This is commonly via bottle, paper and clothing banks and more obviously through the direct action of local authorities implementing segregated kerbside waste collection. WRAP is presenting a number of public messages promoting the activity and also encouraging the development of an infrastructure necessary to handle recovered materials and convert them into reusable products.

In the public domain, the drivers for waste management are loosely and incoherently coupled to an environmental benefit. Typical messages – historically promoted by green campaigners – have targeted recycling as the major route to material de-intensification. This message has been adopted at European level and translated into public recycling targets that are linked to the need to combat dwindling landfill space throughout the continent. Collection authorities and recycling agents have thus felt fully vindicated in pursuing blanket weight-based recovery targets, even if this is at a cost to their constituents. In the commercial domain, waste reduction, recovery and raw material substitution are linked to a cost-saving incentive. However, this does not necessarily translate into environmental gains.

[1] Investment Trends in UK Clean Technology 2000-2004, Library House for Carbon Trust, May 2005

2.2 The waste management paradigm

The current aim of waste management is to reduce the volume of waste committed to landfill and to lower the volume of raw materials employed in production through recycling. There are some direct environmental benefits of landfill reduction – such as lowered methane evolution levels, although these might be achieved by other means, such as trapping and flaring.

However, it is increasingly apparent that all materials are not equal in their environmental effect. As part of a recycling chain, the marginal gains achieved by recycling different materials are related to the absolute levels of re-use and recovery. In this respect, landfill targets, PRNs, LATS and recycling targets form part of a suite of policy measures for tackling disparate waste problem areas. But these measures appear fragmented without a defined framework for measuring success.

This report presents an analysis of materials-based policies that shows the effect of some publicly-financed recycling options can be less than perfect and, in some cases, even counter-productive when examined from a carbon perspective. As the drive to increase the level of recycling continues, there is a danger that hard-won gains in the renewables sector may be eroded unless the relative carbon effect of different recycling strategies is properly understood and acted on.

3. Analysing the context of waste management

3.1 Waste as a policy issue

Traditionally, talk of waste has centred on the management of disposal issues (particularly to landfill sites) and the collection activities of local authorities and waste management companies prior to disposal. Disposal activities have themselves received attention not only because of the perceived decline in landfill capacity in the EU, but also because of direct health and environmental effects attributed to landfill operations. These effects include health complaints associated with noxious materials escaping into air or water and the effect of the emission of degradation products such as CO_2 and methane, both of which are known greenhouse gases.

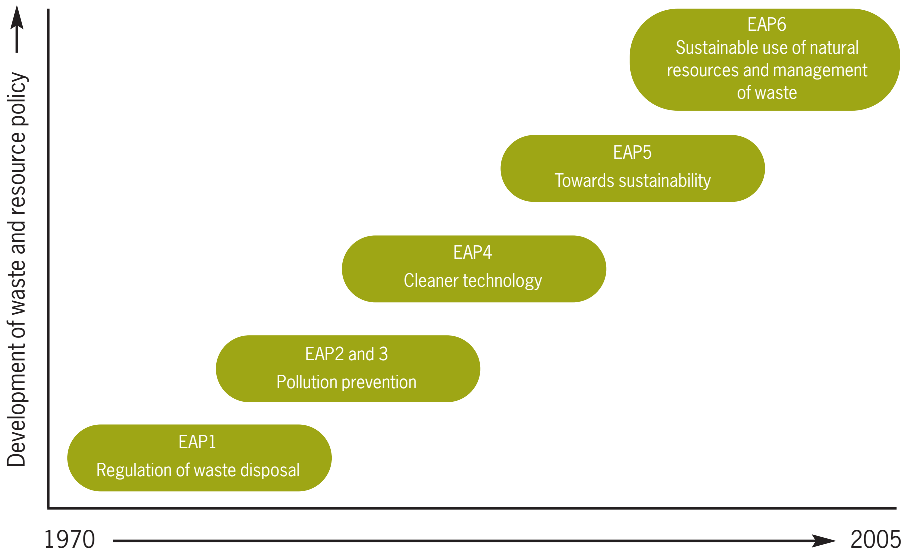
Legislation has therefore sought, successfully, to control these emissions by placing restrictions on waste operators. Such control has seen moves to segregate hazardous wastes and improve the design of landfills as well as carbon-based incentives to encourage the use of landfill gases as fuels.

A second and deeper strand of EU policy has considered the implications of landfill reduction with regards to materials recovery, recycling and re-use policies. A raft of legislation has created increasing targets for recovery, primarily aimed at the collection authorities. However, significant aspects of legislation target industrial and commercial users, for example in the areas of packaging. As a result, a complex infrastructure has developed in respect of the administration and validation of these schemes.

3.2 Indecisive directives

The growing waste mountain and the shortage of landfill has initiated a raft of directives whose effect is now manifesting itself in local policy.

Figure 2: EU Environmental Action Plans (EAP) over last the 30 years



The recent evolution of EU policy is illustrated in Figure 2. It shows a distinct trend from action on isolated waste issues to a broader consideration of resource use which has implications across the whole life-cycle of product manufacture, use and disposal. However, the policies have been developed in an incremental fashion, carrying the baggage of previous initiatives and do not, therefore, incorporate objectives related to specific environmental outcomes.

3.3 Diversion tactics

The Landfill Directive (1999/31/EC) embraces the principles of the so-called waste hierarchy, and is the key driver for much current waste disposal practice, including the capture and use of landfill gas. The resulting energy qualifies for Renewable Obligation Certificates (ROCs) and has given operators an additional financial incentive in the form of a subsidy. This is a successful example of tackling the direct effects of landfill to achieve a specific environmental outcome.

The indirect effects of waste are tackled in Article 5 of the Directive, which requires waste to be diverted from landfill. Specifically, it limits the amount of biodegradable municipal waste that can be sent to landfill to 35% of 1995 levels by 2020. The immediate effect of the Directive has been to set in motion a diverse range of legislation aimed at recovering, reusing or recycling waste materials. Legislation has targeted:

- use of materials in packaging, through the Packaging Recovery Note (PRN) system
- renewable electricity, through permitting landfill gas combustion, or the anaerobic digestion of putrescibles with associated energy allowances[2]
- individual material targets through obligations on local authorities
- specific constraints on, and exclusions from, landfill, such as on tyres
- direct support of fledgling recycling businesses through WRAP.

However, these directives are tonnage targets with no specific link to environmental outcomes – there is no mechanism to judge relative costs or benefits in common, meaningful terms.

In good faith, local authorities have accepted these targets and have translated them into measurable Best Value Indicators (BVIs), as shown in Table 1.

In pursuit of these simplified objectives, decision makers quite rightly make choices based on economics, irrespective of other factors. The waste hierarchy is not sufficiently subtle to reveal the net environmental benefits of each option. A number of analyses that have compared waste management options across materials and technology parameters have used greenhouse gas impact (primarily CO_2) as a relevant indicator of environmental damage in the form of global warming. However, these comparisons are not routinely used in decision making.

Table 1: UK MSW Best Value Performance Indicators

Best Value Performance Indicator	Desired effect	
% tonnage recycled	↑ Increase	Hierarchy of treatment
% tonnage composted	↑ Increase	
% tonnage energy	↑ Increase	
% tonnage landfill	↓ Reduce	
kg collected per capita	↓ Reduce	
Cleansing cost per square kilometre	↓ Reduce	
Cost of collection per household	↓ Reduce	
Cost of disposal per household	↓ Reduce	
Collections missed per 100,000	↓ Reduce	
% kerbside recyclables	↑ Increase	

[2] The UK has chosen not to include Energy from Waste (EfW) in ROCs-qualifying technologies, even though a recent report form the Renewable Power Association (RPA) and Institution of Civil Engineers (ICE) estimates that 17% of the UK's electricity could be generated from it.

3.4 Tonnage targets: Do they work?

Ironically, extensive recycling can produce some undesirable outcomes. When starting up a recycling scheme, the end market is often closed loop recycling[3], which is usually the most beneficial from an environmental perspective. However, at high recycling rates, these markets can become saturated, causing the environmental benefit per tonne recycled to reduce.

In addition, it may not be possible to exploit closed loop markets fully if the value chain economics favour diversion to alternative (less environmentally beneficial) end markets. This can occur if all recycling applications receive equal merit in policy terms, irrespective of the net environmental benefit achieved. This reduces the environmental benefit of recycling at a much earlier stage. It is our contention that this is the current state of affairs in the UK.

It is widely accepted that policy makers are right to set targets that are clear, objective and measurable. It has, however, also been demonstrated that the manner in which targets are defined can have unexpected consequences which need to be taken into account. Targets should then be refined if necessary.

Our research shows that there are few simple choices to be made within today's waste and resource management framework. Benefits depend on scale, technology, local conditions and the prevailing level of recovery activity, among other factors.

In the light of the impact of tonnage policies, it is relevant to ask whether we have properly defined the problem. The effect of choosing tonnage drivers over, carbon drivers, for instance, has serious implications for policy outcomes (this is explored further in Section 4 by reference to the position in the glass sector).

[3] Closed loop applications are those where the recovered material is placed back into the same end use after reprocessing. An example is a beer bottle collected and re-melted for new bottle manufacture. Open loop materials are directed into different applications, such as bottles into bricks.

4. Glass recycling

All mixed up

The previous sections have indicated how the evolution of landscape and public policy have forced a largely incremental and piecemeal change in attitudes to waste management. In this section we discover – by paying particular attention to glass – the counter-productive nature of the current framework for waste management and its concentration on tonnage recovery targets. The major findings are:

- waste policies in the UK are currently focused on meeting tonnage-based recycling targets
- in order to meet these targets at the lowest cost, the grinding of glass to make sand and other materials is encouraged even though this form of recycling offers little or no CO_2 reduction benefits
- these carbon-blind policies are leading local authorities to collect green, clear and brown coloured glass together. Since the glass is not colour separated by the consumer or the local authority prior to recycling, it is difficult to use it for re-melting as new glass (closed loop recycling) due to the man hours and expense involved in the colour separation process
- Grant Thornton believes that higher glass recycling rates (of 80% or more) together with reduced CO_2 emissions could be achieved if policies were better directed
- the Government could achieve higher recycling targets, as well as much higher CO_2 reductions (without spending additional money), by increasing the international trade of glass cullet
- for example, the UK currently imports approximately 500,000 tonnes of green glass as packaging for wine. No more than 45% of this can be used for re-melt in the UK because the supply of new green glass outweighs demand. However, the remaining 55% could be exported for re-melt in bottle manufacturing sites in other countries – particularly those that are large producers of wine
- additionally, policies could be directed to encourage the bulk import of alcoholic beverages, (especially wine and beer, which are traditionally drunk from green bottles) for bottling inside the UK (as opposed to in their country of origin)
- up to 90% of what goes into a glass furnace can be “used” glass. The CO_2 benefits when re-melting glass in the furnace are much larger than when grinding glass for use in construction materials (even taking transport emissions into account)
- Grant Thornton thinks the PRN system should be reassessed as it does not recognise carbon benefits at all
- payment for good carbon processes, such as re-melting, should be higher than for poor carbon processes, such as grinding glass for construction materials.

Glass has been used as an example because relatively comprehensive data exists regarding type, sources, uses and the energy associated with its handling and processing. Critically, recycling is reaching levels which may have negative impacts. In addition, outputs are adversely affecting the recycling infrastructure, making environmental targets even harder to meet.

Other materials offer more complex cases for analysis, but it is likely that similar issues will emerge.

4.1 Not worth the weight

Glass is an attractive material for recycling. Its high density makes it an effective target for local authorities driven by weight-based collection objectives. Also, commercial disposers are obligated to finance its recovery through the mandatory Packaging Recovery Note (PRN) system.

Driven by EU directives, the Government has set challenging targets for the recycling of glass packaging, as shown in Table 2 (note that this table excludes non-packaging applications, but these will be discussed later).

In essence, targets demand that 1.6 million tonnes of glass be recycled in 2008 to achieve a 60% packaging recovery and re-use rate. The largest single use of glass and its greatest re-use is in bottle manufacturing (known as closed loop recycling). A prime requirement for this is the segregation of used bottle by colour into clear (flint), amber and green. The key point to note is that clear and amber are less tolerant to contamination by other colours while green can tolerate some contamination. This sets demands on the "purity" of the collection system for re-melting. Three estimates of the processing capacity of the glass industry have been made by WRAP, Packflow (Valpak) and Colourite (sponsored by WRAP)[4].

Table 2: Government targets for glass recycling

Glass packaging	Achieved					Projected	
	2002	2003	2004	2005	2006	2007	2008
Total glass packaging in waste stream (Mt)	2.191	2.300	2.400	2.500	2.600	2.650	2.700
Glass recycled or required to be recycled (Mt)	0.747	0.862	1.049	1.088	1.370	1.505	1.633
Recycling rate (%)	34.1	37.5	43.7	43.5	52.7	56.8	60.5
PackFlow estimated performance (Mt)	–	–	–	1.191	1.279	1.361	1.448

Note: red figures indicate a shortfall in performance vs. requirement

Table 3: Projected bottle glass processing capacities in 2008

	WRAP market study	PackFlow	Colourite project	Mean of 3 studies
Clear	719,700	630,000	580,000	643,200
Green	295,800	330,000	350,000	325,300
Amber	189,100	140,000	190,000	173,000
Total	1,204,600	1,100,000	1,120,000	1,141,500

Table 3 shows these estimates. Although the totals are broadly similar, there is significant variation in the estimates, with the greatest range being observed in the clear glass. In the absence of better data we have taken the average as a basis for further analysis.

From these estimates, it is clear that closed loop packaging uses alone will not be sufficient to meet the Government's target of 1.6 million tonnes. Therefore, to stimulate other demands for recycled glass, agencies such as WRAP have been developing and supporting new market applications such as its use in aggregates, as a fluxing agent in bricks and as finely ground filtration sands. Table 4 is taken from the WRAP report, and shows that the three closed loop container applications and the aggregates applications are the two projected major growth areas to 2008.

Other estimates of end markets for recovered glass have also been made by Valpak and Colourite (see Appendix 2). These lack the detail of end use presented by WRAP but are included for comparison and completeness.

[4] The Recycled Glass Market Study and Standards Review, 2004 update, WRAP by Enviros, May 2004.
The Colourite Project: Maximising Cullet Additions in the Glass Container Industry. Interim Report1, WRAP by Glass Technology Services Ltd, 2005.
PackFlow 2008. Volume 1: Project Report, Valpak by David Davies Associates, July 2005.

Table 4: Projected glass recycling by end use application ('000s tonnes)

Application	2004 [kt]	2008 [kt]	
Containers- green	250	300	Container growth 700→1060 kt
Containers – amber	100	200	
Containers – clear	350	560	
Fibre glass – container	17	20	
Aggregates – concrete	20	35	Aggregates growth 173→258 kt
Aggregates - general fill	50	60	
Aggregates – bound road base course	100	140	
Aggregates – decorative	3	3	
Water filtration – drinking water	10	50	
Water filtration waste	10	40	
Abrasives	8	20	
Fluxing agent for bricks and ceramics	0	40	
Art/craft	0.05	0.3	
Export	100	100	
Total	**1018**	**1568**	

Source: Recycled glass market study & standards review – 2004 update, Enviros for WRAP.
Excludes flat glass uses (ca. 225 kt), around 50kt of which is into containers.

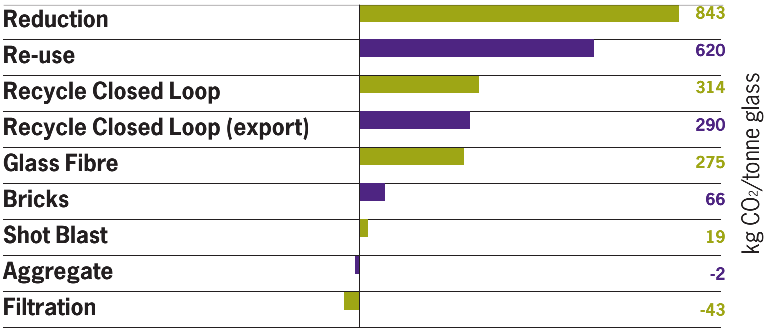
WRAP's estimates provide a platform for the examination of the impact of weight-based (PRN) policies. The following sections assume that the projections are achieved and critically examine the implications in terms of environmental impact. They then ask whether the projections are feasible and, if not, what the consequences might be. This will make explicit the inadequacies of current weight-based resource recovery targets.

4.2.Carbon costs

For the majority of the last century, the economics of the re-use of glass bottles (milk, beer, cordials etc) were well recognised and exploited. Established infrastructures supported the filling, delivery, recovery and re-use of this form of packaging. The analysis shown in Figure 3 illustrates the corresponding CO_2 savings for this and a number of other recycling technology applications that have been employed over the years and promoted more recently by WRAP, among others. The most effective strategy is to eliminate the use of glass altogether. This would be achieved by light-weighting (designing a product such as an aluminium can or glass bottle to the thinnest and lightest specification in weight terms). The benefits of the other applications vary from 314 kg/t in closed loop recycling to -43 kg/t when converted to filtration media.

Figure 3 essentially measures the benefits using bottles as a basis for analysis. The benefits of closed loop re-use are evident but, paradoxically, this is a declining application. Factors such as the increased complexity of supply chains (distance to market, number of players, etc) and the increased significance of packaging as a branding tool in the UK are at work.

Figure 3: LCA analysis of waste technology options for container glass in the UK. CO_2 Savings by End Use (compared to landfill)

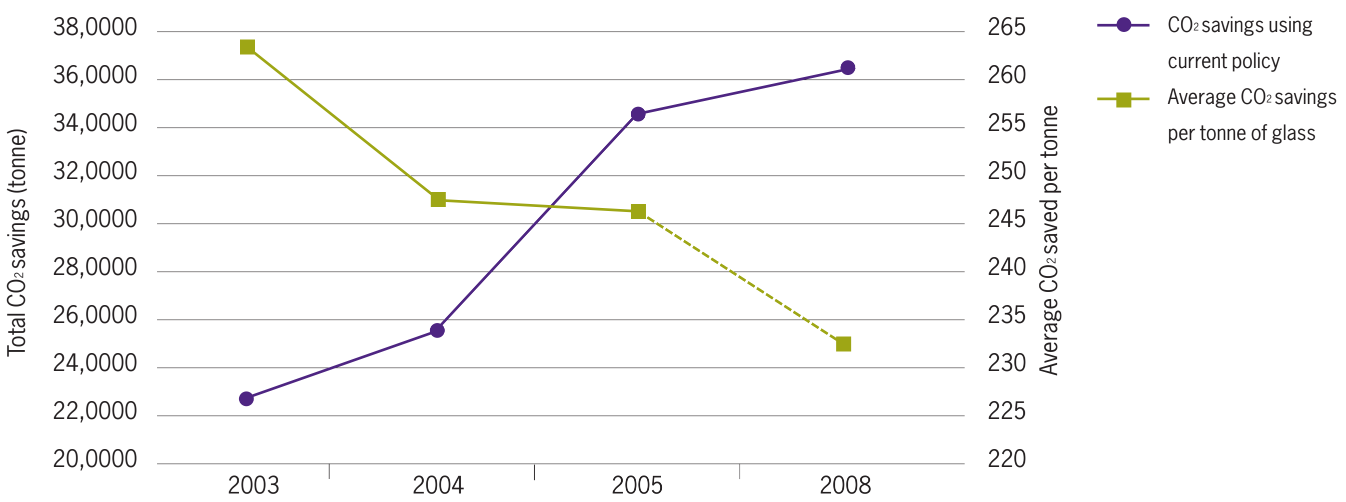


Source: All data with the exception of the re-use figure is taken from Glass Recycling: Life Cycle Carbon Dioxide Emission, Enviros Consulting Ltd, 2003. Re-use data taken from Life Cycle Analysis Assessment of Packaging Systems for Beer & Soft Drinks, Danish Environmental Protection Agency, 1998. Note: Transportation impacts have been included in the data and "reduction" refers to the full embedded CO_2 value of the glass.

4.3 Not all wrapped up

The WRAP data in Table 4 represents the expected movement towards achieving tonnage recycling targets. In this sense it is the base case, or the business as usual position. These targets take no explicit account of the environmental impact per tonne of material re-used. This begs the question: how has WRAP's interventions in developing new applications to meet recycling obligations impacted on the environment? We have illustrated this impact by multiplying the carbon benefits of Figure 3 by the tonnage targets of Table 4 to derive the expected CO_2 benefits in 2008. This case is the benefit over simply landfilling the glass. Appendix 1 contains the full table, but Figure 4 summarises the results.

Figure 4: Projected CO_2 savings from glass recycling (tonnes). Effect of glass recycling policy



The data shows:

- although the total CO_2 savings are rising over time, this is predominantly an effect of the increasing volumes of glass in use, coupled with re-use in bottles. The average saving per tonne tells the true story
- re-melting of glass for use in containers is an established technology, with strong process and energy motives even without the Climate Change Agreement. It could therefore be argued that the efforts of WRAP have had no additional beneficial environmental impact on this industry. WRAP's interventions have targeted the low and negative CO_2 benefit applications to the right of Figure 3
- the landfill option which by way of definition has zero carbon benefit is being discouraged by the Government. With limited bottle re-use capacity, the 2008 scenario thus requires WRAP (for example) to pursue a range of newly developed applications to soak up excess recyclate.

The fraction of material diverted to bottle use remains relatively constant. Other applications of lower CO_2 benefit are increasing and some of them have significant negative benefits. The average CO_2 benefit per tonne is therefore falling.

Under these conditions, the marginal benefit over placing the material in landfill is extremely small and is decreasing the more process-intensive that reprocessing options become. Improved environmental outcomes are governed by the ability of reprocessors to absorb available glass. Understanding such issues could make for more productive intervention.

In conclusion, recycling options have been marginally environmentally beneficial at best. Funding may have been better used improving container recycling technologies or designing lighter and reusable packaging options. Simply by not addressing these options, Grant Thornton and Oakdene Hollins estimate that the current and 2008 recovery targets will miss out on at least 100 kte of carbon savings per annum.

The business as usual case critically assumes that projections of end use come to pass and that bottle re-use remains at current high levels. However, there is now reliable evidence that these levels cannot be maintained. This implies that the marginal benefits of glass recycling will become negative, causing CO_2 gains to be lost (this is explored further in the next section).

4.4 Glass container recycling: A closing window

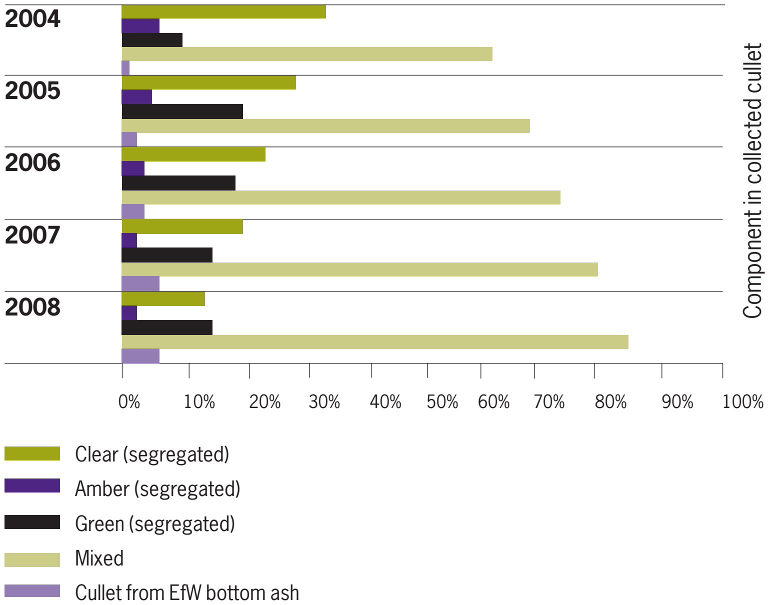
The Government's ambitious recycling targets assume an increase in recyclable content to container applications. However, the stimulated growth in applications of lesser environmental benefit has caused a significant transformation in the way glass is collected. The growth in these applications is based on them being less sensitive to the colour mix of glass. Hence, mixed glass collection is growing rapidly and displacing source-segregated collection, as shown in Figure 5. From 2000 to 2004, closed loop recycling fell from over 90% to around 70% and continues to decline.

Container applications are particularly sensitive to recyclate purity, so with good supplies of source-segregated glass becoming scarce, closed loop recyclers have had to add colour separation operations to their processes. This influences the economics of collection and has a distinct impact on the environmental benefits.

The effect of the move to mixed glass on the segregation capability is serious but can be quantified. This trend will undermine the ability to conduct the high volumes of closed-loop container recycling required to meet recycling targets. As a direct result of moving to mixed glass collection, the glass re-melt industry will operate significantly below its projected 2008 figure of 1,140,000 tonnes. However:

- if all mixed glass is colour sorted, there would be an excess of 775,000 tonnes of green glass for non re-melt applications. The total re-melt industry utilisation would be 850,000 tonnes – around 75% of capacity and half the recycling target
- if only sufficient sorting is carried out to meet green glass demands, re-melt industry utilisation would only be approximately 600,000 tonnes.

Figure 5: Percentage composition of collected glass cullet, 2008

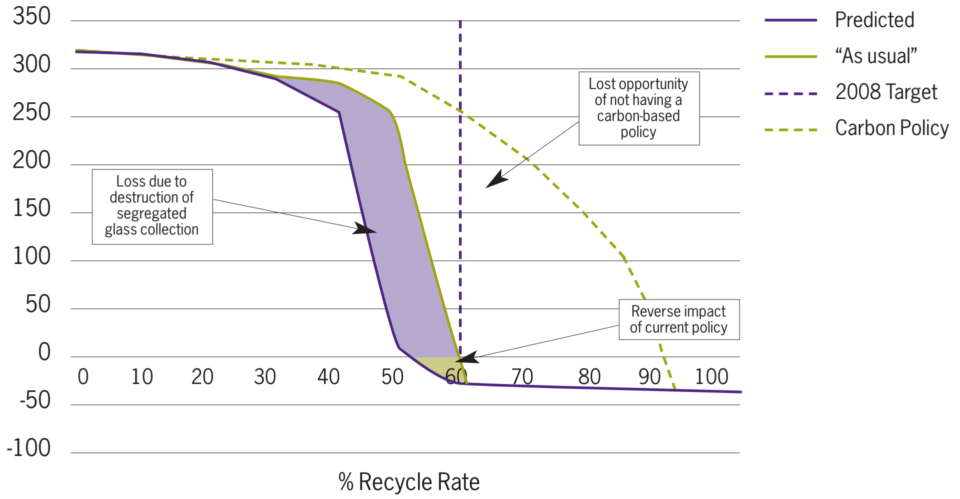


Using WRAP's own data, this study has shown that this business as usual expectation is unfeasible. By 2008, there will be a significant imbalance in colour processing capacity as a result of increases in mixed glass collection – an outcome of WRAP's market development activities. The key issue is to determine the impact of this trend on carbon benefits.

Section 4.3 showed how the postulated growth in recycling would result in falling average carbon benefits per tonne of recycled glass. Our new knowledge of the effect of mixed glass collection shows that this position is even worse than expected. Because bottle glass recycling is nearing capacity, all extra recovered glass must be processed via lower grade options which give significantly less benefit. Even if we elect to recycle using a policy that chooses the best carbon options first, our marginal carbon benefit (ie the effect of the next tonne of recyclate) will fall dramatically until it is negative. Our future efforts will increase CO_2, not reduce it.

The extent of these effects is captured in Figure 6. The curves show that, in general, as recycling rates increase, the marginal carbon benefit of each new tonne of recyclate is falling. This is the result of a choice to use the most beneficial recycling options first and the most harmful last.

Figure 6: Marginal benefit of glass recycling



Source: Oakdene Hollins Ltd/Grant Thornton

- The "as usual" curve is a least worst case[5] for the business as usual scenario (ie The missed opportunity for carbon reduction savings if we continue to collect glass in mixed colour streams). The marginal benefit just crosses zero as the 2008 recycling target is reached. Further recycling would lead to increases in CO_2 emissions.
- We know there are worse cases because recycling options of negative value are already being supported, hence the case illustrated in Figure 6 is somewhat optimistic.
- Our fresh analysis reveals that the "as usual" curve is not feasible. Using current thinking, we cannot sustain the high benefit bottle applications.
- Marginal carbon benefit will fall rapidly as recycle rates increase, crossing the zero in the manner shown and continuing carbon-negative as shown by the "predicted" curve. Our further estimation is that this cross-over is happening now, or will do so in the very near future. New ventures using carbon-negative technologies will create the "perverse impact" represented by the highlighted area under the curve.

Even so, we believe that this figure is dwarfed by what we have labelled the "loss due to destruction of segregation". The progressive move to mixed glass has caused the gap to open unrelentingly as the bottle capacity moves to lower and lower percentages. Investment in recycling technologies has assisted this change, with the result that significant carbon-reduction potential has been and will be, sacrificed.

[5] Note that this curve would continue horizontally for as long as a usable supply of bottle glass were available. We know this is not feasible, therefore it must tail off.

4.5 Conclusions: Learning from glass

This section has explored the impact of current weight-based policies on the future evolution of the glass industry. The major learning points are:

- the economics of these activities have been boosted by the presence of the market-based PRN system. This is paid regardless of the method of recycling, even when it is CO_2 -detrimental
- the pursuit of individual and piecemeal tonnage benefits has started a trend that will shift towards mixed glass collection. This will be to the detriment of high value – and highly environmentally beneficial – resource recovery activities such as the re-use and closed loop recycling of containers. The expectations of recycling within the high-benefit re-melt applications cannot be achieved in 2008
- worse, some of the applications for recyclate are carbon-detrimental – not only compared to landfill, but also in absolute terms.

However, the curve of Figure 6 also offers great opportunity. Even though the application of current recycling policies in pursuit of somewhat arbitrary recycling targets will result in carbon disbenefits, the area to the right of the curve – labelled as the "lost opportunity" – can be reclaimed by future attention to other more environmentally beneficial responses. If this were the case, pushing recycling targets well beyond 60% could be achieved without increasing environmental impact.

The greatest carbon gains can be achieved by light-weighting and re-use strategies. Other economically beneficial steps would be to shift the balance of container colour from green to clear or amber. An unexplored option is the consideration of international trade in wastes. This is especially relevant with glass, where significant local imbalances in the supply and demand of material grades exist. The export of excesses could redress imbalances in a highly carbon-beneficial manner and end the local use of lower value technologies.

These moves are not being undertaken simply because the interests of those who can influence them are not sufficiently aligned. This is either in terms of the supply-chain nature of the decisions that need to be taken, or because such decisions do not matter locally in the weight-driven packaging recovery framework; and because environmental disbenefits are unaccounted for.

If reduced environmental impacts are to be a feature of future production and consumption, it is necessary to move to a framework in which these impacts are recognised and controlled explicitly by all agents in the supply and recovery chain.

5. Development of a carbon-driven waste policy in the UK

Time to change

Section 4 of this report showed how the current waste management policies of a particular material (glass) will not be conducive to environmentally beneficial outcomes. Glass is the subject of extensive regulatory control through the PRN system and technological and market development intervention through WRAP. Local authority recycling targets have acted to shift collection towards a mixed glass method, to the further detriment of high-benefit recycling applications. Because of this, future targets in bottle re-use applications cannot possibly be met.

Glass provides a leading example of where a weight-based policy can act counter to the imperatives of our society – and prevent further progress from being made regarding CO_2 reduction targets. Recovery infrastructure is far less developed in other materials, such as plastics, but it is already apparent through leading edge studies[6] that failure to adopt a sensible decision framework may lead to adverse choices in recycling this material too.

If policies based on incorrect drivers are leading to poor environmental outcomes, the drivers for waste management, recycling and resource use must change. Signals from other areas of policy development and implementation suggest that, among others, carbon impacts will become a core factor for judging the effectiveness of interventions. Accordingly, we predict that the basis of resource use policies will need to be adjusted from the current weight basis. In particular, carbon impacts are a prime target – they align well with acknowledged global needs and increasing political will and also build on previous statements from the Commission from the Sixth Environment Action Programme (6th EAP):

"To identify which wastes should be recycled as a priority, based on criteria which are linked to the resource management priorities, to the results of analyses that identify where recycling produces an obvious net environmental benefit, and to the ease and cost of recycling the wastes. The aim is to recover and recycle wastes to levels that make sense, ie to the point where there is still a net environmental benefit and it is economical and technically feasible."

Such changes will demand modified policies, incentives and metrics. These might build upon existing initiatives such as Producer Responsibility (Packaging Regulations) and Climate Change Levy, or impending legislation such as Integrated Product Policy. It is not possible to be explicit or comprehensive about the content of these policies or when they will come into effect. However, they will almost certainly require a modification of the current weight-based targeting for waste management and recycling, perhaps by building in carbon credits, LCA hurdles or weighting parameters.

Changes in charging mechanisms are by no means exceptional: transformation from "paying for the right to use" to "paying for impact on system capacity" are in effect in areas such as communications and transport, and are certainly relevant to the waste regime (Table 5).

One obvious move to examine would be the modification of the PRN system to include a carbon-based component or weighting. The glass scenario has shown that there are structural problems with glass use that do not respond to current recovery schemes. There is certainly an excess of green glass being imported into the UK, particularly through wine bottles, causing increasing problems for glass re-use. A move towards clear glass, coupled with other measures such as light-weighting, could begin to address these issues. However, the financial implications of recovery do not sufficiently impact upon the bottler and retailer to force changes under a weight-based system.

In the case of glass, there is an opportunity to encourage international waste import/export trade for re-use through a global carbon trading scheme. Given the current price of carbon in the EU is approximately €20 per tonne, glass could attract significant trading incentives. It is likely that this would be relevant to other materials too.

Table 5: Transformations in charging policies

	Communications	Transport	Waste
Old basis	time	time	tonnes
Effect	occupies line	occupies road space	occupies landfill
New basis	byte	CO_2 emissions	CO_2 impact
Effect	occupies bandwidth	creates GHGs	creates GHGs

[6] A critical review of plastics waste management LCAs, Oakdene Hollins for WRAP, 2005

6. Implications for selection and investment

A way forward

This paper has outlined a case in support of the proposition that Government policies surrounding waste management are leading to sub-optimal environmental outcomes. Specifically, the current motivations provided by weight-based recovery targets will have increasingly negative carbon benefits.

Waste management policy should be realigned with the carbon agenda.

There is a misalignment between the emergent high level environmental imperatives and the policies regarding waste and resources. As a result, there must be a change in focus of waste management policy that brings it into line with CO_2 reduction targets, in particular.

We are currently in a period of transition between the old regime and the new.

In this new framework, certain activities that are currently viewed in a positive light – and which have rightly been promoted as ways to achieve material diversion targets – will be disfavoured. Management options that are now opposed, such as energy from waste and landfill, will be recognised for their necessary role in the mix of options.

Investment in technologies and businesses that align with recycling and landfill diversion targets, but not carbon impacts, should be treated with caution.

Support for recycling, recovery and re-use will be motivated by an increasing consideration of carbon impacts and proponents will need to take account of this when seeking support for commercial initiatives. Like the Carbon Trust, other Government agencies will require benefits to be accounted for in economic and carbon terms. Competition for funding across these streams will become keener, with significant shifts in support, perhaps running counter to recent trends.

Our case study has revealed issues in glass recycling, but these are likely to be replicated for any other material.

The waste management business needs to be cautious about adopting technologies which do not reflect the carbon agenda and are based on projected recovery and recycling targets which may change.

The present expectation of ever increasing recycling targets will not persist. Contracts based on this expectation will increasingly jar with environmental outcomes, and will be revised, probably to the detriment of those locked into extended commercial arrangements for waste handling.

There are numerous opportunities to simplify and restructure existing fiscal and market-based instruments to achieve this realignment.

The incentives and policies aimed at materials recovery and disposal are complex and inconsistent. Schemes need to be and can be rationalised around a unifying higher environmental objective. In particular, we would recommend an examination of international carbon permit trading, which could motivate the beneficial export of excess glass to the foreign point of manufacture.

Appendix 1: WRAP glass use data

Current policy

Application	Tonnes * 1000				CO_2 saving per tonne	CO_2 savings (tonnes)			
	2003	2004	2006	2008		2003	2004	2006	2008
Containers – green	302	250	296	300	314	94828	78500	92944	94200
Containers – amber	65	100	189	200	314	20410	31400	59346	62800
Containers – clear	249	350	512	560	314	78186	109900	160768	175840
Fibre glass container	15	17	20	20	275	4125	4675	5500	5500
Aggregates concrete	15	20	25	35	-2	-30	-40	-50	-70
Aggregates general fill	45	50	55	60	-2	-90	-100	-110	-120
Aggregates bound road base course	77	100	120	140	-2	-154	-200	-240	-280
Aggregates decorative	3	3	3	3	-2	-6	-6	-6	-6
Water filtration drinking water	0	10	30	50	-43	0	-430	-1290	-2150
Water filtration waste	0.2	10	20	40	-43	-8.6	-430	-860	-1720
Abrasives	3.5	8	15	20	19	66.5	152	285	380
Fluxing agent for bricks and ceramics	0	0	20	40	66	0	0	1320	2640
Art/craft	0.02	0.05	0.1	0.3	19	0.38	15.7	31.4	94.2
Export	100	100	100	100	290	31400	31400	31400	31400
Total	875	1018	1405	1568		228727	254837	349038	368508
Tonnage totals exclude flat glass applications					CO_2 saving per tonne	0.261	0.250	0.248	0.235

CO_2 driven policy

Application	Tonnes * 1000					CO_2 saving per tonne	CO_2 savings (tonnes)			
	Capacity	2003	2004	2006	2008		2003	2004	2006	2008
1. Maximise use in closed loop recycling	1100	1100	1100	1100	1100314	345400	345400	345400	345400	
2. Maximise use in export market	350	5	143	350	350	290	1450	41470	101500	101500
3. Maximise use in fibre glass market	40	0	0	40	40	275	0	0	11000	11000
4. Maximise use in fluxing agent for bricks and ceramics	Potentially large	0	0	135	303	66	0	0	8910	19998
Total	1105	1243	1625	1793	Total	346850	386870	466810	477898	
						CO_2 saving per tonne	0.314	0.311	0.287	0.267
						Total additional CO_2 savings	118123	132033	117772	109390

Appendix 2: Valpak glass use data

CO_2 driven policy

Application	Tonnes * 1000				CO_2 saving per tonne	CO_2 savings (tonnes)				
	2003	2004	2006	2008		2003	2004	2006	2008	
1. Maximise use in closed loop recycling	1100	1100	1100	1100	1100	314	345400	345400	345400	345400
2. Maximise use in export market	350	5	143	350	350	290	1450	41470	101500	101500
3. Maximise use in fibre glass market	40	0	0	40	40	275	0	0	11000	11000
4. Maximise use in fluxing agent for bricks and ceramics	Potentially large	0	0	135	303	66	0	0	8910	19998
Total	1105	1243	1625	1793	Total	346850	386870	466810	477898	
						CO_2 saving per tonne	0.314	0.311	0.287	0.267
						Total additional CO_2 savings	118123	132033	117772	109390

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