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The Economics of Waste and Waste Policy

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1. Introduction

Waste is part of the economy – it is a by-product of economic activity, by businesses, government and households. Waste is also an input to economic activity – whether through material or energy recovery. The management of that waste[1] has economic implications – for productivity, government expenditure, and, of course, the environment.

Firms decisions over how to manage waste impact on their profitability. Where the benefits outweigh their costs, firms can reduce their overall costs[2] and improve productivity by reducing the use of expensive raw materials, whether metal in industry, or paper in commerce. Equally, costs can be reduced by optimising the management of waste which arises. The decisions of consumers in demanding goods and services which lead to waste impact not only on the environment, but also on the level of government spending required by local authorities to collect and manage household waste.

As well as the economy-wide impacts of waste, there are microeconomic themes around the formation of waste policy. Economics provides a framework in which to think about when intervention by Government might be desirable, as well as what type of policy intervention is appropriate. This paper sets out the key principles for public policy interventions in waste. The aim of applying these principles are to ensure that: there is a reason for Government intervening in a particular market; interventions are cost-beneficial; and any interventions are done in the most cost-effective way.

For example, an important rationale for Government intervention in the waste sector is because of the greenhouse gas (GHG) impacts. The management and disposal of waste produces GHG emissions, the full social cost of which is not taken into account in the production and consumption decisions which lead to the generation of the waste and how that waste is managed. Ensuring that the amount of waste is reduced to the economically efficient level, and is optimally managed, will ensure that waste policy is delivering net benefits for society as a whole. Finally, choosing interventions, or a mix of interventions, which deliver emission reductions cost effectively will minimise costs to businesses, the Government (central and local), and the economy more widely – something which is especially important in the current economic climate. Waste policy interventions have particular impacts on

[1] Defined in the wider sense: both the management of waste that arises, and decisions which lead to a certain amount of waste arising (rather than being avoided/prevented).
[2] A recent Defra-commissioned study into business resource efficiency has identified significant (up to £22bn) savings available to UK businesses, particularly from more efficient use of raw materials (i.e. waste prevention). These relate to measures requiring no, or only small-scale investment, for which payback is within one year, though the report notes the difficulty in estimating the hidden costs of resource efficiency measures. (http://www.defra.gov.uk/news/2011/03/11/research-shows-companies-can-save-money-by-helping-the-environment/)

public sector spending, through spending by local authorities on waste collection and management, and pursuing cost effective interventions at a time of constrained public finances is important.

As well as achieving these aims an efficient waste policy helps to mitigates risks to longer-term sustainable growth, by helping to ensure that natural resources are not unsustainably used today, and contributing to GHG emission reduction targets.

Over the course of the last year Defra has conducted a Review of Waste Policies in England to ensure that the policies and interventions are fit for purpose to meet the challenges we face in seeking to create a more resource efficient economy. The economic analysis has informed the work of the Review and consideration of different policies and intervention.

2. Economic principles

2.1 Transition to a green economy

The natural environment plays an important role in supporting economic activity, both

→ directly, by providing resources and raw materials such as water, timber and minerals that are required as inputs for the production of goods and services; and

→ indirectly, through services provided by ecosystems including carbon sequestration, water purification, managing flood risks, and nutrient cycling.

Natural resources are, therefore, vital for securing economic growth and development – not just today but for future generations.[3] Waste policy is a key part of ensuring that raw materials are used efficiently. However, as set out below, failure to fully account for their value in economic decisions means that these resources are over-consumed. This, in turn, poses risks to long-term economic growth – for example, by breaching critical thresholds beyond which natural assets cannot be replaced and can no longer support the desired level of economic activity – and creates the imperative for shifting to an environmentally sustainable growth path, and eventually to a green economy.

A green economy is characterised where economic value and growth is maximised while managing all natural assets sustainably. Achieving a green economy means the transformation of the whole economy in terms to what is produced and used, who produces and uses it, and how it is disposed of. For example,

- increased demand for new and emerging goods and services that reduce environmental damage;
- transformation of some business sectors to develop 'greener alternatives' to existing products;
- reduced demand for products from certain sectors that cause environmental damage; or
- volatility of earnings in some sectors subject to change in input prices or demand changes.

The policy challenge lies in addressing the market failures and other barriers to the efficient consumption and use of resources in a way that leads to the benefits of action outweighing the costs and which minimises the cost to the economy. In the waste policy context, this requires creating the right market conditions and incentives for business and households to invest and make more efficient choices – in their

[3] Economic Growth and the Environment, Defra Evidence and Analysis Series, March 2010 (http://www.defra.gov.uk/evidence/series/documents/paper2-economic-growth.pdf).

use/consumption of resources and in the management of waste. This is further discussed later in this annex.

2.2 Efficiency, market failure & what it means for waste

As set out above, the waste sector is one of many environmental sectors, with policy actions contributing to the overall macroeconomy, and to a transition to a green economy. Likewise there are microeconomic underpinnings to waste policy, illustrated by the principles of economic efficiency and cost-effectiveness.

The waste hierarchy, as set out in the revised Waste Framework Directive, is reproduced below. This ranks the various waste management options broadly according to their environmental desirability, although there are exceptions. However, it does not include economic considerations, and as such cannot be a complete guide to waste policy.[4] It is therefore necessary to consider the economics of the hierarchy.

Figure 1: The waste hierarchy

The existence of market failures, which prevent economic agents[5] from making optimal choices, mean that market forces alone would lead to an over-production of waste. Environmental externalities are the primary market failure – where economic decisions to produce and consume do not take full account of the environmental consequences of waste generated as a result. Failing to price in the environmental cost/benefit of generating waste leads to economically inefficient production and consumption patterns, and excess waste being produced.

[4] The Directive recognises this in setting out the requirement for the hierarchy to be implemented, Member States ‘shall take into account…. technical feasibility and economic viability’.
[5] Producers, consumers, Governments

Economic efficiency – in the waste context – is attained when the amount of waste generated (and managed at each level of the hierarchy) is optimal, i.e. the costs of reducing waste by one unit is equal to the economic and environmental benefits of having one less unit of waste. There are costs and benefits associated with reducing waste. For example, reducing waste through making production processes more resource-efficient has benefits in terms of greenhouse gas emissions avoided and savings in material costs. However, it is also likely to impose additional costs in terms of the investment in equipment and other resources required to make the change. It is efficient to reduce waste as long as market failures are not internalised and the benefits of doing so exceed the cost.

In addition to incentivising the efficient amount of waste at the aggregate level, markets alone will not necessarily ensure that the efficient amount of waste is going to each level of the hierarchy. Without government intervention, waste treatment options with better environmental performance may be penalised relative to treatments with poorer performance due to higher costs. Accounting for the externality requires that the costs of various treatment options and levels of the hierarchy fully reflect the environmental externality of each option. Appendix A presents analysis of current and projected waste arisings, as well as data on the current destination of waste across the hierarchy.

As an example, pricing instruments such as the landfill tax raise the cost of sending waste to landfill, in part reflecting the environmental externality of disposing waste in this way. However, it does not reflect the relative scale of the externality of treatment and disposal methods further up the hierarchy; for example, the externality associated with incineration, recycling or re-use. A single pricing instrument, such as the landfill tax, can achieve the optimal mix of waste management in a ‘two-treatment world’, say landfill and recycling. Once we go beyond this world – to include energy recovery, recycling, re-use and waste prevention – additional instruments are required to ensure a cost effective waste management system. This is particularly the case for waste prevention, where the effect of the tax is indirect. By increasing the cost of landfilling, the tax thereby increases the overall cost of managing a tonne of waste[6], and therefore should lead to a reduction in arisings as a rational adjustment to the tax. The extent to which this occurs, however, is likely to differ in different sectors and for different materials. Where the cost of having waste collected and disposed of is very small relative to the cost of the resource inputs, one might expect a landfill tax to have little waste prevention effect, whereas if the cost of collection and disposal is a significant part of the costs, then it could have some difference.

[6] Unless that waste had not previously been landfilled.

Cost effective waste management means that the amount of waste managed at different levels of the waste hierarchy is determined by the *equimarginal* principle, i.e., waste is allocated amongst the various management options such that the marginal social cost of each option is equalised across the various options.[7] Where this is not equal, there exists a potential for reducing waste management costs by reallocating waste amongst treatments.[8] Thus, in the context of the waste hierarchy, not only do costs and benefits of reducing an additional unit of waste need to be equalised (economic efficiency), costs also need to be equalised across various levels of the hierarchy in order to ensure that waste is being treated cost effectively. It is highly unlikely to be cost effective to manage all waste in one treatment – as costs of treatments very across different quantities of waste, there should be a mix of treatment methods.

2.3 Other market failures

The above discussion has focussed on the environmental externality associated with waste, but in reality there are other markets failures and barriers to an optimised waste management system.

The illegal dumping of waste can be viewed as a local public good[9] – non-rival[10] and non-excludable[11] in the relevant location. Prior to local provision of collection and disposal services, local environments were spoiled by the unregulated disposal of wastes. To overcome the public good nature of these problems government intervention has been necessary, and local governments have set up collection and disposal systems to ensure waste is properly disposed of by households, as well as regulating to ensure businesses dispose of waste properly.

Other market failures and barriers to an optimised waste management system include imperfect information, imperfect competition, or other barriers to efficiency such as excess planning costs, lack of access to credit, and long payback periods. A particular area of concern is around the ability of the market to deliver the necessary waste infrastructure. Issues such as capital market imperfections, lags in

[7] The costs associated with various waste management options are both financial (collection, disposal fee), as well as environmental. Together these costs make up the social cost of different waste management options.
[8] This assumes that technology remains constant. However, as technologies develop and evolve over time, this will lead to changes in the marginal cost of various waste management options, in absolute terms and relative to each other. In turn, the optimal allocation of waste across various management options will also evolve over time.
[9] In fact a public 'bad'.
[10] Non-rivalry means that one person's 'consumption 'of a good does not diminish what is available for everyone else. In this case, just because one person experiences the disamenity of unregulated dumping, it does not mean that anyone else will experience any less disamenity.
[11] Non-excludability means that it is not possible to be excluded from the effects of local disamenities of dumping. The negative externailites from the public bad provision mean that the market overprovides, and intervention is required.

the investment coming on-line, a combination of uncertainty and long payback periods, and planning problems mean that infrastructure development may be insufficient and require government intervention to incentivise and support the appropriate level and type of investment. Further, as in the case of renewable energy, new technologies can require additional intervention to overcome innovation market failures. Given the existence of externalities and environmental objectives, also tackling these failures alongside the externality reduces the costs to the economy of reacting to policy instruments, and in the transition to a green economy.

3.Environmental Impacts: Externalities

There are several environmental impacts associated with waste management – greenhouse gases, air quality, water pollution, noise and land use change[12]. Whilst there may be specific impact categories associated with particular waste types – for example, hazardous wastes – the preponderance of waste-related environmental impacts relate to greenhouse gas (GHG) emissions.

Different levels of the waste hierarchy, and indeed different options within hierarchy levels, can have very different GHG impacts. A sensible classification of GHG emissions in waste is as follows:

- *Process Emissions**:*** Emissions arising directly from the treatment of the waste itself, e.g. landfill methane[13] or emissions from waste combustion.

- *Net Energy-use emissions:* Net Emissions from fuel use minus any emissions savings where energy output from waste treatment offsets fossil fuel use elsewhere in the economy.

- *Embedded emissions**.*** This third category provides the primary rationale for preventing and re-using waste, and to a lesser extent for recycling, which all avoid (mostly energy-related) emissions generated in producing goods and services from virgin materials.

The GHG impacts of waste treatment are usefully broken down into those that are material-specific, and those that apply to the residual stream

3.1 Segregated waste

Segregated waste refers to waste that has been sorted from the general waste stream, in order to facilitate recycling/composting/Anaerobic Digestion (AD), or any treatment that requires a sorted waste stream.

Figure 2 illustrates the environmental impact of treating specific waste types in different treatments.[14]

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[12] Which could, in turn, have impacts on biodiversity.
[13] The proportion of which is not captured or flared.
[14] Sourced from WRAP's latest carbon factor assessment used to create a 'carbon metric' for the Scottish Government (http://www.zerowastescotland.org.uk/carbon_metric/carbon_metric.html).

Figure 2: Segregated waste emissions impacts[15]

Waste type	Waste Prevention (avoidance excl disposal)	(Preparation for) reuse	Open Loop Recycling (excl avoided impacts)	Closed Loop Recycling	Energy Recovery (Combustion)	Energy Recovery (Anerobic Digestion)	Composting	Landfill
Textiles	22,310	14,369		850	-600			-300
Aluminium cans and foil	9,844			9,245	-31			-21
Steel Cans	2,708			1,702	-31			-21
Wood	666	599	381	523	817		285	-792
Average plastic rigid	3,281			2,148	-1,057			-34
Average plastic film	2,591			1,450	-1,057			-34
Board	1,038		240	240	529			-580
Paper	955		157	157	529			-580
Food and Drink Waste	3,590				89	-162	-39	-450
Glass	895	No Data	-16	366	-26			-26
Garden Waste					63	-119	-42	-213

kgCO2e saved per tonne waste treated.

As an example from the table above, landfilling wood causes emissions of 792kgCO2e/tonne. These landfill emissions are avoided by moving the waste to a non-landfill treatment:

- Composting the paper/card instead causes emissions of 285kgCO2e/tonne (saving 507kgCO2e of emissions compared to landfill).
- Incinerating it (combustion) saves emissions of 817kgCO2e/t (lower emissions of 1,609kgCO2e/t compared to landfill).
- Recycling saves emissions of 381 - 523kgCO2e/t (lower emissions of 1,173 – 1,315kgCO2e/t compared to landfill).
- Entirely preventing the waste would have reduced embedded emissions by 666kgCO2e/tonne (or a saving of 1,458kgCO2e/t relative to landfill).

To draw a few general conclusions from the table above:

-Clearly, sending biodegradable waste to landfill entails significant methane emissions impacts

- After prevention and re-use, the best treatment for non-biodegradable materials is recycling, to a greater or lesser extent

-Non-biodegradable, combustible materials (plastics, some textiles) cause significant GHG emission impacts when combusted

-Textiles, metals, plastics and food have particularly large benefits from prevention.

[15] Inevitably, there are uncertainties in these figures – the landfill emissions figures are inherently uncertain, whilst the exact savings from recycling and prevention will depend on the situation. However, they do reflect the best available knowledge. The uncertainty around the figures is unlikely to alter the direction of the conclusions.

4.2 Residual waste

Residual waste refers to the waste left following sorting (comingled or kerbside sort) or waste arising from purely unsorted waste (such as black bag waste). The emissions impacts of some of the more widespread residual waste treatments are reported in Figure 3[16].

Figure 3: GHG emissions impacts of selected residual waste treatments[17] (all tCO2e/t waste

	Process	Energy use	Energy output	Embedded	Net	Net + embedded
Landfill	0.21	0.01	-0.05		0.17	
Incineration	0.42	0.04	-0.26	-0.06	0.20	0.14
Incincineration + CHP	0.42	0.04	-0.31	-0.06	0.15	0.09
MBT/SRF	0.37	0.04	-0.15	-0.12	0.27	0.14
MBT/Landfill	0.08	0.02	0.00	-0.13	0.10	-0.03

Source: Eunomia, Landfill Restrictions feasibility research[18]

The emissions impacts are summed in two ways – including and excluding embedded emissions. Net emissions describe the sum of emissions from processes, energy use, and energy outputs. Net + embedded emissions further include the impact of materials recovery relative to landfill (reduced embedded emissions).

Taking the example from the table above of incineration without combined heat and power. The process emissions impact of incinerating a typical bundle of waste is estimated to be 0.42tCO2e/t waste combusted in mass-burn incineration.[19] Energy use impacts are 0.04tCO2e/t, and energy outputs save 0.26tCO2e/t for incineration without CHP. Extracting metals from the incinerator bottom ash (IBA) results in savings in embedded emissions of around 0.06tCO2e/t. The net emissions impact is 0.2tCO2e/t. The net + embedded emissions impact of 0.14tCO2e/t reflects the overall better performance of incineration relative to landfill, once embedded emissions from material recovery[20] are taken into account.

[16] As for segregated wastes, there are uncertainties around these figures, particularly the ‘process’ emissions, and within those especially for MBT-landfill. The energy outputs will vary depend upon the specific energy set-up – especially where heat is involved.
[17] It is worth noting that the embedded emissions figures are reported relative to landfill (where no materials recovery is assumed to occur, and the default baseline assumption), and the net + embedded emissions are therefore a combination of absolute, and relative to landfill, figures. ‘Process’ emission in the above table relate to either methane emissions from landfill or emissions from waste combustion
[18] http://www.wrap.org.uk/wrap_corporate/publications/landfillban.html
[19] Alternative estimates of combustion emissions of incineration come from the National Air Emissions inventory (0.275tCO2e/t) and the Environment Agency’s WRATE model (approx 0.375tCO2e/t). The former is calculation of UK GHG inventory calculations, but is likely to be out-of-date as it is based on work dating back to 1993. More recent figures from the Environment Agency and those reported in Table 6 are more consistent with each other.
[20] Primarily metals recovery from the bottom ash.

The table above points to some broad conclusions, based on Figure 2:

- MBT (mechanical biological treatment)-landfill provides the best emissions performance in terms of the treatment/disposal of residual waste. It essentially involves landfilling somewhat stabilised wastes with some material recovery. The magnitude of the environmental impact depends on the extent to which the waste is stabilised.

- According to these figures, the relative performance in combustion emissions vs offset emissions is better for mass burn incineration than for MBT-SRF (solid recovered fuel), especially so if that incineration is CHP. However, the benefit of energy output produced by MBT(SRF) depends on its use – for example, if it is used to offset coal use in cement kilns, its GHG performance is likely to be considerably better. The example cited here, with the SRF going to mass-burn incineration may not be as favourable as those where the SRF is destined for industrial energy uses.

- It is noticeable that the performance of some of the technologies is not much better than landfill. Moreover, as the assumed biodegradability of wastes falls in the future, landfilling may actually become more GHG-friendly than some other forms of residual waste treatment, according to these figures.

However, these estimates are subject to significant uncertainty, and are purely related to GHG emissions – they do not consider, for example, that it may be more practical to produce CHP from SRF at an industrial site, rather than exporting from a mass-burn incinerator.

There is particular uncertainty around the impact of MBT technologies – the behaviour of the stabilised wastes in landfill and the emissions from the burning of SRF, as well as the emissions offset by SRF. Some other studies have come to the opposite conclusion on the overall emissions impact of MBT(SRF) and MBT(landfill) to the figures cited in Table 6, concluding that MBT(SRF) is the better performing option. The conclusion depends upon the assumed degree of stabilisation of MBT (landfill), the offset energy mix assumed, and the end user of the SRF. Studies finding MBT-SRF more desirable tend to use a coal-gas electricity mix as the offset, whereas the above figures, and DECC guidance[21] suggests that the marginal mix should be assumed to be CCGT (gas)[22]. The embedded emission savings from the technologies are also uncertain.

[21] http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx
[22] This is not to say that their conclusions would necessarily reverse in changing this assumption.

4.Delivering efficient outcomes cost effectively

4.1 Range of available policy interventions

This section first considers instrument choice generally, and how it applies to waste policy. Of course, policymakers should always first consider whether intervention is necessary, and whether the benefits of the intervention will exceed the costs. Broadly, policy interventions can be classified into the following categories:

- 'Do nothing'. Where there is not a rationale for intervening in the market, or where interventions do not improve the efficiency of the economy (i.e. where the costs of policies exceed benefits).

- Direct regulation (command and control) where a standard, procedure or process is specified, such as Hazardous Waste Regulations ;

- Market-based instruments (MBIs) such as taxes/subsidies and trading schemes which help reflect the value of environmental resources, e.g. the landfill tax;

- Technology/spending programmes, such as investment grants and subsidies, to encourage innovation and investment in infrastructure, e.g. PFI funding to local authorities. This helps to overcome market failures and other barriers to the efficient level of investment;

- Information provision and public engagement programmes which, respectively, increase awareness and are used to overcome informational failures, and attempt to encourage more pro-environmental attitudes, e.g. WRAP's 'Love Food, Hate Waste' campaign. These can be used in conjunction with other instruments to improve the effectiveness of the policy intervention and reduce regulatory burdens associated with achieving environmental outcomes. Behavioural research and analysis can also allow information to be better targeted to the relevant audience; and

- Negotiated agreements between the government and one or more private parties to reduce the level of environmental damage beyond the level in existing operations, e.g. the Courtauld Commitment. Agreements can be incentivised or voluntary and are useful in raising awareness and achieving improved environmental outcomes at a lower cost under certain circumstances (

4.2 Choosing the right intervention

Assuming action is justified, choosing appropriate instruments is an important part of delivering environmental outcomes cost effectively, without placing undue burden on businesses and the wider economy. This is true in order to enable a transition to a green economy in waste, and more widely:

- Ensuring the policies implemented are the most appropriate to target the identified market failures and barriers to efficient outcomes – the appropriate response to an externality is likely to be different to the response to imperfect information. Table 2 below identifies some of the market failures tackled by policy instruments announced in the Waste Review.

- A policy framework focused on simple, clear and credible intervention will provide a background of greater certainty for business investment and incentivise greater private investment in new processes, technologies, and infrastructure. This type of investment will be essential in bringing about the structural shift required for a green economy.

- A clear, stable and robust policy framework will also help address other behavioural barriers to efficient behaviour, for example, by reducing inertia and raising awareness of inefficiencies in current production and consumption patterns.

- Simplifying the policy framework – for example, by removing overlaps/duplication and focussing interventions on delivering the required outcomes. This reduces the administrative burden of existing interventions on business and the wider economy, without compromising environmental outcomes, freeing up resources to be put to more productive uses. Annex 3 considers two examples from waste policy where there are overlapping instruments.

- Making enforcement effective while maintaining protection of the environment and human health. Designing monitoring and penalties proportionate to any impacts will help ensure administrative burdens are reduced further.

Each instrument from fiscal incentives, regulation and legislation, to voluntary agreements and informational campaigns - when deployed in the right circumstances - can produce an efficient outcome at the least cost, without creating any perverse secondary effects. Table 1 considers the relative advantages of different types of instrument, and therefore when they are best deployed. Appendix 2 considers voluntary agreements in particular as one way to deliver policy aims, and assesses in more detail the conditions necessary to ensure they are well-designed, credible and robust.

Table 1: Conditions for effective deployment of economic instruments

Instrument	Advantages/disadvantages	Suitable conditions for effective deployment
Command and control : quantities or standards-based regulation	• Simplicity: Where there are information barriers, command and control regulations can overcome these and ensure the necessary behaviour change. • Depending on design, can ensure dangerous environmental impacts can be avoided. Unlikely to be the most cost-effective solution – inflexible • May not provide incentives for innovation • Monitoring costs can be lower • Outcome-based regulation can be more efficient than regulations based on specifics, e.g. technology standards	• Regulator has information regarding costs and benefits of measures – if there are a multitude of responses to achieve an outcome, a regulator is unlikely to have the necessary information to design efficient regulation. • Certainty is required with respect to the optimal level of pollutant– possible if damage is irreversible • Where environmental damage is high, or where there are risks of very high damages occurring(e.g. some forms of non-continuous pollution) • Where it is efficient to impose a common standard or procedure on all participants – such as in the case of firm or individuals with similar characteristics and costs of compliance • Where it is possible to announce in advance an intervention, costs can be reduced
Market-based: taxes/trading schemes	• Static efficiency: achieves goals at	• Where price signals are effective, and passed

	least cost. • Dynamic efficiency: incentives to innovate in order to reduce costs of compliance over time • Can have low administrative costs (especially for taxes) • Either price (tax) or quantity (trading scheme) certainty. • Revenues from taxes & potential to cut other taxes (double dividend) • Not necessarily suitable for some types of environmental impacts, e.g. hazardous waste	through chain. • Costs to individuals and firms not known • Costs to individuals and firms not uniform • In the case of trading schemes, a minimum number of participants to create an effective market • Costs of creating institutions for trading scheme not prohibitively high.
Technology/spending programmes	• Overcomes other market failures and barriers, even where other instruments are in place • Can help incentivise new technologies with innovation externalities	• Insufficient investment that cannot be overcome by informational improvements or improvement in risk-sharing • Identifiable point of intervention, such as at project investment level or design stage • Can be conducted in a way that does not unacceptably distort competition
Non-regulatory behavioural interventions such as information, public engagement programme	• Over comes information barriers • Can make other interventions more cost-effective • Can be relatively cheap for Government, and no need for enforcement • No costs imposed upon businesses and householders involuntarily • Ineffective unless tailored to the audience	• Can be conveyed in clear, simple messages • Behaviour change is receptive to mode and mean of delivery • Suitable where behaviour change does not have to be immediate (allows time for messages to influence behaviour)

Negotiated agreement	• Avoids costs of regulation • Can be costly to negotiate • Asymmetric information could lead to capture by firms • Risk of reducing market competition	• Private benefits outweigh private costs • Effective threat of regulation • Costs are not uniform and unknown to regulator • Environmental risk is not high - costs of delay to improving environmental outcome is not excessive • Flexibility enables lower costs for firms • Where accurate baselines and suitably ambitious targets can be established • Monitoring and enforcement cheaper – usually if number of participants is low

It is clear that the above set of instruments have different characteristics, and are suitable in different situations. Where there are multiple market failures and barriers, multiple instruments are required in order to deliver efficient outcomes in a cost-effective manner. For example, the cost of achieving an outcome of a market-based instrument can be reduced if information is provided in order to overcome any such barriers.

4.3: Waste policy instruments

Waste is covered by a range of interventions targeting households, local authorities and business (including waste management companies), with interventions occurring through the chain from production through to disposal. Table 2 sets out some of the major interventions that already exist in waste policy[23], matching the interventions against the waste hierarchy, the market failures they are trying to address, and

[23] Specifically, the table sets out interventions that impact upon the propensity for waste to be treated at different levels of the hierarchy, rather than the *way* waste is dealt with at each particular treatment (such as licensing requirements for sites).

statutory targets. All of the statutory targets are derived from EU directives. Some of the commitments in the Waste Review are not directly addressing market failures – there are other drivers, such as service provision, to consider in policy formulation.

Table2: Waste policy: Key instruments and new measures

Stage of Hierarchy	Key instruments (current)	Type of instrument	Group affected	Statutory targets	Additional Proposals in the Waste Review	Market failure/barrier addressed
Waste prevention and re-use	Negotiated Agreements Awareness campaigns/ funding to delivery bodies Landfill tax (indirectly)	Voluntary Information/expertise MBI	Business Business/households (see 'Disposal')		Responsibility deals with business, including e.g. hospitality sector Funding for LA reward and recognition trial schemes Creation of a waste prevention loan fund Range of initiatives with business – & supported by WRAP - looking at opportunities design, manufacturing and service provision.	Externalities & information failure Price pass-through Financing and information failures Imperfect information
Recycling	Waste Framework Directive: Separate collection requirement (by 2015) on paper, metals, plastic, glass. Producer Responsibility Regulations Landfill tax (indirectly)	Regulation Regulations, MBI MBI	Business, local authorities (indirectly) (see 'Disposal')	Revised Waste Framework:50% recycling of waste from households by 2020. Producer Responsibility targets (WEEE, packaging, batteries, ELV)	Responsibility deals with business, including e.g. hospitality sector Responsibility deal with the waste management industry (including MRF code of practice). Develop household waste & trade waste recycling and collection commitments. Funding for LA reward and recognition trial schemes	Externalities & information failure Information asymmetry Price pass-through

Recovery	PFI funds Renewable energy incentive schemes (ROCs, RHI, FiTs) Landfill tax (indirectly)	Government Spending MBI MBI	Waste management industry (see 'Disposal')	Revised Waste Framework: 70% of construction and demolition waste recovered by 2020.	Clear statement of Government support for recovery of waste which cannot be recycled. Production of an EfW guide. AD Strategy. Incentivisation of community buy in to hosting waste infrastructure.	Information, market certainty Public goods: aligning the costs and benefits
Disposal	Landfill Tax Landfill Allowance Trading Scheme LATS) Landfill restrictions where already exist (e.g. ban on landfilling of tyres)	MBI MBI Regulation	Business, local authorities(directly), households (indirectly) Local authorities(directly), households (indirectly) Business, local authority	Landfill Directive: Reducing landfilling of biodegradable municipal waste to 35%of 1995 levels by 2020		

Aside from waste-specific policy measures, there are also wider policy interventions from climate change and energy policy which have an impact upon the outcomes for waste. Understanding the impact of such measures on waste is important in order to determine the appropriateness of waste policy intervention. The following box details some of the interactions with non-waste policies, which are important to consider when formulating waste policies.

Box 1: Overlap with policies on electricity and heat

Electricity. Electricity-related impacts are largely internalised by the EU Emissions Trading Scheme (EU ETS). Therefore, where a treatment process uses or produces electricity, it will not require additional intervention to account for the environmental impacts as the emisions are capped under EU ETS[24]. Where electrical energy is produced from waste, the environmental benefits of doing so are reflected in the price received by the operator for the electricity. In essence, AD plants or EfW incinerators are rewarded under EU ETS for offsetting fossil energy elsewhere[25]. In addition, the renewable (biogenic) element of the electricity is rewarded through Renewable Obligation Certificates[26] when the electricity is produced by AD, pyrolysis, gasification, or an incinerator with CHP (electricity-only incinerators are not eligible for ROCs).

Heat. Heat-related impacts are internalised only when the plant in question – the heat user – is included (directly) in EU ETS. These are primarily likely to be industrial intensive energy users of SRF (offsite users of heat from EfW plants are unlikely to meet the minimum 20MW capacity threshold required to be included in EU ETS). In addition, the introduction of the Renewable Heat Incentive is aimed at increasing the production of renewable heat, but arguably also rewards the carbon savings from such heat (implicitly, as renewable heat is lower carbon than non-renewable heat).

Embedded emissions: There are instruments in place, such as EU ETS and the CRC, however these will not cover the embedded emissions from many materials which are imported (even final goods produced in the UK are likely to have components imported from uncapped economies). At the margin, it is assumed that changes in production of materials as a result of prevention, re-use and recycling will occur abroad. However, where emissions are already covered by instruments such as the EU ETS, care needs to be taken to avoid the presence of overlapping instruments, where some emissions are 'charged for' twice.

[24] Except in the rare cases that electricity is produced on-site, and the EU ETS thresholds are not met.
[25] Equally, environmental impacts from electricity use by plants are already covered by EU ETS.
[26] For which the size of incentive depends upon the specific technology.

Given the impacts of waste treatments in the energy sector, one way to consider policy design is to try to account for the many different potential energy sector outcomes. However, given the range of options that are available, this can become prohibitively complex. To simplify, policy can be focussed on internalising the process and embedded emissions, and not address externalities in follow-on markets for electricity and heat from waste, which should instead be best tackled by energy market interventions. Tackling energy impacts through energy policy is more likely to be feasible, and avoids potential distortions from waste interventions.

5. Conclusions: Towards an efficient and cost effective outcome

This paper has presented the economic principles around waste and the choice of waste policy instruments. It should be noted that in addition to the economic aspect, there are clearly other policy drivers in waste, as there are across the public policy spectrum. There may be statutory targets, such as on renewable energy or landfill diversion, equity considerations, or other policy reasons for a particular course of action. Nonetheless, over time a transition towards the framework set out will provide benefits for economy and environment, so long as the costs of intervention are justified by the benefits.

Where there remain un-priced environmental impacts in the management of waste, there are grounds for considering further intervention in the market to reflect these impacts. As described in Section 2, the landfill tax is the primary pricing instrument in waste policy. It directly targets the amount of landfilling, and thus affects the amount of waste dealt with at different levels of the waste hierarchy. However, as noted, the landfill tax cannot reflect the differences in environmental performance between all levels of the waste hierarchy above landfill.

Firstly, for the treatment and disposal of waste:

- On the whole, those treatment options which reduce embedded emissions by reducing energy associated with extraction, primary production etc., such as re-use and recycling, do not have their full external benefits reflected in the price of disposal.

- The emissions from waste combustion of non-biogenic material (via any technology including mass-burn incineration) are also not comprehensively reflected in the price of disposal. Unless the installation in question is in the ETS (municipal solid waste incinerators are excluded) a negative externality persists – such installations are creating GHG emissions without paying the relevant price.

- Subject to proving its environmental performance, MBT-landfill does not have its environmental benefits reflected in the price of disposal.

To supplement the landfill tax, the Waste Review has introduced measures to encourage recycling, such as better accessibility to recycling for businesses and consumers, agreeing responsibility deals with business sectors, and introducing new packaging targets. This is in addition to other non-market instruments, such as the revised Waste Framework Directive requirement on separate collection due to come into force in 2015. While such measures help internalise market failures and barriers, they have some limitations; for example, in incentivising/determining the optimal level of activity (see Table 1 above).

As well as ensuring that the relevant instruments are in place to reflect the impact of treatment options, it is also necessary to address barriers to efficient response . For example, the lack of direct pricing of household waste collections – households pay for their waste collections indirectly though council tax and general taxation, rather than paying directly for the amount and type of waste produced - means that other instruments such as information policies may take more prominence, although they are unlikely to achieve efficient outcomes. Funding announced in the Waste Review for trial reward-and-recognition schemes is a step in the right direction, and will help develop the evidence base on the effects of pricing mechanisms on household waste.

Second, even if all the externalities of waste treatment options were covered by policy, there would still be a need for additional intervention to ensure efficient production and consumption decisions, and the optimal level of waste arisings (in the absence of these intervention, waste arisings will be inefficiently high). This is an important policy area because the additional greenhouse gas benefits from waste prevention are significant (see section 3). In addition to the environmental benefits, there are financial savings for businesses, consumers and government from waste prevention - through reduced material use and reduced collection, treatment and disposal costs.

Waste prevention policy solutions are more difficult to effect, because of the nature of the change being targeted and because of the often global nature of the necessary interventions. Non-pricing options, such as product standards, information policies and voluntary agreements, alone are unlikely to deliver efficient consumption and production decisions. The Waste review introduces a number of measures aimed at increasing waste prevention, including responsibility deals, funding for reward schemes and the creation of a waste prevention loan fund.

The waste review is a step towards more efficient and cost effective waste disposal, treatment, and prevention. As policy evolves over time, opportunities exist to make the waste system more efficient, both with respect to the amount of waste that arises and the way in which that waste is dealt with.

Appendix A: Data, projections and 2050[27]

An understanding of the current level of waste arisings and a quantitative assessment of likely levels of waste arisings in the future is necessary for informing waste policy development, whether to assess progress against existing targets and commitments, support infrastructure planning, or identify gaps in incentivising the appropriate level and type of waste management. The projections do take policy into account to an extent. For example, the commercial and industrial waste projections account for the assumed prevention impact from landfill tax. Both of the household waste projections methodologies implicitly account for changes in household behaviour, although these are not tied to specific policy instruments. However, they do not take into account any of the specific policy measures from the Waste Review itself.

A.1 Household waste

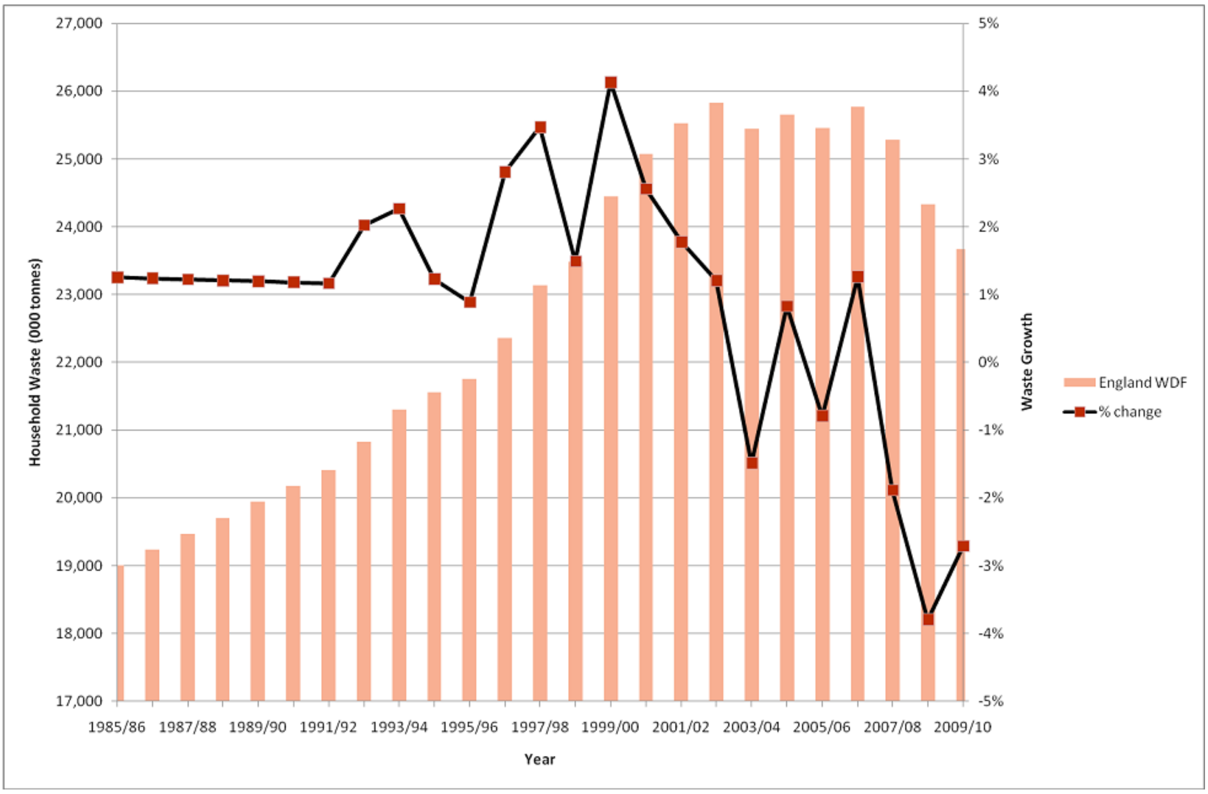
Figure A.1 illustrates household waste arisings for the 1985 -2007 period, with corresponding growth rates. Specifically:

- pre-1990 shows a constant rate of annual waste growth, indicating that the data is likely to have been interpolated;
- post-1990 tonnages of waste arising fluctuate quite significantly on an annual basis;
- since 2003, waste arisings have fluctuated around a flat/downward overall trend, indicating some decoupling of waste arisings from economic growth; and
- recession effects begin to appear in the data from 2008/09[28].

[27] The analysis in this section is expressed in terms of household, and C&I waste. The revised definition of municipal waste for the purposes of the meeting the 2010, 2013, and 2020 Landfill Directive targets, includes household wastes and a significant proportion of C&I wastes.

[28] The recession began in Q2 of 2008 (i.e. the first quarter of 2008/09). See: http://www.statistics.gov.uk/cci/nugget.asp?id=192

Figure A.1: Household waste arisings and growth rates (1985-2010)



Source: Waste Data Flow

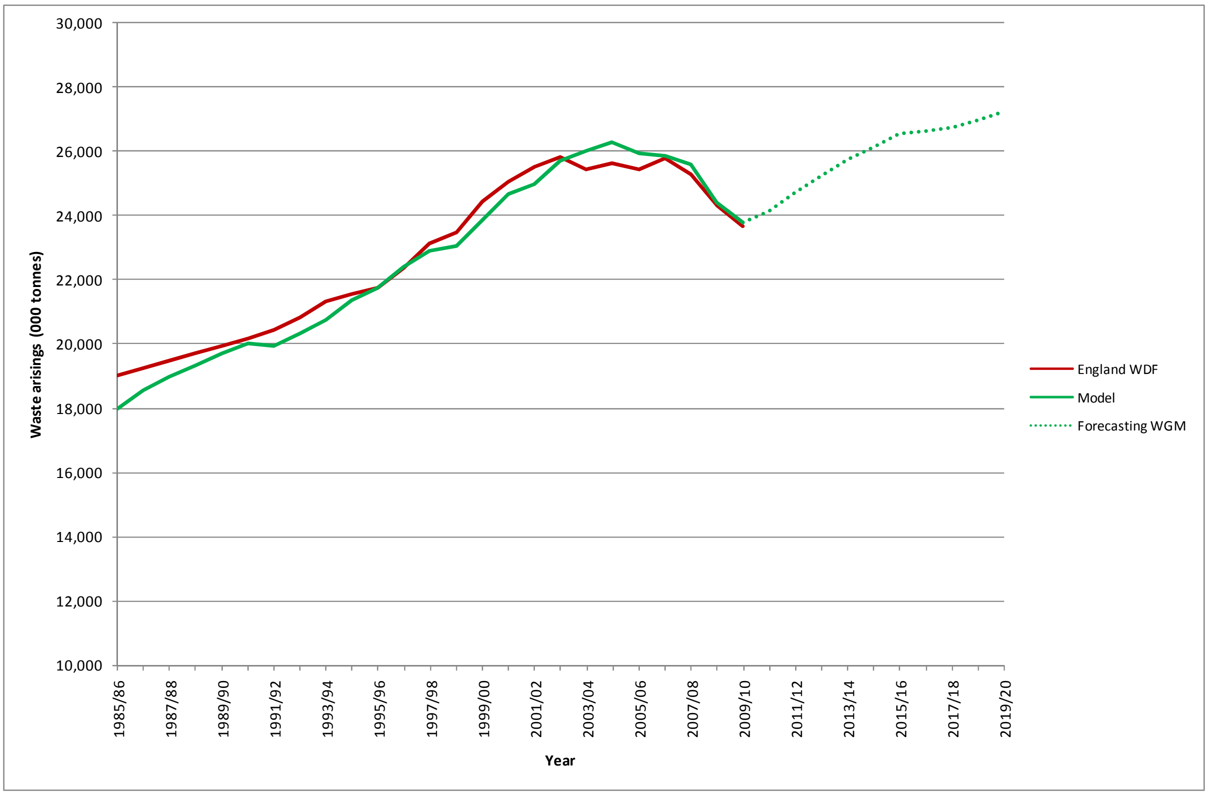
Two possible modelling approaches have been explored in order to provide arisings projections for household waste. Both approaches attempt to assess the extent to which the fall in waste arisings are due to temporary recession effects and the extent they are being driven by genuine decoupling in the years preceding 2008. The central forecast is provided by the second of these modelling approaches.

(i) Input-output model. The model is primarily driven by consumption expenditure, moderated by various trends in, for example, household behaviours. Figure A.2 below illustrates that the model is able to explain some of the past variation in arisings, reinforcing consumer expenditure (as a proxy for wider economic activity) as a significant driver of waste arisings. It performs less well in explaining arisings in the 2003-2006 period, when the upward trend in arisings ceased. The model forecasts a return to pre-2003 trend growth once consumer expenditure begins to grow[29] and as a result of the lag effects of durable goods[30]. However, the trend in arisings since 2003 points to some potential decoupling of waste from economic

[29] Economic growth assumptions from Oxford Economics (http://www.oxfordeconomics.com/oef_win/)
[30] Some goods, such as Waste Electrical and Electronic Equipment, are kept for a number of years before being disposed of, unlike other types of goods such as food, which – for the most part – arise as waste in the year of purchase.

growth, and calls into question the value of using expenditure as the driving factor in forecasting waste arisings.

Figure A.2:Household waste projections (input-output model).[31]

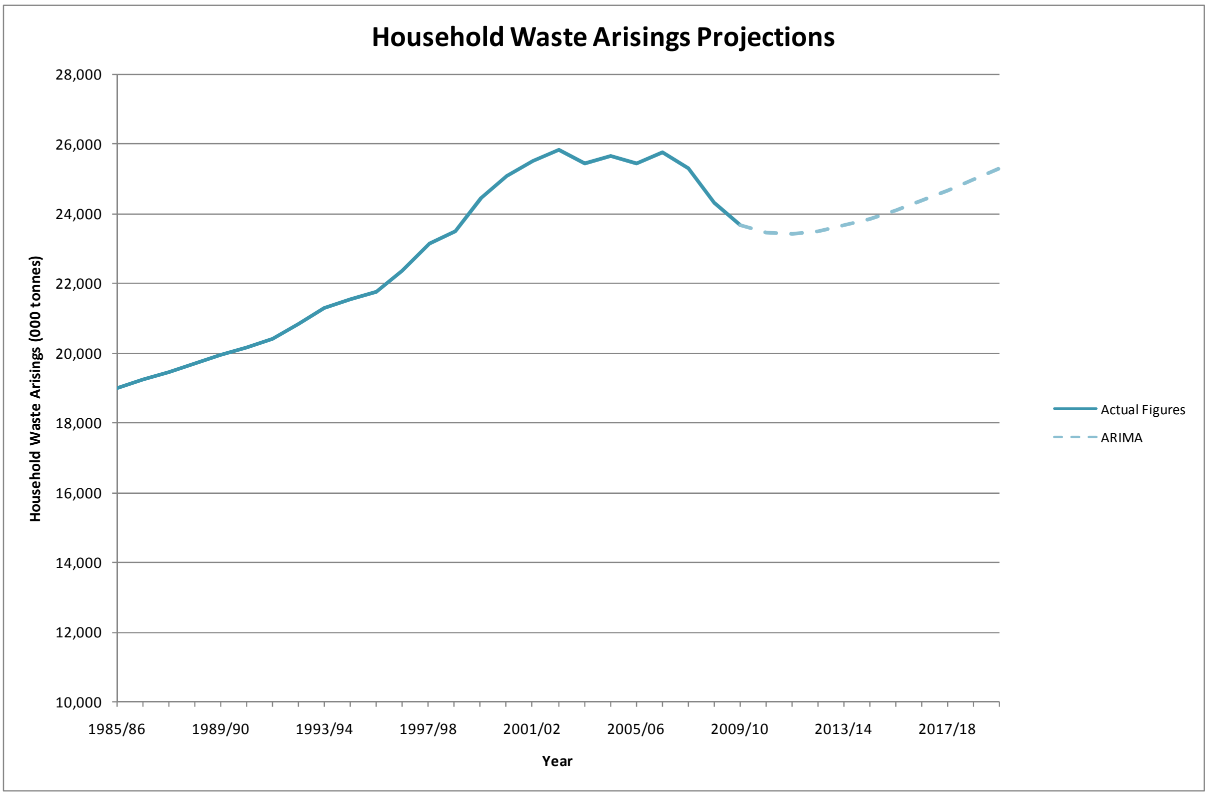


Source: Household Waste Growth Model (Trajectory Partnerships)

(ii).Time series forecasting model (central forecast). Given the concerns with the input-output model, alternative forecasts were developed using time series forecasting techniques. The ARIMA[32] model developed as part of this exercise generates forecasts based on past events and trends, and provides an alternative to models unable to fully explain the decoupling observed since 2003 (see Figure A.3). The ARIMA model forecasts slower growth compared to the input-output model, reflecting recession effects and the preceding decoupling that could not be completely explained by economic growth/expenditure alone. Consequently, this forecast is more credible compared to that produced by the input-output model.

[31] These projections have not been updated since Summer 2010, unlike the ARIMA forecasts.
[32] Autoregressive Integrated Moving Average

Figure A.3: Household waste projections (ARIMA model)

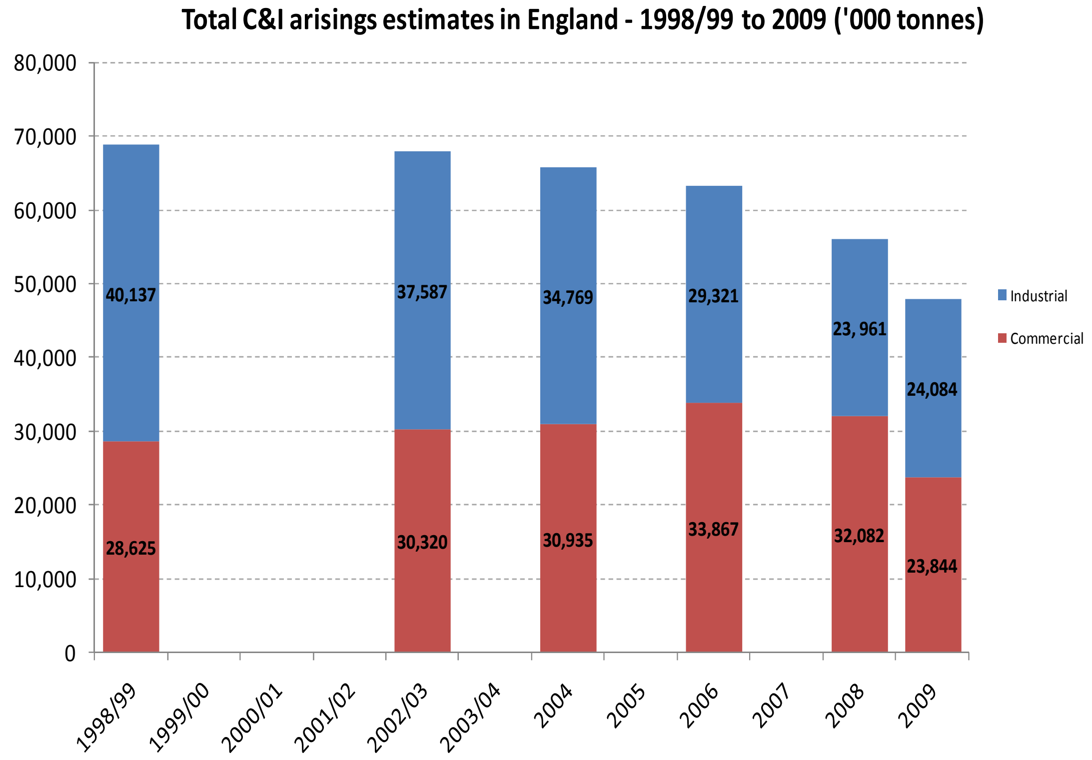


Source: **Defra Projections**

A.2 Commercial and Industrial (C&I) waste arisings

Data and information on C&I waste is less robust than on household and local authority-collected waste. The results of a recently concluded national survey were published in early-2011. Prior to that, the last national survey was in 2002/03, and there have only been regional studies and the Defra waste statistics team's own estimates between then and now. Existing information on arisings from the national survey's of 98/99, 02/03 and 09/10, and from Defra waste statistics estimates are shown in Figure A.4.

Figure A.4: Commercial and industrial waste arisings estimate



Notes: 1998/99 figures based on Environment Agency survey data. Estimates for 2004, 2006 and 2008 were calculated as part of returns under the Waste Statistics Regulation (WSR), and extrapolate 2002/03 estimates using business population data, along with adding estimates of waste from end-of-life ships and road vehicles. 2009 figures based on Defra Survey of Commercial and Industrial Waste Arisings 2010.

Source: **Defra Statistics**

Existing data indicates a declining trend in overall C&I waste arisings, especially since 2006. This is driven initially by sharp declines in industrial waste arisings, although the decline in volumes from 2008 to 2009 is driven entirely by a decrease in commercial waste arisings. There is a need to exercise caution in interpreting the 2009 results as these were recorded in the midst of recession, and therefore are likely to be depressed below trend. As with household waste, two approaches are taken to forecasting C&I waste[33].

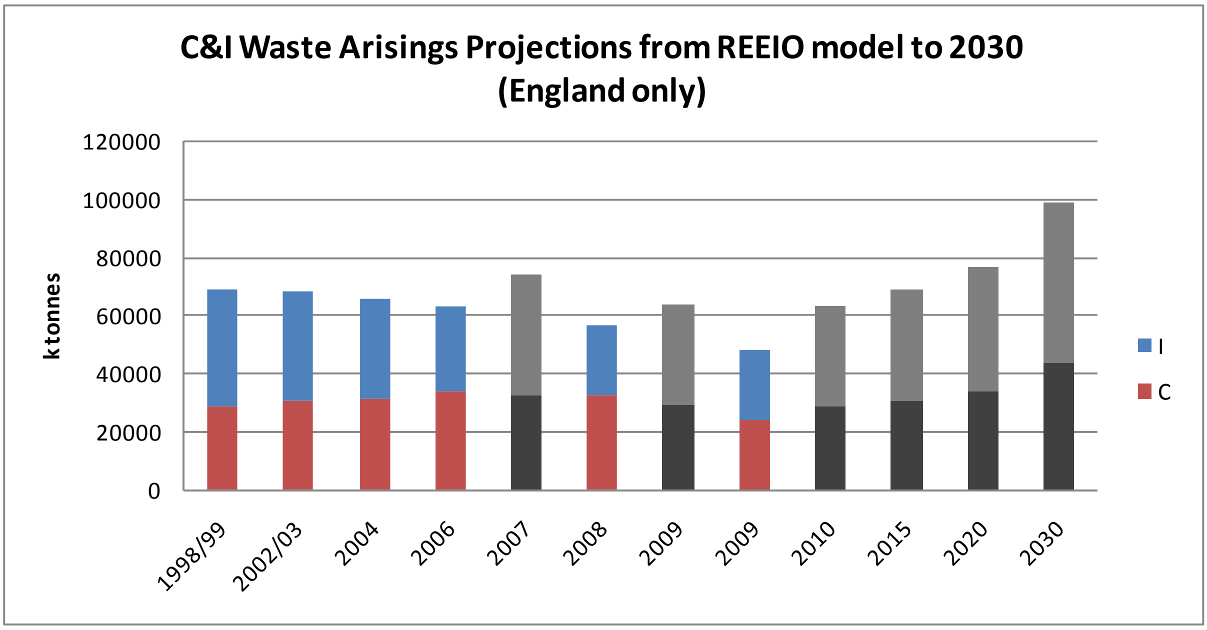
(i) Input-output model. The Regional Economy Environment Input Output (REEIO) Model[34] is an input-output model used to assess the environmental implications of production in a region. It links economic activity in 21 industrial sectors to environmental impacts, and is used to measure and compare the environmental impact of economic development.

The REEIO model takes waste data from the 2002/03 survey and projects them forward using economic growth projections for each industry sector in each region[35],

[33] As with the household waste input-output model, both of these modelling approaches reflect analysis completed in Summer 2010, and therefore do not reflect the most recent C&I survey.
[34] http://www.scpnet.org.uk/reeio.html
[35] Economic growth assumptions from Cambridge Econometrics

with no changes assumed in waste efficiency or waste management practices, i.e., greater economic output leads to greater waste.

Figure A.5: REEIO projections of C&I arisings



Source: **REEIO model**

As illustrated, the modelling provides estimates for waste arisings to 2030 (see figure A.5).[36]. It estimates average annual growth rates of 2.3% in the industrial sector and 1.9% in the commercial sector. From the combination the coloured (actual data) and grey/black bars (model estimates), it is possible to assess the model's predictive performance in recent years. The model overestimates the waste arisings from the sector (by around 15 million tonnes in 2009), indicating that the modelled relationship between economic output and waste arisings is not accurately specified. Assuming that the waste intensity of production does not increase significantly over time, the forecasts to 2020 and 2030 are also likely to be large overestimates of waste arisings.

(ii) Extrapolating based on regional data (central forecast). The 2009 ADAS study into C&I waste arisings[37] uses C&I arisings data from North West England to produce a snapshot of similar arisings in other English regions. The estimates are primarily based on the number of companies in each industrial classification (SIC) for each region. The 2007 estimates represent a drop in C&I waste of about 15% compared to the 2002/03 survey, with some large variations across the regions[38]

[36] These projections include economic projections from April 2008 and include the effects of the economic downturn.
[37] http://www.eera.gov.uk/publications-and-resources/studies/topic-based-studies/waste-studies/national-study-into-commercial-and-industrial-waste-arisings/
[38] Especially in the North East, which may reflect the decline of waste-intensive heavy industry.

due to the difference in size and composition of industries (see table A.1). This is similar to estimates produced by Defra's waste statistics team – unsurprising, as both estimates are based on business population projections.

Table A.1: Regional Waste arisings

	EA 02/03 survey ('000 tonnes)	**Estimate using NW 06/07 survey ('000 tonnes)**	**Change**
East Midlands	8,093	6,159	-24%
East of England	6,564	5,689	-13%
London	7,507	7,207	-4%
North East	4,599	2,441	-47%
North West	8,335	7,532	-10%
South East	8,852	8,702	-2%
South West	5,556	4,760	-14%
West Midlands	7,265	6,290	-13%
Yorkshire & Humber	11,136	9,752	-12%
England Total	**67,907**	**58,352**	**-15%**

Source: ADAS study (2009)

Forecasts of C&I arisings to 2030 are made for the East of England, based on the assumption that C&I waste arisings in the future will reflect the base of companies operating in the region, thereby allowing for sector-specific growth. This makes the assumption that the results from North West England can be applied to other regions (including the East) assuming that companies in the same sectors and in the same employee size band produce similar quantities and types of waste (not assuming that the industrial make-up itself is similar).

Forecasts such as this of waste arisings using employee numbers do not take account of changes in productivity. However, the relationship between waste per employee and productivity is not straightforward. Gains in productivity could mean less waste is produced per unit of production but could also mean more units per employee. The overall effect would also depend on the specific definition of productivity being discussed – environmental, labour or total factor productivity.

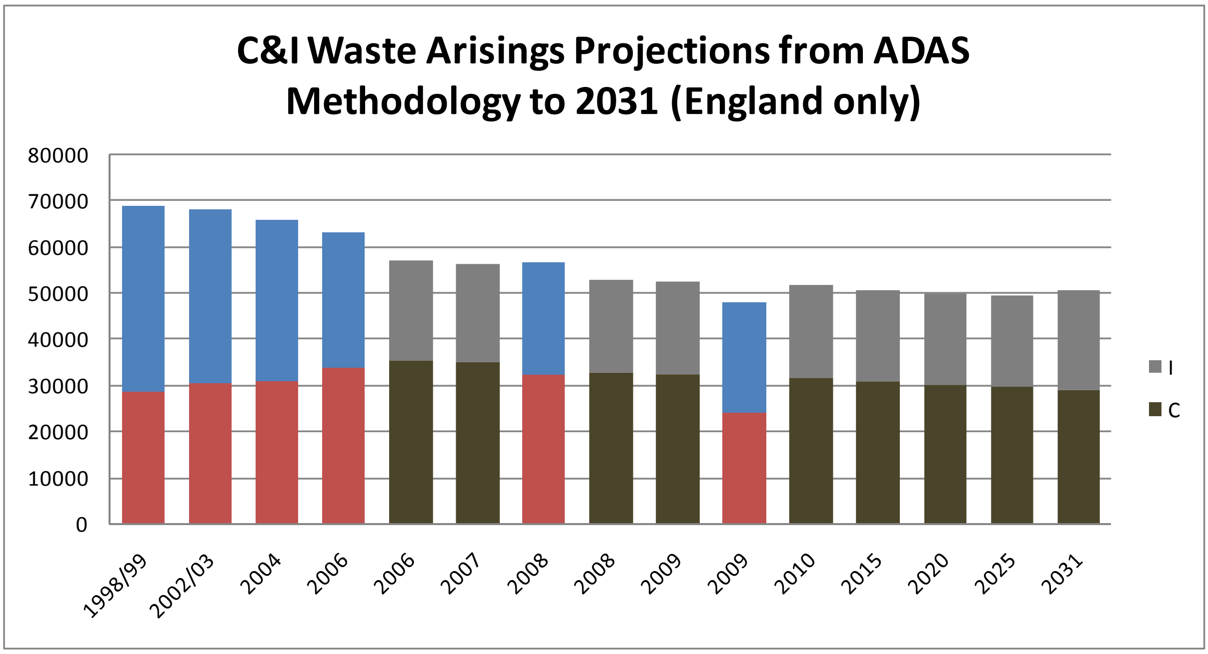
The ADAS methodology is adjusted to account for different regional employment forecasts and to allow for improvements in waste efficiency over time. Waste per employee is assumed to fall by 20% by 2031, with the greatest improvements occurring in response to landfill tax increases up to 2014.[39] This is reflected in the

[39] A 2007 Defra Report on Business Benefits of Resource Efficiency discusses the potential resource savings from the reduction or improved management of waste through low or no cost interventions. The report suggests efficiency improvements from no or low cost interventions (achievable within a

forecast (see figure A.6) by continuing decreases in waste arisings until 2014 (when the efficiency impact of the landfill tax exceeds employee growth) and rises thereafter (when the opposite is the case).

The projections in Figure A.6 give annual growth rates of -0.2% for the commercial arisings and +0.57% for the industrial arisings over the 2010-2030 period. The arisings estimates from this model are much closer to that actually observed – for example the 2009 estimate of 52 million tonnes in 2009 is only a few million tonnes above the outturn of 48 millions tonnes.[40] In turn, this methodology produces much more gradual changes in waste arisings over time.

Figure A.6: C&I waste arisings projections



Source: Defra Projections using adjusted ADAS methodology

Clearly, there are major uncertainties and gaps in the evidence base for C&I waste. It will be important to develop a better understanding of the relationship between output/ employee numbers and waste arisings in order to improve the robustness of the forecast and to better understand the drivers of waste; for example, whether employee numbers are indeed the relevant parameter or whether a re-specified REEIO-type model (see below) would be preferable. Following the most recent C&I survey, we will reassess the different C&I forecasting options in order to provide as robust projections as possible.

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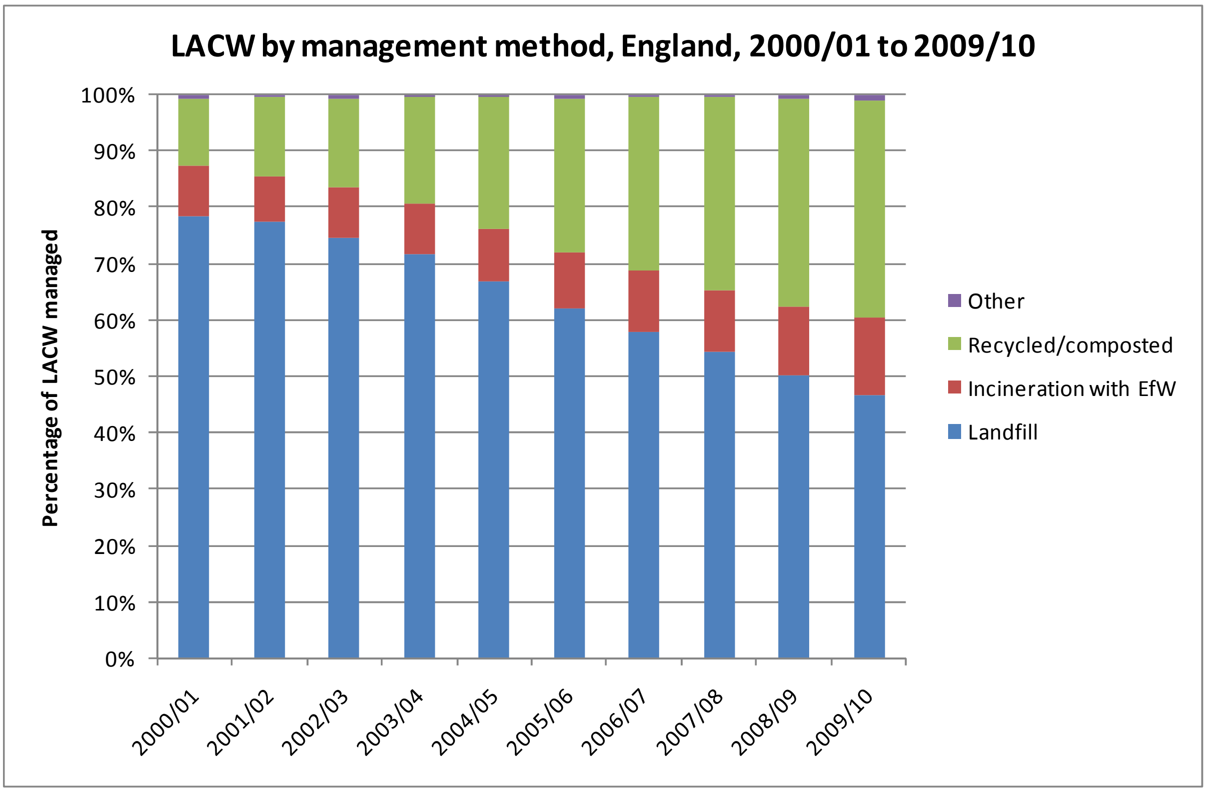
year) of 13.1% for the industrial sector, and 12% for the industrial sector. Given that these are no or low cost interventions, the potential for additional opportunities in the future indicate that the 20% reduction in waste per employee by 2031 is reasonable. Since the above projection were completed, the resource efficiency study has been updated, and has identified even higher potential efficiencies in resource us (see footnote 2).

[40] A figure itself, that was lower than expected.

A.3 Destination of waste

The following charts illustrate the changes that have taken place in the management of waste, both for local authority collected[41], and commercial and industrial, waste.

<u>Figure A.7: Local authority-collected waste management</u>



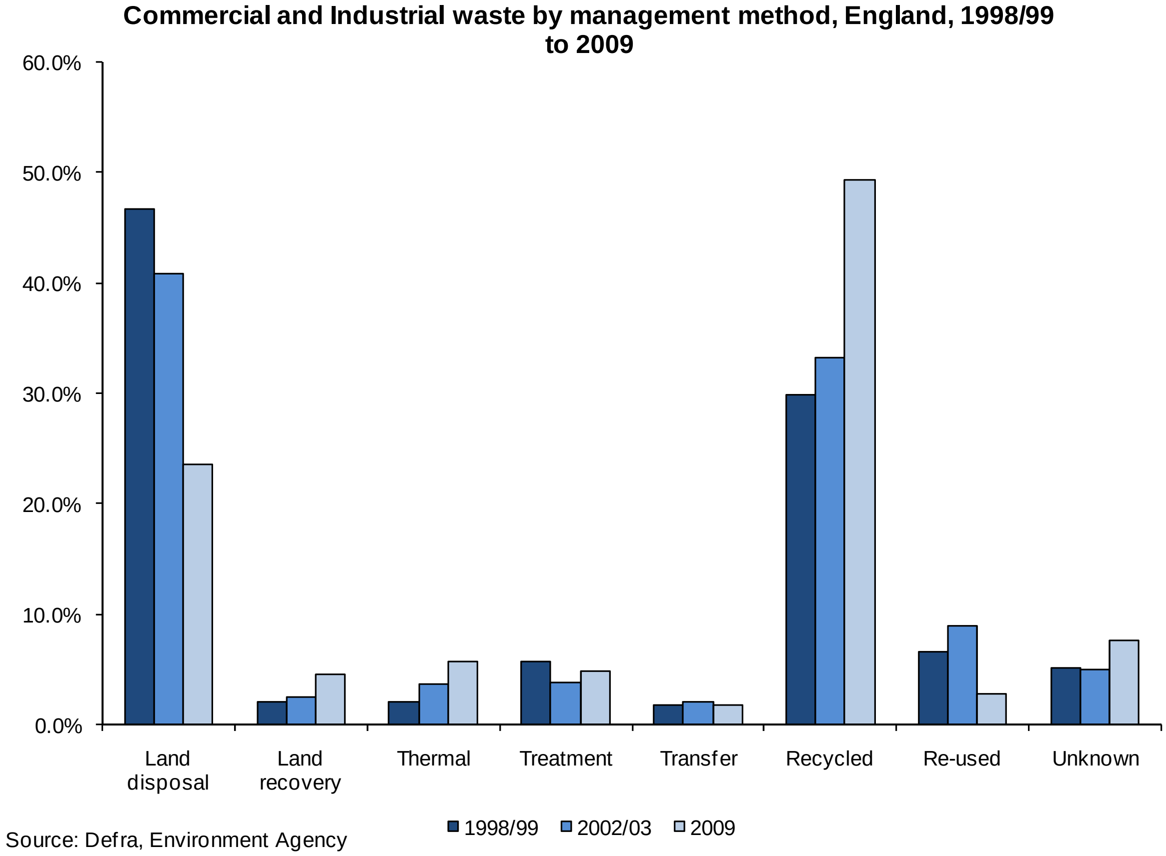
The chart demonstrates the significant improvement in local authority-collected waste treatment method over the decade to 2010/11, with landfill's percentage of management falling from nearly 80%, to below 50%, and recycling increasing from less than 15% to over 40%.

There is a similar picture for commercial and industrial waste (Figure A.8 below), where the landfill share has fallen by around half from 1998/99, and recycling has increased from around 30% to nearly 50%. Although from a higher base, the improvement is of a similar magnitude to that of local authority-collected waste.

These trends are expected to continue for both waste streams, although the rate of improvement will slow as the incremental gains become more difficult and costly to achieve.

[41] Previously known as 'municipal' waste. Statistics are presented for local authority collected waste, rather than household, as data is not collected for household waste for all management methods.

Figure A.8: Commercial and industrial waste management



A.4 Outlook to 2050

The 2050 scenarios analysis published alongside the waste review set out possible outcomes for waste arisings and management under different future states of the world. The scenarios provide a useful framework for considering possible waste outcomes – based on assumed levels of economic activity and the waste intensity of that activity (with improvements in waste resource efficiency reflected reductions in waste intensity).

The business-as-usual case is based on current trends in waste arisings and management. In addition, a number of illustrative scenarios are developed based on various levels of the key factors such as economic output & structure, the state of technology, policy direction and consumption patterns/behaviour. The scenarios include:

- Scenario 1: Business-as-usual
- Scenario 2: Sustainability Turn driven by societal decision and behaviour change to go green
- Scenario 3: High-Tech/Large-Scale Solutions where technology is the key to dealing with waste issues

- Scenario 4: Unlimited Wastefulness characterised by a lack of action and an increasing waste intensity

The scenarios illustrate the range of possible states of the world – from a technology-driven outlook to a scenario where behaviour change is the primary driver of change in the waste sector. They represent extreme states of the world, with the reality likely to be somewhere in between. The quantitative outcomes of this 'horizon-scanning' exercise are illustrated in Figure A.9.

The scenarios are not based on the principles of economic efficiency or cost effectiveness. For example, the scenarios are not based on achieving the efficient level of waste reduction, but are intended to illustrate likely waste outcomes resulting from the different states of the world. Moreover, they do not include the costs associated with achieving the different states of the world. The principle of cost effectiveness would imply that a combination of scenarios and policy levers – pricing, technology and behaviour change – is likely to be more cost effective in delivering the desired outcome than any one scenario or lever alone.

Combining the insights provided by the scenario analysis with the wider economic principles described in this section can provide a robust basis and help inform the future direction of waste policy.

Figure A.9: future Waste Scenarios

Overview of Key Scenario Characteristics and Data

	Data Today[1]	Reference Scenario		Sustainability Turn		High-Tech / Large-Scale Approaches		Unlimited Wastefulness	
Scenario Core	n.a.	The scenario assumes current trends to continue.		The entire nation (society, industry, and politics) opts for deep green.		High-tech approaches are regarded as the key to solving waste and resource problems, rather than a shift in behaviours.		Overall waste intensity and arisings increase strongly due to an early period of economic stagnation.	
HH Waste Arisings	2010: 28.2 Mt	2020: 29.0 Mt (+2.8%) 2030: 29.1 Mt (+3.3%)		2020: 24.3 Mt (-13.5%) 2030: 21.9 Mt (-22.4%)		2020: 30.1 Mt (+7%) 2030: 31.2 Mt (+10.8%)		2020: 29.4 Mt (+4.5%) 2030: 32.6 Mt (+15.8%)	
HH Treatment Shares	**2010**	**2020**	**2030**	**2020**	**2030**	**2020**	**2030**	**2020**	**2030**
Recycling	41%	50%	54%	57%	69%	52%	63%	41%	44%
Landfill	45%	33%	25%	23%	12%	24%	09%	44%	39%
EfW/Incin.	13%	18%	20%	19%	18%	24%	27%	15%	17%
C&I Waste Arisings	**2010:** 61.1 Mt	**2020:** 67.9 Mt (+11%) **2030:** 71.6 Mt (+17%)		**2020:** 60.9 Mt (-0.4%) **2030:** 56.9 Mt (-7%)		**2020:** 67.5 Mt (+10%) **2030:** 74.6 Mt (+22%)		**2020:** 64.1 Mt (+5%) **2030:** 77.3 Mt (+26%)	
C&I Treatment Shares	**2010**	**2020**	**2030**	**2020**	**2030**	**2020**	**2030**	**2020**	**2030**
Recycling	50%	55%	60%	61%	72%	60%	71%	50%	52%
Landfill	33%	24%	18%	17%	08%	16%	05%	32%	28%
EfW/Incin.	09%	13%	14%	15%	12%	16%	16%	11%	12%

[1.] Extrapolated data, based on latest available data.

Appendix B: Voluntary Agreements - Effectiveness and Application

This box considers the effectiveness of voluntary agreements and how they can be designed to work best. Overall, the empirical evidence suggests that voluntary approaches are not likely to be as effective as pricing instruments in delivering significant behaviour change. The literature[42] on voluntary agreements considers that although the stipulated environmental targets are generally met, the achievement is driven by factors other than the agreement itself – in other words firms would have done what the agreement stipulates even in its absence.

However, it also finds cases of voluntary agreements which do appear to impact on behaviour, and some quite significantly, which suggests that these agreements can be made to work in practice, where they are well-designed and targeted:

- Where a majority of costs and benefits to be realised are private rather than social, and there are behavioural barriers to achieving the economically efficient outcome; for example, low and no cost resource efficiency measures.
- Where they are used alongside a pricing instrument they are more likely to be effective in generating the economically efficient level of behaviour change in a cost effective manner.
- Where there are significant reputational drivers to which to link the voluntary agreement.
- Where the costs of regulation are particularly unclear, a voluntary agreement offers the opportunity to begin environmental improvements with less risk of costs outweighing benefits and with greater flexibility if the costs of abatement are higher than thought.
- Where they can cover a wide variety of industry participants, voluntary agreements can encourage greater participation (by mitigating potential negative competitive effects of individual action) and allow more challenging targets to be set. The capability to self-regulate and self-enforce is critical in ensuring that such agreements are effective – to manage the free rider problem.

Following from these observations, one can draw the following design principles:

1. Firstly, it is essential to clearly understand the drivers of company participation.

[42] Such as: OECD (1999a): *Voluntary Approaches for Environmental Policy: an Assessment,* OECD, Paris. Available at http://www.sourceoecd.org

2. Secondly, it is important to identify and target companies at the point in the supply chain best able to deliver the outcomes of the agreement.

3. Third, it is important to set a baseline by which to judge the additional value of the voluntary agreement in delivering environmental outcomes, over and above other instruments/business-as-usual behaviour.

Appendix C: Overlapping instruments

Where instruments overlap in terms of the behaviour and waste stream targeted, it is sensible to consider whether both instruments are required, or whether there is unnecessary duplication. Overlapping instruments may achieve nothing, or little, whilst still imposing administrative and enforcement costs on both businesses and Government. Two such policy areas are considered below: one where the multiple instruments appear unjustified, and one where they are necessary, *given the target regime in place.*

C.1 Landfill Allowance Trading Scheme (LATS) and Landfill tax

As set out in Table 2 the Landfill Directive contains targets to reduced the amount of biodegradable municipal waste sent to landfill. Before the re-definition of municipal waste, LATS covered all the waste counted under municipal waste. Post-redefinition, LATS now only covers around half of municipal waste. However, the question around whether both policy mechanisms are necessary remains relevant. The instruments are detailed below:

1. Landfill Tax: Rising from £48/tonne in 2010/11 by £8 per year until it reaches £80/tonne in 2014/15, with a floor at that rate until 2020.
2. The Landfill Allowance Trading Scheme (LATS). A quantity constraint on the amount of biodegradable waste that can be landfilled by local authorities. The trading element of the scheme ensures the cap on quantity is achieved at the lowest cost across all authorities.

The significant increase in the Landfill Tax - since LATS commenced operation in 2005 - acts as a much greater incentive to divert waste from landfill than when the landfill tax was at lower levels, and LATS was of much greater importance in making progress towards Landfill Directive targets.

LATS acts as a quantity constraint on the amount of biodegradable municipal waste sent to landfill by local authorities, with the aim of allowing trading to meet the targets as efficiently as possible. The Landfill tax acts to disincentivise the amount of waste being sent to landfill. Should the Landfill tax act sufficiently strongly as a disincentive to landfilling, so as to reduce the amount of landfilling below the quantity constraint level on its own, then demand for additional allowance purchases will fall to zero, as will the price of LATS allowances. LATS becomes a redundant policy instrument and the accompanying costs of monitoring and compliance become unnecessary.[43]

[43] For further details, see the Impact Assessment on the removal of LATS published alongside the Waste Review.

C.2 Packaging targets and the landfill tax

Through Producer Responsibility Obligations, there are targets in place in relation to, amongst other waste streams, packaging recycling and recovery. Packaging, as with other waste types, is subject to the landfill tax (if landfilled). In addition, businesses that handle packaging are required to purchase Packaging Recovery Notes (PRNs) in order to demonstrate that the requisite amount of packaging has been recycled. PRNs are created by reprocessors who carry out recycling, which they can sell on to obligated businesses. The value of PRNs encourages recycling.

As discussed in sections 2 and 5, whilst the landfill tax incentivises waste out of landfill, it does not direct the waste to any particular level of the waste hierarchy. Market conditions, such as gate fees, collection costs, the value of materials recovered, and costs of various treatment options, determine the extent to which waste diverted from landfill are directed to recovery, recycling, and re-use.

On the basis of the analysis presented in the Impact Assessment which accompanied the consultation on 2011-12 targets, the landfill tax alone will not ensure EU minimum recycling targets are met for all materials. In some cases, the landfill tax is able to deliver recycling levels similar, if not additional, to the packaging targets. If this were the case across the board, there would be no need for additional instruments to incentivise further recycling/recovery of packaging. However, this is not the case for a some materials, for which the landfill tax alone does not ensure the necessary diversion further up the hierarchy. Thus the PRN system, delivering packaging recycling targets, are important in order to ensure compliance with EU requirements for recycling and recovery of packaging waste.