Understanding the Policy Options for Implementing a Scottish Specific Landfill Tax

Final Report for the Scottish Government

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18/05/2011

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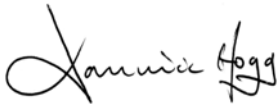

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Acknowledgements

Our thanks to all the members of the steering group and those involved in the stakeholder interviews.

Disclaimer

Eunomia Research & Consulting has taken due care in the preparation of this report to ensure that all facts and analysis presented are as accurate as possible within the scope of the project. However no guarantee is provided in respect of the information presented, and Eunomia Research & Consulting is not responsible for decisions or actions taken on the basis of the content of this report.

EXECUTIVE SUMMARY

Eunomia Research & Consulting is pleased to present this Final Report to the Scottish Government on the potential options for varying the landfill tax. This is an option which is likely to be available to Scotland once the relevant powers have been devolved, expected to be in 2014/15. The stimulus of this study comes from the following recommendation by the Calman Commission: [1]

> *"Stamp Duty Land Tax, Aggregates Levy, Landfill Tax and Air Passenger Duty should be devolved to the Scottish Parliament, again with a corresponding reduction in the block grant."*

The Coalition Government of 2010 committed to implementing these recommendations, including the transfer of legislative responsibility to Scotland to set the level of Landfill Tax along with some other fiscal instruments.[2] The Scottish Government now has the ability to set the level of landfill tax from 2014/15 (the end of the period of application of the current UK landfill tax escalator).[3,4] No decision has been made regarding changes to the levels, or structure, of the landfill tax as yet. The aim of this project is to consider options for varying the landfill tax with respect to the rest of the UK, and to consider the impact this would have on waste policy, and Scotland's goal of achieving a Zero Waste Society.

The definition of a Zero Waste Society is summarised below:[5]

> *"everything we use and throw away is a resource which has a value, a value that we should try to preserve, capture, and use again wherever possible.*
>
> *That is what a zero waste Scotland means - not a country where we never throw anything away, but a new approach to making the most effective use of all resources, and avoiding wasting resources or making them unusable wherever we can."*
>
> Richard Lochhead, MSP - Cabinet Secretary

This piece of research aims to inform decision making regarding the landfill tax. It also aims to be a progressive piece of economic research in the field of waste management. As far as the authors are aware, part of the approach used in this study, to model the impacts of changes in a landfill tax, has not been used before, neither in the UK, nor anywhere else in the world.

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[1] Commission on Scottish Devolution (2009) *Serving Scotland Better: Scotland and the UK in the 21st Century*, Final Report, June 2009, http://www.commissiononscottishdevolution.org.uk/uploads/2009-06-12-csd-final-report-2009fbookmarked.pdf

[2] Scottish Government (2010) *Research Specification: Understanding The Policy Options For Implementing A Scottish Specific Landfill Tax*, Tender Ref: CR/2010/04

[3] Scottish Government.

[4] HM Treasury (2010) *Budget 2010*, http://cdn.hm-treasury.gov.uk/junebudget_complete.pdf

[5] Scottish Government (2010) *Scotland's Zero Waste Plan: Ministerial Forward*, Accessed 16th July 2010, http://www.scotland.gov.uk/Publications/2010/06/08092645/1

E.1.0 Approach

The overarching aim of the project that was given in the tender specifications is:

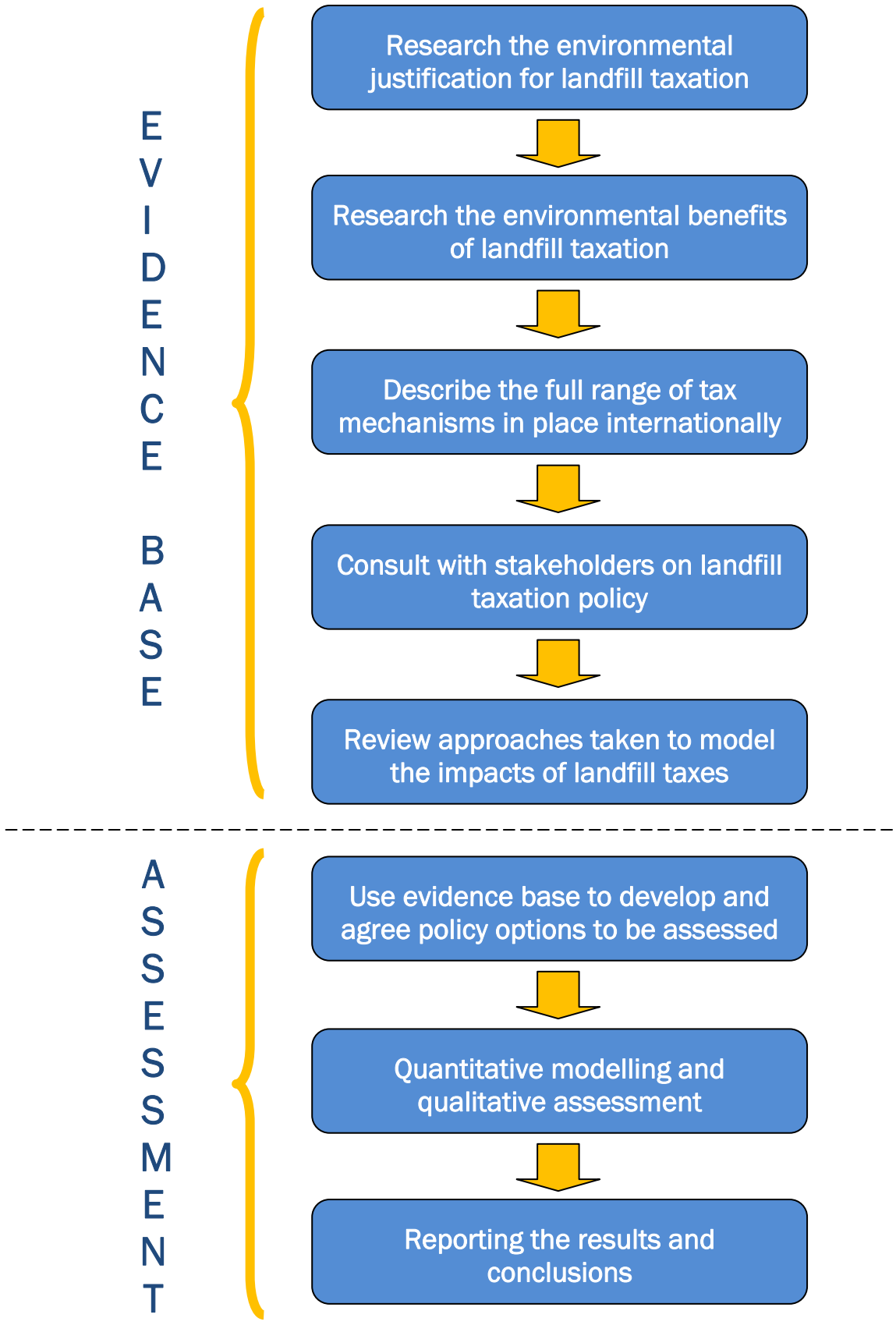
> *"To be able to understand and establish the current impact of the landfill tax on the UK and disaggregated to devolved countries and the impact of designing and implementing a Scottish specific landfill tax".*

In doing this it would enable the Scottish Government to:

> *"advise Ministers on options for varying Landfill Tax with respect to the rest of the UK, and the impact this variation will have on:*
>
> - *The proportion of waste going to landfill;*
> - *Recycling rates;*
> - *Certainty to investors – business and waste industry;*
> - *Cross border movements of waste;*
> - *LA waste management services and contracts including costs".*

The specification also stated that certain tasks were to be undertaken, such as a literature review and the development of a Scotland specific landfill model. These requirements shaped the general approach to the research. A summary of the tasks undertaken to deliver the objectives of the study is given in Figure E 1-1.

Figure E 1-1: Project Methodology Flow Diagram



E.2.0 Summary Findings of the Study

This study has approached the issue of understanding landfill taxes for a variety of angles. The initial review of evidence included a number of different approaches, including a literature review, stakeholder interviews, investigation of the approaches taken in other countries to *ex ante* or *ex post* evaluation of such taxes and exploration of modelling approaches already used in the UK. The work then progressed to develop policy options for further investigation, and based the analysis of these on a combination of quantitative modelling and qualitative assessment.

The key findings of the study are presented below.

E.2.1 Review of Literature and Other Country Experience

The following points summarise the findings from the literature review:

- Many countries within the European Union have utilised landfill taxes since around the mid-1980s;
- The rationale of most landfill taxes was to stimulate waste minimisation and reuse/recycling. This is realised by increasing the cost of landfilling, and thus making alternative management methods more cost competitive, and waste prevention more financially rewarding. In addition some countries specifically seek to raise revenue, or internalise the externalities of landfilling;
- The revenue can be used for a number of purposes, including being directed to the national budget, funding environmental projects and supporting waste management activities;
- Most landfill taxes covers all waste streams, rates are often split between active and inert wastes, and in many cases, the rates have increased significantly over time;
- Most countries exempt some materials from the tax when they are landfilled;
- With the UK landfill tax at £80 per tonne, however, it will be one of the highest rates in Europe. Only the Netherlands has a comparable level of tax (which is used to support a policy banning many waste streams from landfill);
- Spain, Belgium and Italy each have regional variations in landfill tax policy;
- In Belgium and Italy, there are mechanisms in place to effectively apply a form of border tax adjustment between regions when waste is moved from one region to be landfilled in another. The details of these mechanisms have, however, been difficult to obtain;
- Many countries with higher landfill taxes include supporting policies to help drive whatever behaviour is required by the national waste management plans. These include policies directed at increasing recycling, and measures to ensure residual waste does not simply switch from landfill to incineration. In some countries, however, where recycling policies have not been so strong, landfill taxes have, alongside landfill bans, had the effect of shifting residual waste from landfill to other treatment routes (typically, incineration);
- In terms of the link between landfill taxes and landfill bans, some countries have noted the need to have higher taxes to dissuade companies from having repeated recourse to exemptions from a ban (which may be necessary in some contexts). In Austria, where a ban on landfilling biodegradable wastes was implemented, this was

incentivised through offering a lower rate of tax for wastes that had been pre-treated such that their tendency to generate methane when landfilled was significantly reduced;

- There is a complete dearth of ex ante analyses of landfill taxes in other countries as far as we could discern. Most countries appear to have taken a much more pragmatic approach to the design of their landfill tax, and we could find no country where there was some officially sanctioned model of the workings of a landfill tax (which does not mean to say that this does not exist); and
- Finally, there is a tendency, which appears to be gathering pace, for countries to establish taxes on other waste treatments too, notably incineration. Several countries – Denmark, Austria, Belgium, Sweden and Catalunya among them – have 'waste taxes' which cover incineration as well as landfill, albeit that the tax rates for incineration are generally much lower than for landfill.

E.2.2 Stakeholder Perspectives

A range of stakeholders within Scotland were consulted regarding their experiences with the tax, how it was currently working, and for their views on whether or not the tax should be changed (and if so, how). Some observations drawn from these consultations are offered below:

- It was generally felt that the administration and regulation of the existing tax mechanism was good;
- The current and proposed structure and levels of the tax were considered 'about right' and it was generally accepted that the tax was a key driver in changing waste management behaviour. Indeed, there was a view that 'landfill' was certainly not the best industry to be in today;
- There were mixed opinions in regards to whether the level of the tax should remain at £80 or be increased further;
- There was some concern expressed regarding the possible fracturing of waste policy within the UK and of the possibility of 'unlevelling the playing field' for industry. Some commentators considered that a UK wide system was considered to be easier and cheaper to administer. It was also believed that any change to the tax mechanism should be simple;
- Differences in the level of tax are likely to cause waste to move across borders as in the current economic climate industry is very closely watching 'the bottom line'. The magnitude of the flow is uncertain but the distance waste travels is directly related to the difference in price.
- The current level of waste movements across the Scottish border was considered to be low, though exact figures were not generally known; and
- The current level of landfill gate fees was also reported to be low in the southern and central areas of Scotland, closest to the border with England. This was offered as one of the explanations for the (presumed) low level of export of waste for landfill outside of Scotland.

E.2.3 Review of Modelling

Several models were reviewed with a view to seeking pointers as to how a Scotland-specific model could be developed. There was, however, no model that really captures the full

dynamics of the waste sector, and hence, which really considers all the variables affecting the landfilling of waste. The following comments highlight some key points:

- No econometric exercise of any significance has been conducted, as far as we can see, on the tax to elicit specific response parameters associated with it. This is not especially surprising given a) the poor quality of the historic data, and b) the fact that the tax affects a range of waste producers who effectively face different 'menus' of alternatives to landfill;
- Notwithstanding this fact, many of the models (e.g. HM Treasury) understandably, perhaps, rely on the use of elasticity based functions to drive the change in behaviour. Such models rarely incorporate cross-price effects, basing predictions instead upon constant price elasticity of demand functions. These are unlikely to be reliable over non-marginal price changes;
- The LAWRRD model used in England to consider household waste management takes an approach based upon marginal costs of 'managing waste' in different ways. The drawback of such approaches is that they are heavily reliant upon extremely accurate data. No such approach has been developed for other waste streams, and to do so would rely upon characterising different waste producers according to which alternative options are available to them and at what price. This would be a substantial task, and would have to address the fact that the relevant cost data is not obviously available in the public domain; and
- The REEIO – Regional Economy Environment Input Output model incorporates a number of parameters and equations that describe the functionality of the model, but no price response functions or parameters could be identified in the model descriptions. The model also appears to be described as assessing changes in arisings and keeps the pattern of waste management (i.e. the proportion being sent to landfill, being recycled, etc.) constant. Therefore, as this study is primarily concerned with responses to landfill prices, it appears to have little to offer. It must be stated, however, that we were not privy to the model itself so could not be certain whether this was the case in the actual model.

There is, therefore, no 'easy choice;' when considering how to develop a model of 'waste management' which gives a clear indication of how much might be landfilled in future. One key problem – which own-price elasticity models conveniently sidestep – is that even if all one is interested in is 'the quantity of waste landfilled', it is difficult to ignore the fact that the price of the most important (and in the ideal world, all other) waste management alternatives needs to be factored in, in some way, to the model.

On balance it was felt that given that much of the remaining landfilled waste appears to be of a nature similar to residual household and commercial waste, it might be possible to gain a handle on the costs of the key alternative management options. Hence, the more complex approach of constructing cost curves for key recycling alternatives, as opposed to using own- and cross-price elasticities (which could only be guessed at), was chosen for this piece of research. In reality, the model also includes some elements which are modelled using an elasticity approach, typically where we have insufficient evidence to develop the relevant marginal cost curves for the alternatives.

E.2.4 Development of Policy Scenarios

Through considering the international review, and taking into account the views of stakeholders, and then through setting out the pros and cons of various possible policy options, we arrived at a final set of options that were taken forward to the modelling stage.

Some options were conducive to quantitative modelling techniques, similar to those discussed in the review stage of the study. However, some are not far enough advanced in conceptualisation, or rely upon data that has not yet developed to a sufficient degree. Therefore, these policy options have been appraised through both quantitative analysis and qualitative discussion. This is reflected in how the final options are presented in the following list:

Options for Quantitative Modelling;

- Increase Level of Standard Rate Tax;

Options for Qualitative Appraisal:

- Increase Level of Lower Rate Tax;
- Lower Rate for Stabilised Wastes;
- Introduce Incineration Tax;
- Revenue Used to Incentivise Recycling Activities;
- Combustion Residues Classified at Standard Rate;
- Export / Border Adjustment / Equalisation Tax to discourage cross-border waste movements;

E.2.5 Scottish Landfill Tax Model - Baseline Development

Included in the study was the requirement to develop a mass flow model of Scottish waste and to understand the possible effects of adjusting the already announced levels of the tax against two baselines:

1) A Business as Usual (BaU) Baseline; and
2) A Zero Waste Plan (ZWP) Baseline.

The organisation of the relevant data proved to be a challenge. Moreover, there was some concern raised about the quality of the data used to underpin the macro modelling undertaken in this study, and therefore some of the quantitative results. However, the Scottish Government is aware of the issues and is setting out to resolve data issues in future, to the extent possible, through powers gained under the Climate Change (Scotland) Act 2009.

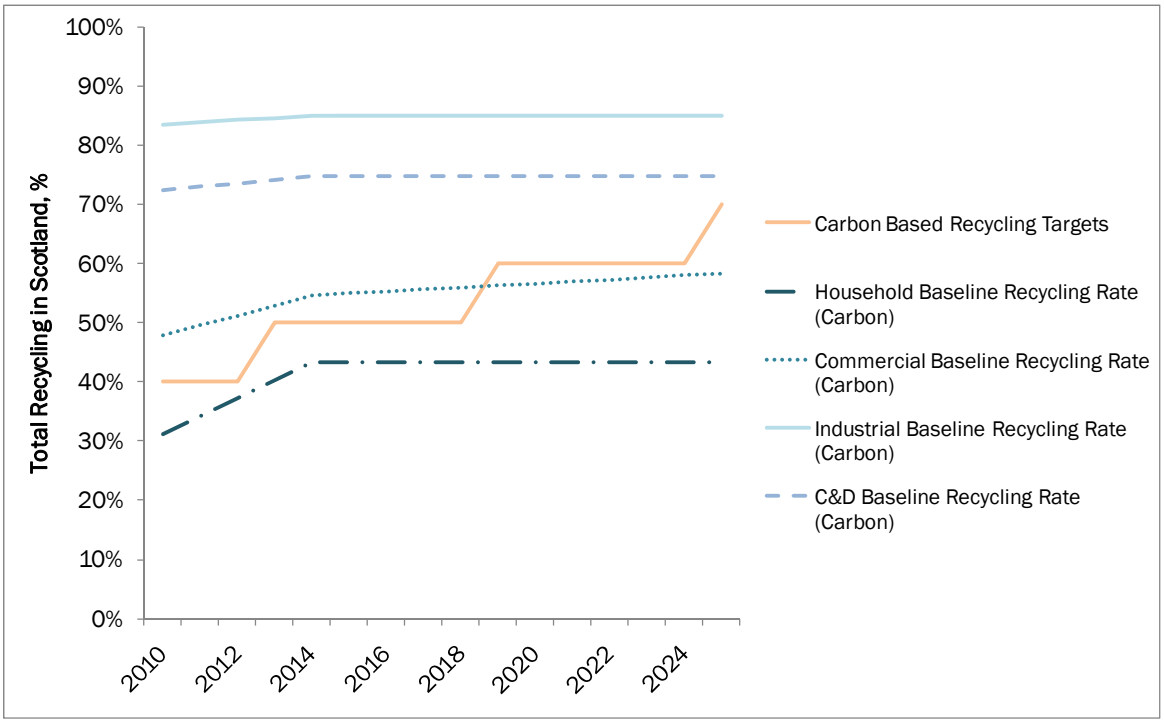
The following points, relating to the modelling of waste management projections under the two approaches, are worthy of note (see also Figure E 1-2 and Figure E 1-3):

- For household waste none of the interim carbon targets are met under the BaU baseline. Under the ZWP Baseline, the 70% recycling target for 2025 proves to be difficult to meet;
- The extent of the change between the two Baselines is not significant for industrial waste. Indeed much of the 'high carbon weighting' material is being captured well already, and 'low carbon weighting' material, such as wastes from thermal processes (i.e. ash) is still being landfilled. For the commercial sector, carbon based recycling rates are already higher than is the case for household waste, but the 2025 target is still missed under BaU. Under the ZWP Regulations, effort can shift more heavily to 'high carbon weighting' materials so the rates increase significantly, and the targets are met;
- For the C&D sector, the carbon based target is met even in the BaU Scenario. The extent of the change between the Baselines is not as great as that for household

waste. Carbon based rates are more easily exceeded, reflecting the higher proportion of 'low weighting' materials in the waste stream;

- The Waste Framework Directive and Landfill Directive targets are being met under both baselines; and
- In essence, the comparison between the baselines shows that there is still a significant additional change that can be made to waste management in Scotland over and above the influence of the existing landfill tax escalator.

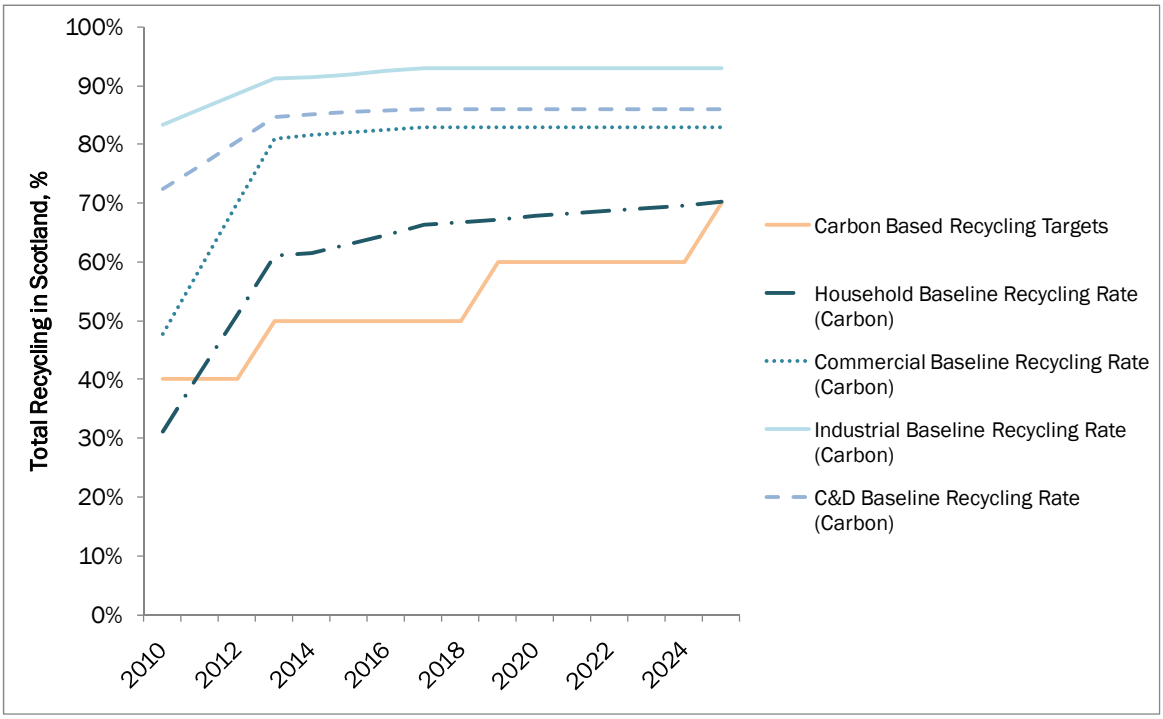
Figure E 1-2: Carbon Based Recycling Rates for All Sectors v Time (BaU Baseline)



Source: Eunomia Landfill Tax Model

Note: The carbon based targets prior to 2025 apply to household waste only.

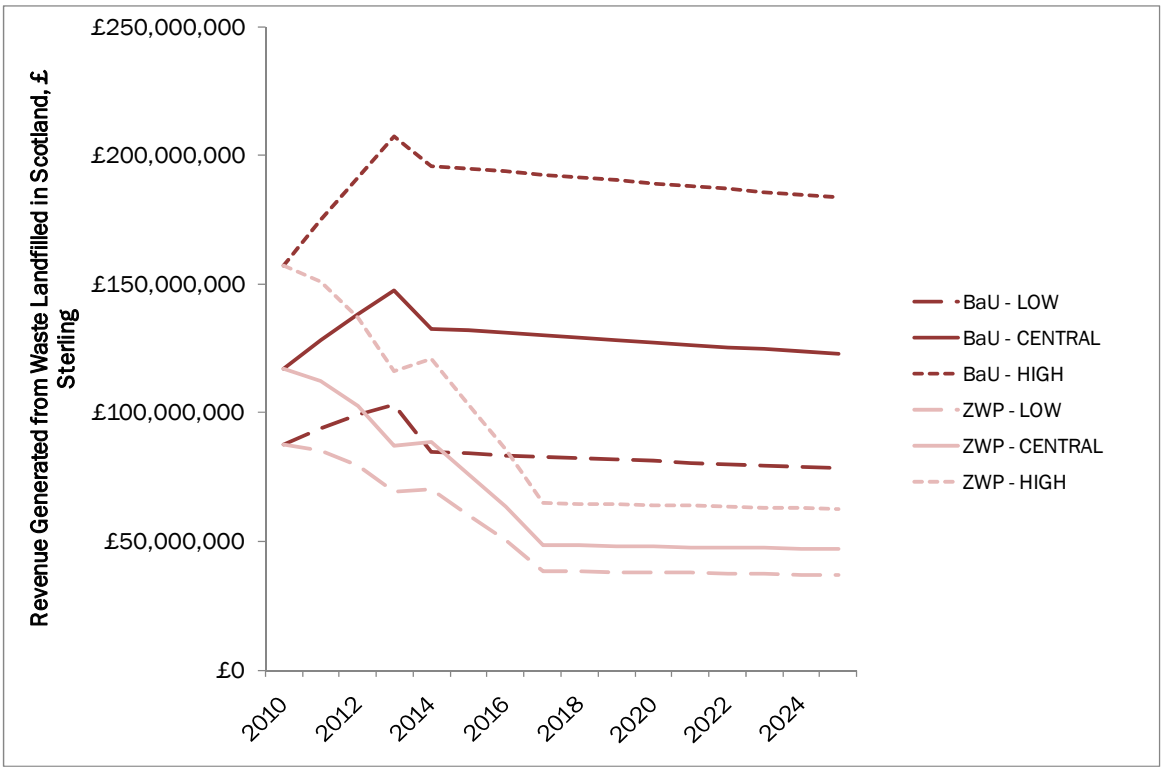
Figure E 1-3: Carbon Based Recycling Rates for All Sectors v Time (ZWP Baseline)



Source: Eunomia Landfill Tax Model

Note: The carbon based targets prior to 2025 apply to household waste only.

Figure E 1-4: Baseline Landfill Tax Revenue Generated under LOW, CENTRAL and HIGH Sensitivities (BaU and ZWP Baselines), £ 2010 Real Terms



Source: Eunomia Landfill Tax Model

Following from the recycling and treatment of waste the quantity of waste landfilled can be derived, and the landfill tax revenue estimated. HMRC do not hold disaggregated tax receipts for Scotland so this figure cannot be benchmarked at the current time. Some sensitivity analysis was undertaken, where a number of key baseline parameters were flexed (see Section 7.2.7). The results are shown in Figure E 1-4. One can see that under BaU the uncertainties in the project tax take are much higher than under the ZWP, mainly because the quantities landfilled are estimated to be lower.

E.2.6 Scottish Landfill Tax Model - Quantitative Results

The aim of the quantitative modelling was to develop a model to enable the effects of a change in standard rate tax to be modelled. The scenarios chosen were:

1) Increase Standard rate by £8 to £88 per tonne in 2015 (£8 Scenario); and
2) Increase Standard rate by £8 to £88 per tonne in 2015 and by £16 to £96 per tonne in 2016 (£16 Scenario).

To provide some context to the results of the study we first summarise the discussion around the uncertainty in the residual waste treatment market.

Uncertainty in the Residual Waste Market

In the central approach to the modelling, we have assumed that those who are seeking to offer residual waste treatment capacity at costs competitive with landfill (once the tax reaches £80 per tonne in nominal terms) on a merchant basis are already likely to be engaged in the planning process. Due to the extended periods of time these facilities can take to become fully operational (over 7 years in some cases), then given also the period already elapsed between the announcement of the tax rising to £80 per tonne and the time of writing,[6] we have taken the view that, in terms of household and commercial waste, the only increase in treatment capacity which is motivated by the level of the £80 per tonne tax is what is already known about by virtue of its being in the planning process. For household waste, this amounts to an additional capacity of around 320,000 tpa, or 16% of Scotland's household waste.[7]

Other than these facilities, therefore, we have assumed that landfill tax is the benchmark figure for 'avoided disposal' which drives increases in recycling under BaU. The significance of this assumption was explored in the Main Report (Section 5.1). Evidently, if other residual waste treatments 'undercut' landfill, then in sectors where there is a strong price focus, it will be the price of these treatments, and not that of landfill, which drives the behavioural response. This affects not just the modelling of any change in tax which might be considered, but it also affects how the BaU (and to a lesser degree, the ZWP) baseline mass flows are developed (it would, of course, affect the *costs* of both Scenarios).

There is, therefore, some uncertainty in the modelling which relates to the price of residual waste management alternatives to landfill. In consequence, a scenario based approach was chosen in modelling the effects of the tax on the up-take of residual treatments. Three levels, low, medium and high, were set to provide a realistic range. These scenarios are evident in the quantitative findings below.

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[6] This is May 2011.

[7] Scottish Futures Trust (2011) *Untitled* http://www.scottishfuturestrust.org.uk/docs/262/File%206%20-%20Copy%20of%20Project%20Data%20-%2014%20Dec%202010.pdf

Quantitative Results

In this section the key quantitative results of the modelling work are summarised. The total waste landfilled, revenue generated and costs to Local Authorities (LAs) and businesses under BaU and the ZWP are shown.

Note that the tax revenue figures for Scotland may be understated for reasons outlined in Section 6.1.2.4. More accurate estimates could be derived if, for example, over the coming years, HMRC or Scottish Government requested tax returns from operators to report by site rather than in the aggregate by reporting company.

Table E 1-1: Waste Landfilled Resulting from Increasing Standard Rate, M tonnes

	BaU			ZWP		
	2015	2020	2025	2015	2020	2025
£8 Scenario - Low	3.2	3.1	3.0	2.0	1.2	1.2
£8 Scenario - Medium	3.0	2.9	2.8	2.0	1.2	1.2
£8 Scenario - High	2.2	2.1	2.0	1.8	1.1	1.1
£16 Scenario - Low	3.2	2.7	2.6	2.0	1.2	1.1
£16 Scenario - Medium	3.0	2.3	2.2	2.0	1.1	1.1
£16 Scenario - High	2.2	1.2	1.2	1.8	1.0	1.0
Baseline	3.6	3.5	3.4	2.0	1.3	1.3

Source: Eunomia Landfill Tax Model

Table E 1-2: Total Tax Revenue under Standard Rate Tax Scenarios (Relative to BaU Baseline), £ millions 2010 Real Terms

	BaU			ZWP		
	2015	2020	2025	2015	2020	2025
£8 Scenario - Low	£124	£120	£115	£77	£48	£47
£8 Scenario - Medium	£116	£112	£108	£76	£47	£46
£8 Scenario - High	£85	£81	£77	£71	£43	£42
£16 Scenario - Low	£124	£112	£107	£77	£49	£48
£16 Scenario - Medium	£116	£96	£92	£76	£47	£46
£16 Scenario - High	£85	£50	£49	£71	£41	£40
Baseline	£130	£126	£121	£74	£47	£46

Source: Eunomia Landfill Tax Model

Table E 1-3: Net Change in Costs to Scottish Local Authorities and Businesses Relative to BaU and ZWP Baselines, £ thousands 2010 Real Terms

	LA - BaU	LA - ZWP	Business - BaU	Business - ZWP
£8 Sc. - Low (2015)	-£391	-£80	-£5,454	-£296
£8 Sc. - Medium (2015)	-£417	£103	-£5,624	£99
£8 Sc. - High (2015)	-£519	£833	-£6,305	£1,681
£16 Sc. - Low (2016)	-£760	-£155	-£8,811	-£545
£16 Sc. - Medium (2016)	-£810	£200	-£9,136	£187
£16 Sc. - High (2016)	-£1,008	£1,619	-£10,073	£3,116

Source: Eunomia Landfill Tax Model

Sensitivity Analysis

To account for uncertainties such as that discussed above, and also, to take into account the effect of varying some key behavioural response parameters, sensitivity analysis was conducted with a view to generating high and low estimates of the magnitude of change around our central scenario.

The sensitivity analysis shows that there is a clear uncertainty in the quantity of waste landfilled and the revenue that will be generated for the Scottish Government. These uncertainties should be made clear when address the issues of a reduction in the block grant for Scotland when the powers to set the landfill tax are devolved.

The sensitivity analysis around the costs of increasing the standard rate of tax shows that, again, there is some uncertainty in the results, but that, importantly, the mean values do not deviate from zero, or cost neutral, significantly. In addition, there is no instance where the financial costs switch to a significantly positive value. In the main this is due to the predicted state of the recycling market, where increasing costs of recycling are mostly, or fully, outweighed by the avoided costs of disposal.

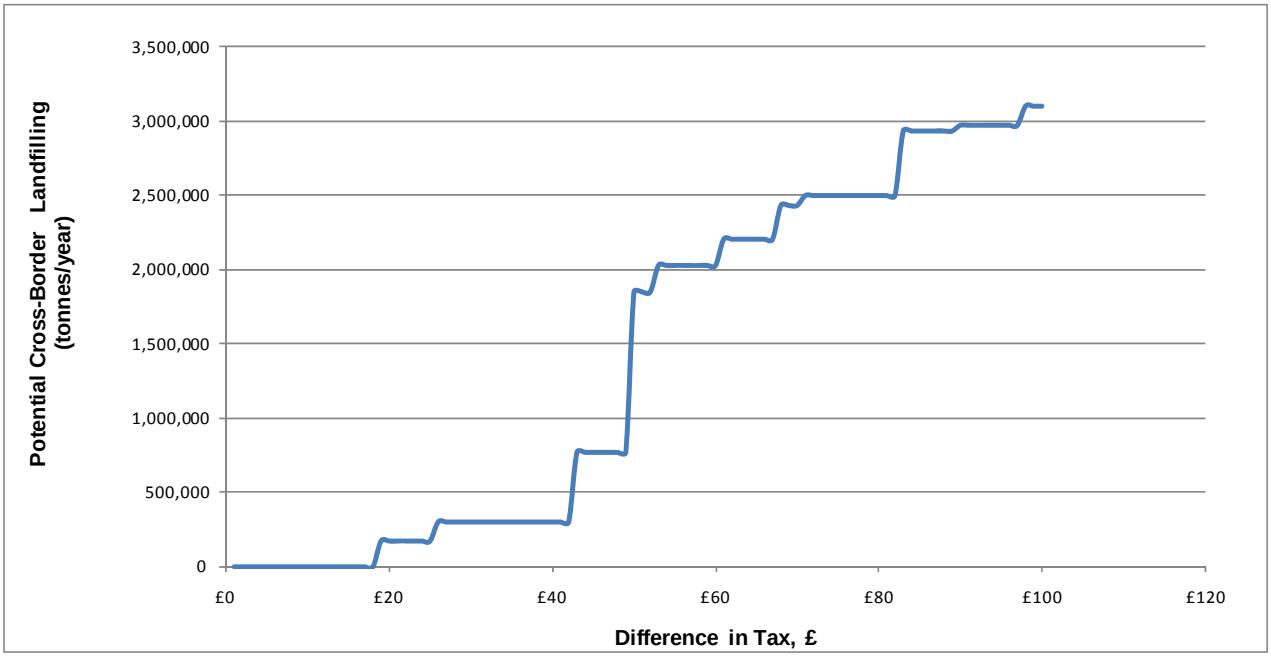
Cross-border Movements

Higher landfill taxes in Scotland could lead to additional movements of waste across the border to England. During the data gathering stage of the project, however, it was determined that very little waste currently crosses the border with England, or other countries. Some hazardous waste is transported to find appropriate treatment facilities, but non-hazardous waste, such as residual waste, is nearly all treated or disposed of in Scotland. Therefore, it was assumed that current movements of residual waste to English landfills are zero in the Baselines.

We modelled the amount of landfill void space in England which would 'become available' as one moves an increasing distance from the border, and translated this into a typical haulage cost. There are of course some uncertainties with this kind of modelling (the accuracy of the waste data, the potential for landfills to expand beyond their permitted capacities, local and national contractual arrangements, the relative pricing and availability of alternatives, the capacity of rail transport and the propensity to export waste to other EU Member States for recovery, amongst others).

Notwithstanding these points, there does not appear to be a significant amount of waste that would cross the border at low levels of increase in the tax. The plot of the potential size of the movement against the required cost differential is shown in Figure E 1-5. At tax differentials of up to £15 to £20 there is not likely to be any significant additional migration of wastes to English landfills. Once the differentials increase above this level waste exports may find cheaper alternative routes by being transported by road to landfills in England, and at above £40 per tonne the movements could become very significant. For rail transport the situation is more finely balanced. At differentials of maybe even £5, some waste transport to England could be cost effective.

Figure E 1-5: The Potential Cross-Border movement of Scottish Business Waste Destined for Landfill, tonnes per year



Source: Eunomia

One important caveat needs to be added at this point. There may be non-landfill residual waste treatments which become competitive at prices below the level of landfill plus tax, once the tax reaches £80 per tonne. If this happens, then of course, the price differential between Scotland's landfills and England's treatment facilities may be wider than has been predicted here, and waste may well flow not to English landfills, but to English incinerators and other non-landfill treatments. The effect of low cost recovery facilities in other EU countries would have a similar influence.

If the landfill tax was to be increased more significantly, or greater certainty was required, one option could be to introduce some fiscal mechanism to provide a financial penalty for transporting waste out of Scotland for disposal. This is discussed within the next section of the qualitative assessment of the policy options.

E.2.7 Qualitative Assessments of Policy Options

This Section summarises the findings of the research undertaken for each policy option examined, including those assessed through a more qualitative approach. These were:

- Increase Level of Lower Rate Tax;
- Lower Rate for Stabilised Wastes;
- Introduce Incineration Tax;
- Revenue Used to Incentivise Recycling Activities;
- Combustion Residues Classified at Standard Rate;
- Export / Border Adjustment / Equalisation Tax to discourage cross-border waste movements;

It should be noted that several of the policies examined might, if they were introduced, benefit from some form of mechanism to ensure cross-border movements did not undermine the measure. Although the final policy in the above list is presented as a standalone policy, it is, in fact, a measure which complements other policies.

The key findings, in terms of the pros and cons of introducing the policy in Scotland, are summarised below.

Increase Level of Lower Rate Tax

PROs	*CONs*
Increased costs of disposal would allow for other recycling options to become cost effective and provide the economic stimulus for operators to reduce the quantities of inert waste landfilled (mainly from the C&D sector and combustion residues from the Industrial sector).	The magnitude and destination of the waste diverted from landfill is not certain. There is a possibility that wastes would simply be diverted to exempt sites where the value of the recovery activity might be limited.
The modelling suggests that increasing the level of tax would stimulate landfill diversion.	Although the costs of transport are higher for dense materials, there is still the possibility that wastes would migrate across the border to England for disposal, unless constraining mechanisms were put in place. However, there would appear to be a very low likelihood of this happening.
It is possible that the recycling and recovery of inert wastes would increase.	Landfill operators, some of whom are already struggling to find relevant engineering materials, may find the tax exacerbates shortages.
	Some landfill operators in need of engineering materials may simply absorb the tax in preference to paying for alternative materials. The tax might not always be 'passed through' to waste producers, therefore, with the tax incident largely on the operators in these cases.

Lower Rate for Stabilised Wastes

PROs	*CONs*
The research suggests that stabilised wastes produce less methane emissions when landfilled, and thus cause less global environmental damage. The monetised environmental damages are estimated to be around £15 per tonne, less than the £61 to £76 range estimated for untreated residual waste. As the UK landfill tax was based upon the principle of internalising environmental externalities, it is appropriate to set the level of the landfill tax at around this lower level.	The research around landfill emissions is caveated by a number of assumptions and modelling parameters. Thus the extent of the reduction in environmental damages resulting from stabilisation of waste is not certain.
The reduction in disposal costs for processes which stabilise wastes will translate to lower gate fees for businesses and Local Authorities. This would be helpful in the current economic climate.	By reducing the gate fees for residual waste treatment processes, the cost of stabilising waste before landfilling might become the 'back-stop' price in the residual waste market. This would reduce the financial drivers for more recycling and waste prevention. It should be noted, however, that this issue is more of a concern under BaU than under ZWP, since under ZWP, specific drivers seek to deliver additional recycling at levels in excess of what the tax alone seems likely to deliver.
This policy aligns with the aim to ban biodegradable waste under the Zero Waste Plan (ZWP).	If the costs of residual waste treatment fall in Scotland, compared with England, this may stimulate 'waste tourism' to Scotland. For reasons discussed in Section 9.6.4, however, the differentials would likely need to become significant for this to occur.
	Potentially introduces a new rate into an established tax structure.

Extend the Landfill Tax to Incineration

PROs	*CONs*
Under BaU, the policy ensures that waste does not simply switch from landfill to other residual waste treatments.	There is currently no legal basis for this tax in Scotland and it lies outwith the scope of the devolved landfill tax policy.
The evidence suggests that there are environmental externalities associated with incineration which are not currently internalised in any policy mechanism, only WID emission limits which seek to constrain the risks of airborne pollutants exist.	Indecisive action on this policy could result in further uncertainty, and future costs, for Scottish businesses.
The policy can be designed to promote abatement of emissions which contribute to health damages.	The tax could be undermined if facilities with available capacity exist in the rest of the UK, or in other EU Member States.
	May increase costs of residual waste management to local authorities and businesses (depending upon counterfactual).

Revenue Used to Incentivise Recycling Activities

PROs	*CONs*
The revenue raised from the tax goes directly back to the waste management industry to help pay for the costs of developing the required infrastructure.	There is some uncertainty about the outcomes likely to be obtained
There a number of potentially different mechanisms which could be considered, some of which act to incentivise performance. Some of these are performance levellers (e.g. targeting residual waste per household instead of a recycling rate)	Some argue that where mechanisms reward the best performers, this tends to leave the laggards behind and entrench their position.

Combustion Residues Classified at Standard Rate

PROs	*CONs*
A growing body of scientific evidence supports the notion that ashes from municipal waste incinerators have the potential to cause environmental damage.	No compelling evidence to suggest that furnace bottom ash from coal fired power stations or foundries is toxic and would cause environmental damage if untreated.
Increased costs of disposal for ashes would stimulate the market for the recovery of precious and rare earth metals, supporting the idea of sustainable production and consumption.	May increase costs of residual waste management to local authorities and businesses (depending upon counterfactual).
Increased costs of disposal for incinerator ash would increase the gate fees for the process and have the same effect as an incinerator tax i.e. ensure the costs are sufficient not to constrain the reuse, recycling and recovery markets. This could be relatively important under BaU in increasing the incentive to recycle and prevent waste.	

Export / Border Adjustment / Equalisation Tax to discourage cross-border waste movements

PROs	*CONs*
Supports a Scotland-specific policy implementation of landfill tax.	Questions regarding legal competence arise under some of the possible options.
Initial analysis suggests that the issue might not be a major one anyway unless the tax rates in Scotland and the rest of the UK diverge significantly.	Might impose additional administrative burdens on waste carriers.
Once the tax increases beyond a certain level, the cost of local alternatives to landfill may present themselves before it becomes economic to export to the rest of UK.	May be difficult to enforce.
There are already procedures which have to be followed for trans-frontier shipments, so border tax adjustments related to export for recovery to other EU	

member states may be easy to track.

E.2.8 Policy Changes and the Issue of Certainty

The act of reviewing, or considering, changes in, a particular policy raises expectations that the policy concerned could be the subject of change. The effect of this is to create a degree of uncertainty, the scope of which may depend upon how the nature of any such review is communicated, and the credibility of that communication.

Within an uncertain policy environment, decisions regarding 'what to do' are affected pending further clarity about the policy procurement. In particular, if decisions regarding investments in waste prevention, waste collection or waste treatment are under consideration, the uncertainty may lead to delay in the making of these decisions until the uncertainty is removed (or diminished).

Scotland is in a relatively fortunate position from this respect in that:

a) The general direction of policy – the move to higher recycling / composting / digestion rates, and reduced landfilling - is becoming increasingly clear; and

b) Some of the decisions regarding the commitment of large sums of capital have yet to be made.

In this context, the sooner the policy environment in which these treatments must operate is known with a tolerable degree of uncertainty (it cannot be expected that nothing ever changes, after all), then the earlier investors, waste companies, local authorities and other decision makers can come to a view as to what is the best strategy for them going forward.

Whatever changes are made to the landfill tax upon introduction in 2015 the levels going forward must be decisive and clear. Indeed, in anticipation of taking control over the lever of landfill tax, it would seem prudent for the Scottish Government to make clear its intentions well in advance of those intentions being translated into real changes in the tax. This is especially true for changes in the tax which would affect the relative costs and competitiveness of different treatment options, such as the increased tax on landfill, taxes on incineration, the tax on incinerator bottom ash, and the reduced tax for stabilised biowaste. The decision regarding these should be made clear at an early stage, and the commitment to tax rates in future years should extend as far forward in time as is politically, and practically, possible. The ideal solution would be to set the progression of tax rates deemed necessary to achieve the longer term objectives as soon as possible and commit to these once responsibility for the tax is transferred to the Scottish Government.

Contents

1.0 Background and Introduction

Eunomia Research & Consulting is pleased to present this Final Report to the Scottish Government on the potential options for varying the landfill tax. This is an option which is likely to be available to Scotland once the relevant powers have been devolved, expected to be in 2014/15. The stimulus of this study comes from the following recommendation by the Calman Commission: [8]

> *"Stamp Duty Land Tax, Aggregates Levy, Landfill Tax and Air Passenger Duty should be devolved to the Scottish Parliament, again with a corresponding reduction in the block grant."*

The Coalition Government of 2010 committed to implementing these recommendations, including the transfer of legislative responsibility to Scotland to set the level of Landfill Tax along with some other fiscal instruments.[9] The Scottish Government now has the ability to set the level of landfill tax from 2014/15 (the end of the period of application of the current UK landfill tax escalator).[10,11] No decision has been made regarding changes to the levels, or structure, of the landfill tax as yet. The aim of this project is to consider options for varying the landfill tax with respect to the rest of the UK, and to consider the impact this would have on waste policy, and Scotland's goal of achieving a Zero Waste Society.

The definition of a Zero Waste Society is summarised below:[12]

> *"everything we use and throw away is a resource which has a value, a value that we should try to preserve, capture, and use again wherever possible.*
>
> *That is what a zero waste Scotland means - not a country where we never throw anything away, but a new approach to making the most effective use of all resources, and avoiding wasting resources or making them unusable wherever we can."*
>
> Richard Lochhead, MSP - Cabinet Secretary

This piece of research aims to inform decision making regarding the landfill tax. It also aims to be a progressive piece of economic research in the field of waste management. As far as the authors are aware, part of the approach used in this study, to model the impacts of changes in a landfill tax, has not been used before,

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[8] Commission on Scottish Devolution (2009) *Serving Scotland Better: Scotland and the UK in the 21st Century*, Final Report, June 2009, http://www.commissiononscottishdevolution.org.uk/uploads/2009-06-12-csd-final-report-2009fbookmarked.pdf

[9] Scottish Government (2010) *Research Specification: Understanding The Policy Options For Implementing A Scottish Specific Landfill Tax*, Tender Ref: CR/2010/04

[10] Scottish Government.

[11] HM Treasury (2010) *Budget 2010*, http://cdn.hm-treasury.gov.uk/junebudget_complete.pdf

[12] Scottish Government (2010) *Scotland's Zero Waste Plan: Ministerial Forward*, Accessed 16th July 2010, http://www.scotland.gov.uk/Publications/2010/06/08092645/1

neither in the UK, nor anywhere else in the world.

The report has been structured in the following manner:

1) Background and Introduction;
2) Methodology
   This section describes the project aims, and the approach taken to meeting them;
3) Review of Landfill Taxes
   This is a summary of a full review of international landfill tax policies (to be found at Appendices A.1.0 to A.3.0), the rationale for them, their structure, level, the use to which revenue is put and any exemptions, amongst other parameters. This section also includes a summary of the stakeholder interviews that were carried out and a review of different approaches to modelling the impacts of landfill tax policies;
4) Choice of Policy Options for Assessment.
   This section summarises the decision making process taken to derive the final set of policy options. A longer list of options was initially developed following the review of landfill tax policies;
5) Key Contextual Issues
   Sets the scene for the approach to modelling the policy options in the context of an uncertain residual waste treatment market and the potential for waste migration out of Scotland;
6) Description of Scottish Landfill Tax Model
   This describes the main model used to the undertake any quantitative assessments (further details are found in Appendices A.6.0 and A.7.0);
7) Results from Scottish Landfill Tax Model
   The key quantitative results from the Scottish Landfill Tax Model are described in the section;
8) Qualitative Assessment of Other Policy Options
   This section presents, and discusses, the policy options which were not deemed conducive to mainly quantitative approaches; and
9) Summary Findings of the Study
   This section then summarises the key findings of the study to the Scottish Government.

A number of Appendices are then provided with further details and supporting evidence for the research. These are as follows:

- A.1.0 Externalities Associated with Landfill and Incineration
- A.2.0 Environmental Benefits from Landfill Taxation
- A.3.0 Landfill Tax Policy Review
- A.4.0 Stakeholder Interview Summaries
- A.5.0 Selection of Policy Options for Assessment
- A.6.0 Baseline Mass-Flows

- A.7.0 Description of 'Local Authority' Collection Cost Model
- A.8.0 Landfill Tax in Catalonia
- A.9.0 Environmental Impacts from Combustion Processes

2.0 Methodology

The overarching aim of the project that was given in the tender specifications is:

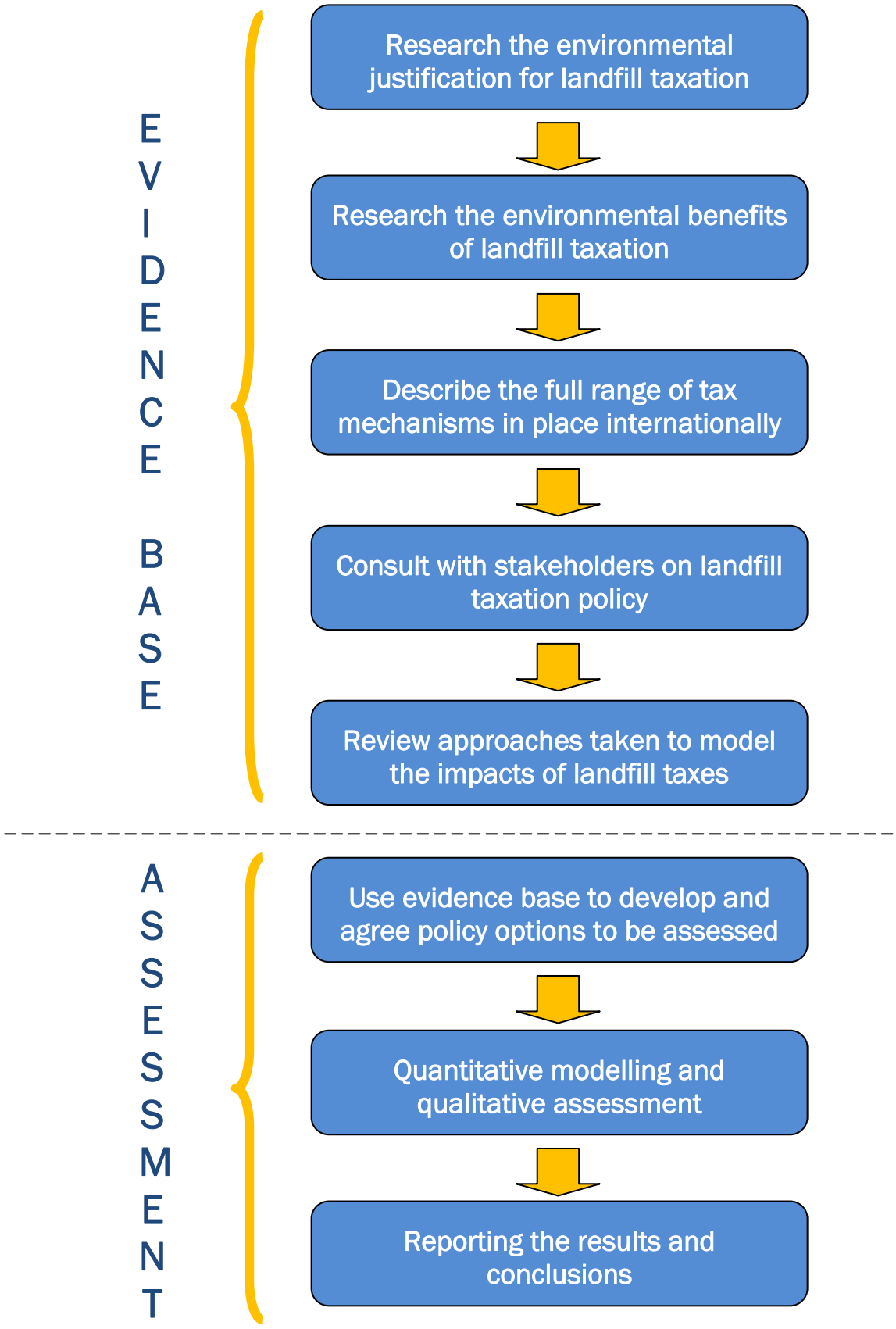
> *"To be able to understand and establish the current impact of the landfill tax on the UK and disaggregated to devolved countries and the impact of designing and implementing a Scottish specific landfill tax".*

In doing this it would enable the Scottish Government to:

> *"advise Ministers on options for varying Landfill Tax with respect to the rest of the UK, and the impact this variation will have on:*
>
> - *The proportion of waste going to landfill;*
> - *Recycling rates;*
> - *Certainty to investors – business and waste industry;*
> - *Cross border movements of waste;*
> - *LA waste management services and contracts including costs".*

The specification also stated that certain tasks were to be undertaken, such as a literature review and the development of a Scotland specific landfill model. These requirements shaped the general approach to the research. A summary of the tasks undertaken to deliver the objectives of the study is given in Figure 2-1. These relate to the structure of the report indicated in Section 1.0.

Figure 2-1: Project Methodology Flow Diagram



3.0 Review of Landfill Tax Policies

The first stage of work was a review of the rationale for, and design of, landfill taxes. This review effectively had four distinct objectives:

1. First, the rationale for having a landfill tax at all was researched. The aim was to understand the rationale for such taxes, and the basis for changes to them. The full depth of the field of work cannot be fully appreciated in a summary suitable for this report. However, it was considered useful to contextualise the environmental basis for such taxes and whether current rates fully internalise environmental externalities from landfilling waste.[13]
2. Second, a detailed understanding of the landfill taxes in place in other countries was sought. This was intended to inform the development of a number of potential policy options that the Scottish Government could have considered modelling in this study. The intention was to understand the most feasible and practical mechanisms. As such, the research was pragmatic and not wholly theoretical. Given the context of the possible inclusion of landfill bans in Scottish Law (in line with the Zero Waste Plan, and as already consulted on[14]), a section weighing up the relationship between landfill taxes and landfill bans is also included.
3. Third, the current UK landfill tax was reviewed through interviewing key stakeholders in the waste management industry;
4. Fourth, a review of approaches to policy formation and *ex ante* assessments of landfill tax policy, through modelling work, was completed.

A summary of the full research (Appendices A.1.0 to A.4.0) is given in the following sub-sections 3.1 to 3.7.

3.1 Justification for Landfill Taxation

The justification for landfill taxes arises from the consideration of the issue of market failures, and in particular, the presence of externalities in various different markets. Externalities may be described as 'untraded interdependencies' between actors within a market.

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[13] Environmental externalities are related to pollution from process that is emitted into a shared resource, for example the sea, rivers or the atmosphere. The balance sheet of the business would not be affected no matter how much pollution was emitted, meaning that the product could be sold at a lower price. Internalising externalities means capturing, in monetary terms, the resulting degradation from pollution within market prices. Thus, the hitherto 'external' pollution becomes part of the business's decision making process and is reflected in prices. In terms of landfill the tax, it seeks to ensure that the price of landfill seen in the market includes the damage costs associated with emitting methane into the atmosphere, amongst other things.

[14] Scottish Government (2011) *Regulations to Deliver Zero Waste: A Consultation on the proposed Zero Waste (Scotland) Regulations 2011*, available at: http://www.scotland.gov.uk/Publications/2011/02/09135833/0

It is generally accepted that the first-best solution to the problem of environmental externalities is a Pigouvian, or optimal, tax (or subsidy). Such a tax (subsidy) would be designed such that the tax (subsidy) is set at the level where the marginal private benefits (or costs) associated with a given activity are equal to the marginal social costs (or benefits) associated with it. In the ideal world, therefore, farmers might be compensated through subsidies for providing environmental goods, for which public benefits are derived, up to the point where the costs of providing additional public benefits exceeded the additional benefits derived. In principle, the same applies to landfill. A landfill tax would be set at the level where the marginal private benefits associated with additional landfilling were equal to the marginal social costs associated with the activity.

The theoretical principles supporting the theory of optimal taxes are not always so easily translated into practice. For a start, the use of a marginalist approach is not always practical. Marginal private cost / benefit curves are not always well known, whilst the shape of marginal damage cost curves is also subject to uncertainties. For example, with respect to landfills, marginal social costs will be affected by the quality of the operation, the nature of the waste landfilled, the spatial location of a landfill site (which will influence the effects of any pollution released), the disamenity associated by local populations (which is almost certainly likely to be very small in the marginalist sense), and the fundamental uncertainties relating to the nature of the links between the source of pollution and its ultimate effect. In theory, it might be possible to consider a tax whose structure allowed for the calculation of externalities based upon a number of such variables. In practice, most landfill taxes opt for a relatively simple design reflecting the fact that the nature of the operation is such that the potential of the waste to do harm at a given landfill is not extremely well known when the load arrives at the site. Its composition cannot be accurately known without significant investment, whilst the management of sites varies considerably at any given time owing to factors related to age, the nature of infrastructure, and the quality of operation (amongst others).

Partly for this reason, those countries which have attempted to consider the appropriate rates for landfill taxes – and they are few and far between – have tended to consider externalities of 'average' waste landfilled at 'average' facilities. Factors such as disamenity tend to be considered as 'averaged out' for waste landfilled at a given site rather than as true marginal effects. The evidence in this respect is considered below.

3.2 Landfill-related Externalities

As discussed in Appendix A.1.0 a number of different studies have attempted to estimate the economic consequences of landfills for society. The review shows that the range of externalities associated with landfill is large, but that their value appears to be increasing over time as research progresses and as more evidence becomes available. In particular, it appears that, for modern landfills (at which it is assumed that problems of leachate are minimised, and where the likelihood of accidents occurring is considered to be low), the majority of landfill-related externalities are associated with the emission of methane, a potent greenhouse gas. Consequently, , the methodology and assumptions used to calculate the emissions from landfills is a significant determinant of the externalities, as is the figure chosen to reflect the

damages associated with methane emissions. The disamenity related to, typically, living close to a landfill, is also considered.

Partly reflecting the fact that the consequences of GHG emissions are now considered much more serious than they used to be (even a decade ago), older studies have tended to arrive at figures in the range £10 to £20 per tonne of waste disposed. However, the other key determinant of the externalities from landfilling (which has become more important as the estimated damages associate with GHG emissions has risen) is the assumption made regarding the proportion of landfill gas generated which is actually captured by the landfill. Where this is used to generate electricity, this is also assumed to offset the emissions associated with fossil-fuel derived (usually, now, from CCGT) generation. Many UK studies have used quite high figures for this, sometimes of the order 75%. The evidence in favour of using these as lifetime captures for landfill gas is currently weak.

A recent study used a detailed life-cycle analysis model to help determine the damage costs associated with landfilling residual municipal waste.[15] The result – based upon a lifetime capture rate for landfill gas of 50% - was between £61 and £76 per tonne (low and high respectively), higher than previous estimates which have been based on low damage costs for the emission of methane, and high capture rates for the landfill gas which is generated. Similar modelling indicates that where waste is stabilised prior to being landfilled, the externalities fall to £15.28 per tonne. This line of argument was used elsewhere to argue in favour for reduced landfill taxes to be applied to such materials.[16] Evidently, the landfilling of completely inert materials is likely to be related more to the disamenity and land-use related effects of landfilling rather than the emissions of methane.

The evidence highlighted in this summary (and the Appendix) of landfill modelling is brief compared to the possible depth of analysis. However, it should be clear that although the range of environmental costs associated with landfill is high, the higher costs do reflect more accurately the most up-to-date level of understanding. With this in mind one can suggest that the current landfill tax escalator (at £80 in 2014) is likely to be above the environmental damages caused by landfilling. Or put in another way, the environmental externalities of landfilling are potentially fully internalised by the current tax, so the minimum level of landfill tax, based upon environmental grounds, will be met. This indicates that the rationale for the tax has evolved from a primarily environmental tax to a policy mechanism used to incentivise behaviour change. The rationale for landfill taxes is further discussed in Section 3.4.2.1.

3.3 Environmental Benefits from Landfill Taxation

The research undertaken in this study on environmental benefits from landfill taxation

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[15] Eunomia (2009) International Review of Waste Management Policy, Final Report for the Department of Environment Heritage and Local Government

[16] Eunomia (2008) *'Biostabilisation' of Waste: Making the Case for a Differential Rate of Landfill Tax*, January 2008, http://www.eunomia.co.uk/shopimages/Eunomia%20Landfill%20Tax%20Paper%20Final.pdf

is summarised in this section. Full details can be found in Appendix A.2.0.

Most countries use a range of complementary instruments to influence the relative desirability of competing options. Consequently, whilst taxes make specific options less desirable, other policies also influence how materials subject to a tax are dealt with. Another feature of taxes is that they generate revenue. Many of the countries which deploy taxes do so with the intention of using some or all of the revenue for specific purposes related to waste management (or other environmental purposes).

The environmental impact of taxes, therefore, depends upon both:

a) the extent to which the structure of taxes makes the activities targeted by the tax less desirable;

b) the way in which other policies affect the desirability of alternative management routes (i.e. those not subject to taxes); and

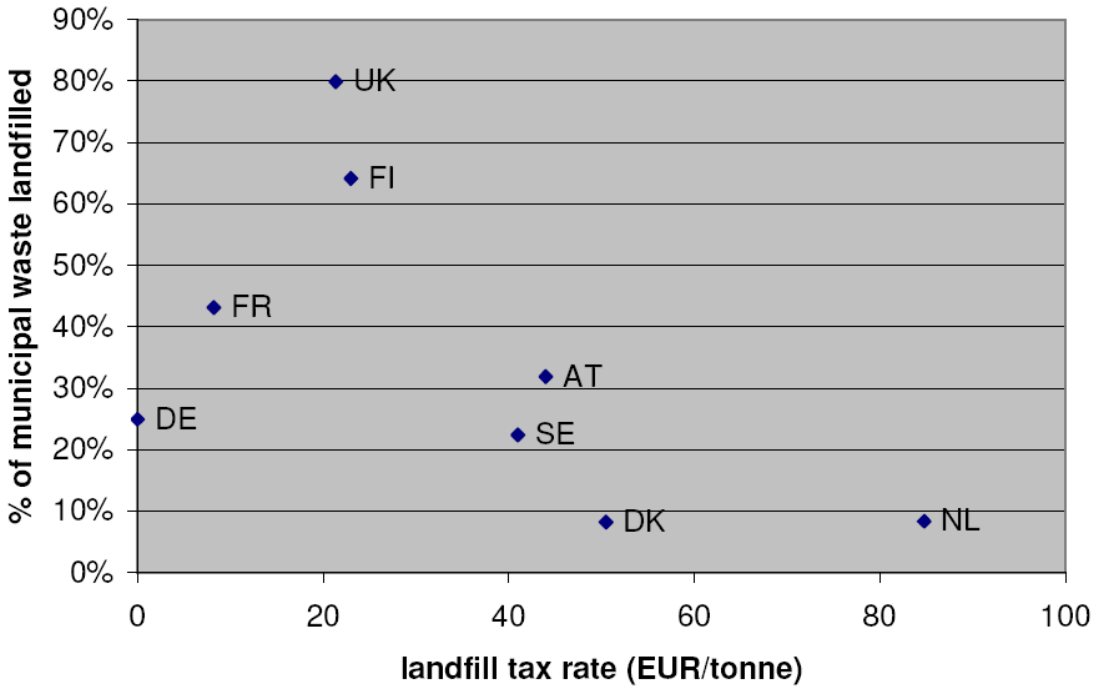
c) the effects of the use of tax revenue in terms of environmental improvement.

The basic premise is that as landfill prices rise, less waste will be disposed to landfill and more will be minimised, re-used and sent to alternative treatments.

There are generally benefits associated with reducing the quantity of waste disposed of in landfills, though these vary with the nature of the material, and with the change in the management method. For example, when plastics are switched from landfill to incineration, the net impact in terms of climate change is, under most reasonable assumptions, strongly negative.

To determine what environmental benefits are associated with a landfill tax, one study sought to understand whether there is a relationship between the level of the tax and the proportion of waste landfilled in that country. Figure 3-1 shows that, at a glance, there is a weak relationship between landfill tax levels and municipal waste landfilled.

Figure 3-1: Correlation between Landfill Tax and Waste Landfilled



Source: Bartelings, H., P. van Beukering, O. Kuik, V. Linderhof, F. Oosterhuis, L. Brander and A. Wagtendonk (2005) Effectiveness of Landfill Taxation, R-05/05, Report Commissioned by Ministerie von VROM, November 24, 2005.

However, the combination of waste policies in each of the countries, and specific intentions of the landfill tax, are different, making such a univariate analysis almost useless. For example, one of the clear outliers is Germany (DE), with a low level of municipal waste landfilled but no landfill tax. In Germany the Ordinance on Landfilling of waste significantly restricts landfilling (it bans landfilling of waste which has not been pre-treated, and whose calorific value exceeds a specified threshold), and has had a significant effect in reducing the quantity of waste landfilled. Equally, to take the view that the tax is responsible for the low levels of landfilling in Netherlands and Denmark would be to miss the influence of the landfill bans in those countries. Notwithstanding the lack of a clear trend in the data, the overall evidence considered in the review does suggest that, alongside a mix of policy instruments, landfill taxes can help reduce the quantity of waste landfilled.

In terms of waste prevention, the international evidence on waste minimisation impacts resulting from landfill taxation is inconclusive, but some evidence does exist at the UK level to link the two. This includes a business survey by Cambridge Econometrics and ECOTEC shortly after the introduction of the tax in 1996 and communication with industrial food waste manufactures (during previous studies) noting that the tax does have a direct bearing on business decisions regarding production processes and waste minimisation,.[17] Finally, and perhaps most

[17] ECOTEC (1998) *UK Landfill Tax Study, PART 2: Effectiveness of the Landfill Tax in the UK: Barriers to*

importantly given the aspirational aims of the Scottish Zero Waste Plan, recycling is considered.

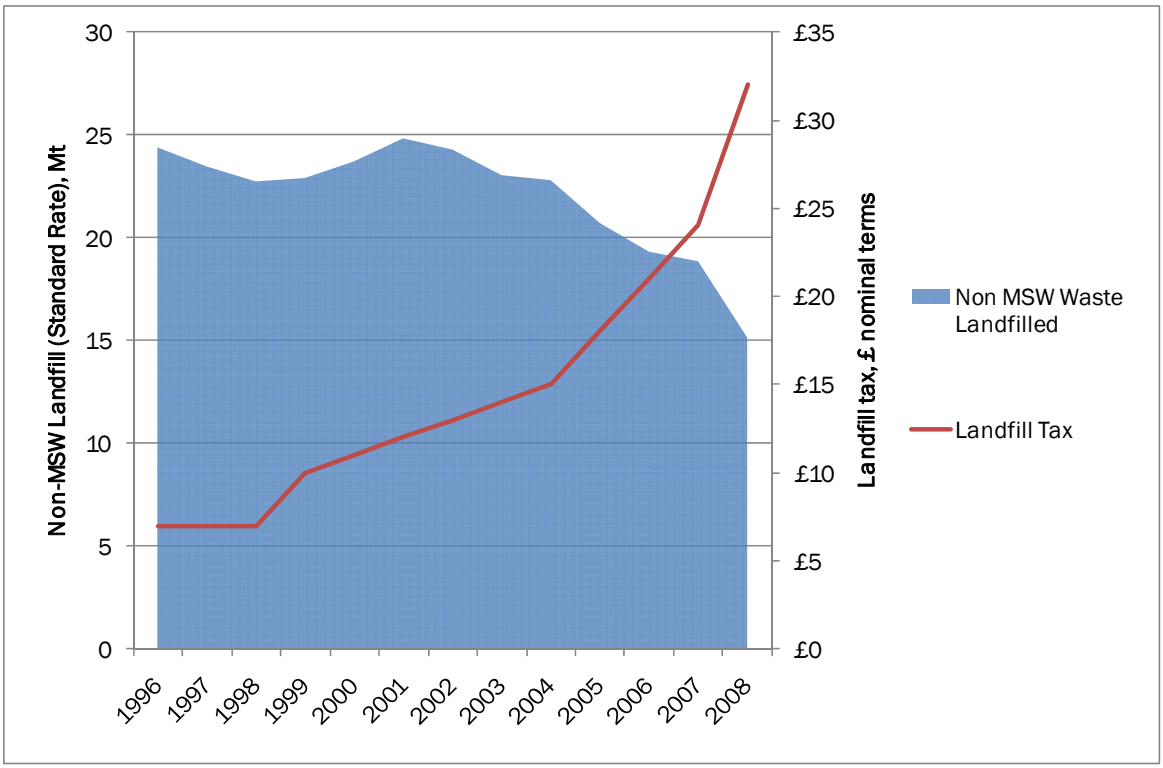
Some of the environmental benefits associated with recycling relate, as with waste prevention, to avoidance of landfilling, but there will also be additional savings from avoiding virgin material use, and the associated embodied energy achieved through material recovery. Recycling rates in most of the countries considered in this report have been increasing (though in some, such as Denmark, this is barely discernable any more). As with waste prevention, however, there is relatively little documented evidence to demonstrate that the introduction of a tax or a ban *on its own* correlates strongly to any increase in recycling.

In the UK, however, one can make some inferences based upon knowledge of a reduction in landfilling and the increase in other management routes. Figure 3-2 below shows that non-municipal waste landfilled at the standard rate has been decreasing in the period when the tax was on the rise. In fact one can see a significant change after 2001 when the landfill tax escalator was announced. The chart suggests that the rate of reduction in landfill appears to be mirroring the rate of increase of the tax.

For the business sectors the landfill tax is the key policy driver. Businesses are primarily concerned with costs, and if the cost of disposal increases alternative options are sought out. Therefore, the influence of other drivers is likely to be limited. Between 2000 and 2008 the quantity of non-MSW landfilled has decreased by 10 million tonnes. Some of this reduction could be attributed to the waste prevention, some to recycling and some to other treatments. As discussed above the waste prevention effect is difficult to quantify. Therefore, it could be said, the main shift in waste management was from landfill to recycling or other treatments.

Increased Effectiveness and Options for the Future, A report submitted to the European Foundation for the Improvement of Living and Working Conditions

Figure 3-2: Non-MSW Waste Landfilled at Standard Rate in the UK, Mt



Source: Eunomia

The increase in other treatment capacity could be attributed to source segregated industrial wastes or mixed C&I waste. The former is not easily unpicked from national EA data. The latter has been estimated by Eunomia as currently around 250 ktpa; a small fraction of the 10 million tonnes. Even with the limited data on treatment it is certain that some level of additional recycling in the C&I sectors has occurred. C&I waste surveys also suggest this trend.[18] Given that the key policy driving waste management behaviour in the C&I sectors is the landfill tax one can suggest that the landfill tax does have a direct relationship with increased recycling.

Generally, the absence of strong evidence should not be taken as evidence of the absence of an effect. Most countries which deploy landfill taxes and bans, however, also deploy an armoury of other policy instruments. Taxes and bans tend to support these policies, and assist in moving waste up the hierarchy, but the degree to which they, and not other policies, are responsible is difficult to discern for wastes in the municipal sector. However, the link appears more pronounced when considering non-municipal wastes.

In the next section of the report the actual tax mechanisms that are seeking to obtain the environmental benefits discussed above are considered. This is achieved, primarily, though researching the policies found in the European Union, where the

[18] Environment Agency C&I Surveys 1998 and 2002/03, Urban Mines Surveys in the North West and Wales.

mechanisms are more mature compared with those found on other continents.

3.4 International Landfill Tax Mechanisms

The principle aims of this review were to understand what the main types of landfill taxes are, how they differ from the current UK tax and, based upon international experience, what are the potential ways that the Scottish Government could make improvements when the Scottish only landfill tax is implemented in 2014/15.

To set the scene the UK landfill tax is briefly described. This is followed by an investigation into the types of landfill tax seen in European countries. This includes analysis of the key features of landfill taxes:

- Rationale for the Tax
- Year the Tax was Introduced
- Tax Structure and Rates
- Administration of the Tax
- Use of Revenue
- Exemptions from the Tax
- Perverse Effects of the Tax
- Performance of Tax Mechanisms

The key lessons learned from European landfill taxation are then summarised.

3.4.1 UK Landfill Tax

The UK Landfill Tax was introduced in October 1996. It is a tax on all landfilled waste, with some exemptions. It is applied at two rates: a standard rate, applied to a range of materials, including household waste; and a lower rate, applying to specific 'qualifying materials', typically, those deemed to be 'inert', including materials such as rubble.

The tax affects all sectors of the economy. As the levels of landfilling at the introduction of the tax were very high, the tax could be considered a 'general disposal tax', as most residual waste was (and still is) disposed of to landfill.

The aims of the tax as set out in the UK Waste Strategy were:

> *'to ensure that landfill costs reflect environmental impact thereby encouraging business and consumers, in a cost effective and non regulatory manner, to produce less waste; to recover value from more of the waste that is produced; and to dispose of less waste in landfill sites (DoE and WO 1995, 12).'*

From this, it seems clear that the primary aim was, in the early stages, to internalise environmental impacts within landfill prices.

Ecotec's report on taxes and charges in the EU indicates that the tax level and the

proposals for the tax were widely consulted on before being introduced.[19] The initial rates at which the tax was set were:

- Inert Wastes (lower rate tax) £2 per tonne
- Active Wastes (standard rate tax) £7 per tonne.

Mixed wastes are taxed as active wastes even if much of the material is 'inert' if certain minimal levels of mixing are exceeded.

A Eunomia report from 2007 describes how the tax has evolved:[20]

- 1993 – The introduction of the Landfill Tax was preceded by an assessment of the external costs associated with landfill and incineration and by work assessing waste management options in the UK after the introduction of such a tax.[21] A proposal for a tax based on a percentage of disposal costs (an ad valorem tax) emerged, with the order of magnitude of the tax heavily influenced by the external costs study;
- November 1994 – Government makes clear its intention to introduce the Landfill Tax;
- March 1995 - a consultation process was undertaken to elicit the views of industry, environmentalists, and local authorities. Its major outcome, as announced in the November 1995 Budget, was a change in the tax design, from a percentage of disposal cost (ad valorem) system, to a weight-based tax. Furthermore, it was intended that there should be no exemptions from the tax; and
- November 1995 – Budget announces the tax will be introduced in October 1996.

At the outset typical disposal fees pre-tax for municipal wastes, or non-inert industrial wastes, were between £7-£25 per tonne so that the tax implied an increase in price of between 30-100% in the overall cost of landfilling. The level of taxation for non-inert wastes (i.e. those that degrade to produce GHGs) was increased by means of an annual price escalator that was first introduced in 1998. Since then the magnitude of the escalator has increased (initially £1 per tonne escalator over five years, then £3 per tonne over three years, to current £8 per tonne per year over 3 years, and due to continue at this rate for a further 4 years). As of April 2010, the tax rate is £48 per tonne. The tax rate for inert wastes has remained relatively steady with only a 50p increase to £2.50 per tonne in 2007.

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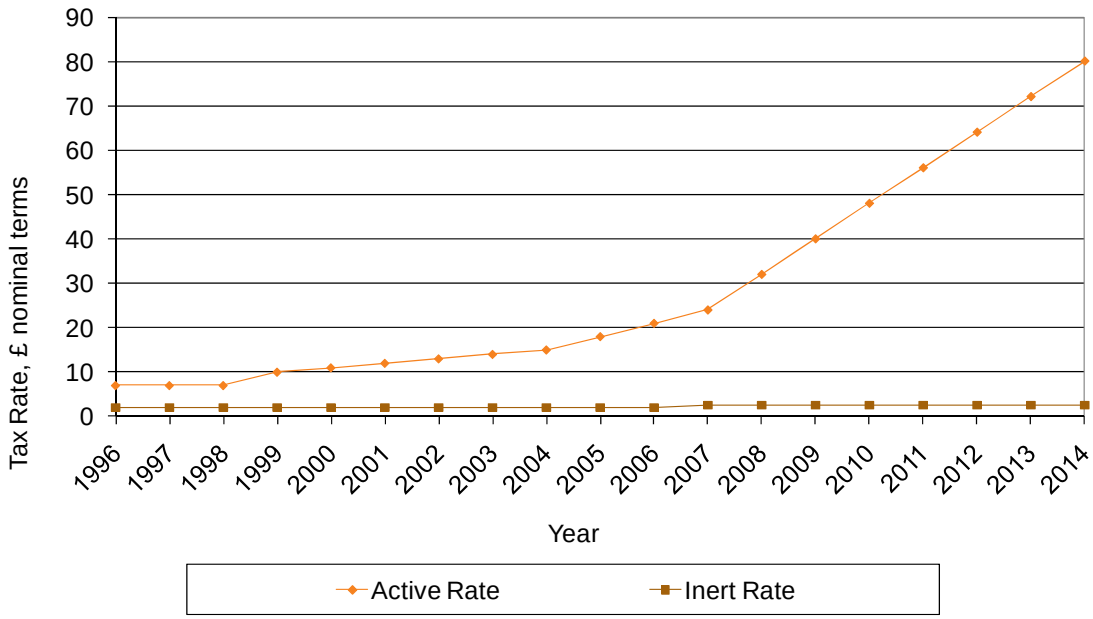
[19] ECOTEC (2001), *Study on the Economic and Environmental Implications of the use of Env. Taxes & Charges in the EU*

[20] Eunomia et al (2007) *Household Waste Prevention Policy Side Research Programme*, Final Report for Defra

[21] CSERGE, Warren Spring Laboratory and EFTEL (1993), *Externalities for Landfill and Incineration: A Study by CSERGE, Warren Spring Laboratory and EFTEL*. Coopers & Lybrand (1993), *Landfill Costs and Prices: Correcting Possible Market Distortions*.

Implemented through central government via the Chancellor of the Exchequer (HM Treasury) and the annual budget, Figure 3-3 shows the change in tax levels for active and inert wastes from the implementation of the policy in 1996 to 2014 when the current escalator expires at £80 per tonne.

Figure 3-3: UK's Landfill Tax



The revenues generated from the tax were initially used to allow for a decrease in the employers' higher rate national insurance, along with a scheme to fund waste management research and improvement projects around landfills. Those wishing to utilize the funds had to register as environmental bodies under an organization named ENTRUST. This organisation has adopted the approach of a pro-active regulator with a 'risk based' approach to both the operations of the 2700+ EBs it regulates and the projects delivered. [22]

Funds are directed to the Landfill Communities Fund, WRAP, LASU, WIP and various other Defra schemes. The Landfill Communities Fund enables operators of landfill sites to contribute money to enrolled Environmental Bodies (EBs) to carry out projects that meet environmental objects contained in the Landfill Tax Regulations.[23] Over 22,000 projects have been submitted to ENTRUST for review and registration since the inception of the Scheme in 1996.

The Government saw the LCF as a way for Landfill Operators (LOs) and EBs to work in partnership to create significant environmental benefits and jobs and to undertake projects which improve the lives of communities living near landfill sites.

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[22] ENTRUST (2010) ENTRUST, Accessed 15th November 2010, http://www.entrust.org.uk/home/about

[23] ENTRUST (2010) LCF, Accessed 15th November 2010, http://www.entrust.org.uk/home/lcf

3.4.2 Landfill Taxes in EU Member States

The review in this section of the report focuses on key EU Member States, and utilizes a report to Enviros, written by Eunomia as part of the UK landfill tax review in 2001, and a review of international waste policy for the Irish Government.[24,25]

The following countries are covered:

- Austria
- Denmark
- Finland
- Belgium (Flanders)
- France
- Ireland
- Italy
- Netherlands
- Sweden
- Norway
- Switzerland

3.4.2.1 Rationale for the Tax

In Austria the tax was intended to support the identification and remediation of contaminated sites. In 1989 the Clean-Up of Contaminated Sites Act was introduced as a result of a number of contaminated soil incidents such as the *'Fischer Deponie'* (European Topic Centre on Soil 1997).[26] The Act foresaw increased work in surveying and identification of potential problem sites and thereafter funding for operations to contain and treat them. In Switzerland the Government also implemented a landfill tax in order to meet the costs of cleaning up contaminated land.

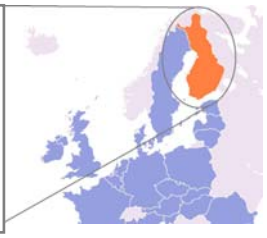
[24] Eunomia (2001) *Review of Landfill Tax*, Report to Enviros

[25] Eunomia (2009) International Review of Waste Management Policy, Final Report for the Department of Environment Heritage and Local Government

[26] Hazardous chemicals had been dumped on this municipal waste site threatening the water resources of 50,000 local inhabitants. The clean-up of this site is still not complete and the total cost of the operation is expected to reach 1,500 – 2,000 M ATS (109 –145 M□).

In Denmark, the motivation for the landfill tax was the scarcity of available landfill void space. The other key driver in Denmark was the desire to ensure the country's energy from waste capacity was fully utilised. Initially reported as a tool to stimulate recycling, there is now a stagnant recycling market due to the waste required to meet plant capacity.

Finland imposes a tax on municipal waste landfill sites. The rationale behind Finland's municipal waste landfill tax was to stimulate waste minimisation and material re-use. The hazardous waste landfill tax is targeted at the waste processing industry and was introduced to meet waste targets and to raise revenue.



The Flemish tax is intended to discourage landfilling whilst stimulating waste prevention and recycling, as well as financing regional environmental policy. The tax was reinforced by the Flemish waste management plan for 1991-1995 which prohibited the landfilling of domestic wastes from 1995 unless they were pre-treated. Building and demolition wastes are also prohibited from landfill if they meet the technical criteria for application in road building. The waste management policy implemented in Flanders follows the EU waste management hierarchy. Wallonia introduced a waste tax in regions in which household waste arisings exceeded specified levels, thus providing an incentive to local authorities to promote waste recovery and recycling.

In France the tax is part of a national strategy which aims at restricting disposal to landfill to final waste that cannot be recovered by any other treatment by 2002. This objective has still not been fully realised, however. The tax was implemented with the intention of streamlining French waste management through increasing waste recovery, and providing for full cost recovery of waste management.

In Italy a tax was seen as a means of encouraging source separation of wastes, hence reducing demands on landfill void space. Higher landfill taxes were believed to act as a stimulus to local authorities to activate source separation systems. The tax is set at a regional level.

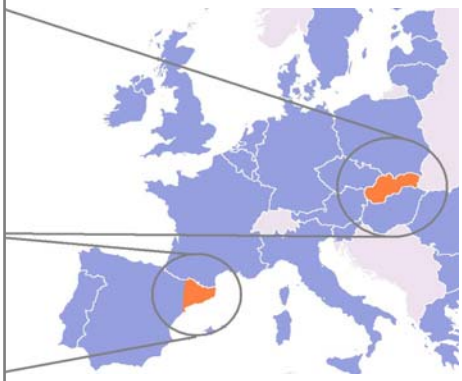
In the Netherlands the idea for a waste disposal tax began in 1992 when an environmental tax on fuel was being developed. The Dutch Parliament asked The Dutch Cabinet to develop other environmental taxes to raise additional revenues, instead of raising fuel tax to unacceptably high levels. By applying the Polluter Pay's Principle to these new environmental taxes it was believed that the tax burden would be more equitably distributed amongst tax payers. The two aims of the waste tax, therefore, are to raise revenue and generate positive environmental effects. Recent increases in waste tax rates have been attributed to a desire to accelerate the "greening of the fiscal system". However, the Dutch were also trying to support their network of incinerators, so changed the structure of the tax to incentivise the shift to EfW plants.

The purpose of Sweden's landfill tax is to increase the costs for landfilling and thus make waste minimisation, reuse, recycling or energy recovery (in district heating plants) more economically feasible. A further aim of the tax is to reduce the number of landfill sites, concentrating disposal at a smaller number of highly engineered sites in the future.

The waste tax in Norway was introduced to reduce the volumes of waste being sent for final disposal and to encourage progression up the waste hierarchy. A further stated aim was to raise the costs of waste disposal, thereby going some way towards internalising the environmental costs of the final treatment of waste. The Norwegian Government also believes that waste taxation is an important tool in helping make the transition from taxation on income and employment (so called red taxes) to taxation on pollution and the use of resources (green taxes).

Another European country to vary tax rates depending on upstream recycling is Slovakia. The tax was implemented in 1992 but the structure changed in 2004 because of the low level of collection systems in place when they joined the EU.

A very different mechanism has been implemented in the Catalonia region of Spain. This is one of few landfill taxes in the country and is structured to incentivise the uptake of collection services for



recycling, and fund the separate collection of biowaste.

The Irish levy was designed to encourage the diversion of waste away from landfill and generate revenues that can be applied in support of waste minimisation and recycling initiatives. Recent changes to the levy were implemented to further drive waste away from landfill, and also to internalise the externalities of landfilling.

The rationales described above are summarised in Table 3-1. The prime focus of most landfill taxes is to stimulate waste minimisation and reuse/recycling. This is realised by increasing the cost of landfilling, and thus making alternative management methods more cost competitive, and waste prevention more financially rewarding. The distribution of taxation - moving towards a polluter pays world - is also a key factor affecting the structure of taxes in some countries.

Table 3-1 Reasons for Implementing Landfill Taxes

Country	Stimulating waste reduction, reuse & recycling	Revenue Raising	Internalising Externalities
Austria		✔	✔
Catalonia (Spain)	✔	✔	
Denmark	✔		
Finland	✔		
Flanders (Belgium)	✔	✔	
France	✔		
Ireland	✔	✔	✔
Italy	✔		
Netherlands	✔	✔	
Norway	✔		✔
Slovakia	✔		
Sweden	✔		
Switzerland		✔	✔

UK	✔ (Now)		✔ (Start)*
Wallonia (Belgium)	✔		

** Note: as far as we are aware the UK is the only country to use economic valuations in this process.*

3.4.2.2 Year the Tax was Introduced

Table 3-2: History of Landfill Taxes Start Dates

Country	Date Introduced	Country	Date Introduced
Austria	1989	Italy	1996
Catalonia (Spain)	2004	Netherlands	1995
Denmark	1987	Norway	1999
Finland	1996	Slovakia	1992
Flanders	1987	Sweden	2000
France	1993	Switzerland	2000
Ireland	2002	UK	1996

Note: In Austria, the tax was originally introduced in 1989 but it was not until 1996 that the structure was differentiated and increased. Also in Slovakia, the tax was originally introduced in 1992 but it was not until 2004 that the structure was differentiated.

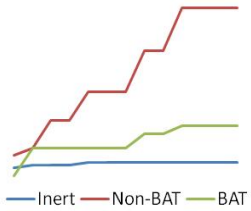
3.4.2.3 Tax Structure and Rates

In this section a comparison of the structure and rates of landfill taxes across Europe is given. There is, foremost, a table giving summary information and a full list of references. Further analysis of the key trends and variations is given in Appendix A.3.0.

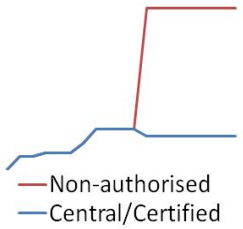
For each country, the Table first shows what categories of waste are covered by the tax. Exemptions from payment of the tax are discussed in Section 3.4.2.6 below. The tax rate at key dates is then shown. A summary chart to show the evolution of the tax follows. The time frame for the chart is from the start date of the tax (given above) and either 2010 or the final year of any known increases (this range is indicated beneath each chart). The next field gives information relating to whether the tax is dependant in some way upon the performance of some system, be it the landfill or implementation of upstream collection services. As Scotland, in many respects, is a region of the UK, any taxes that operate at the regional level are quite relevant to this study. Therefore any known regional variations in the landfill tax across Europe are highlighted. Finally, any key supporting instruments are indicated.

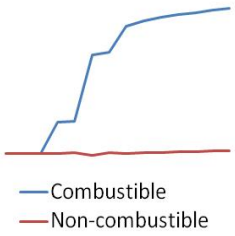
In all cases the tax is measured according the weight of waste landfilled. Also note, as exchange rates vary, tax levels given in £ Sterling will only be approximate for countries outside of the UK.

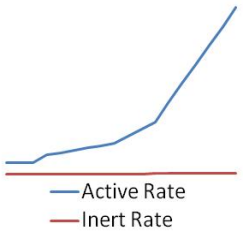
Table 3-3: Landfill Taxes across European Countries and Regions

Country	Waste Types	Tax Rates, £	Rate of Evolution	Performance Related	Regional Variation	Supporting Policies
Austria	Demolition waste Excavated soil Waste with certain concentrations of dangerous elements Domestic waste or similar	Inert 7.3 € Domestic Massive variation dependent on waste type & landfill quality, latest levels are £23 to £76	 1989 - 2010	Differentiated rates for landfills with Best Available Technology (BAT). Further surcharges for landfills with no basement seal or vertical enclosure or no landfill gas capture and treatment system.	None.	Landfill Ban on wastes covered by the Landfill Directive, and on wastes with a carbon content of 5% or above (this is to ensure the stabilisation of waste before landfilling).
Catalonia (Spain)	Municipal Waste Construction waste	£8.50 for municipalities with separate food waste collection and £17 for those that don't.	The tax rates have not increased but the refunds have.	The tax is differentiated depending on whether the municipality has separate food waste collections in place. Some of the revenue is refunded to stimulate the development of a range of recycling services.	Yes, the autonomous regions of Spain have their own waste management remit. Madrid also has a low level tax on the landfilling of certain wastes.	Objectives to meet recycling rates. No other policies directly related to landfill. Incineration tax.

Country	Waste Types	Tax Rates, £	Rate of Evolution	Performance Related	Regional Variation	Supporting Policies
Denmark	All waste entering landfill site (exemptions apply, mainly hazardous waste and contaminated soil) Sewage Sludge Other Sludges	1987 – £4.70 1992 – £23 1998 – £44 2010 – £44 Higher levels for sludges. From 1998 – £25 for slag and fly ash.	All Waste  1987 - 2010	N/A	None.	Waste Tax also covers incineration Landfill ban on combustible waste Natural Resource Tax (equivalent to aggregates tax)
Finland	Wastes at public landfill sites Wastes at private / industrial sites which also accept wastes from multiple sources Hazardous waste	1996 – £13 2001 – £22 2005 – £26 Hazardous waste – £234	Municipal Waste  1996 - 2010	Waste taxes are not payable on wastes that are recovered or suitably treated through composting or incineration, for instance.	None.	Landfill ban introduced in 2006. Covers landfill directive wastes, waste that is not pretreated (except inert waste) and household waste, or similar, where the bio fraction has not been separately collected.
Flanders (Belgium)	Household Industrial Inert	£12 to £54 Landfill rates dependent on waste type & landfill quality (Note that a 50 € export tax is imposed to prevent waste tourism to Wallonia)	Increased over time.	One of the most complex systems in the EU. The levies vary based on the possibility to apply more environmentally friendly alternatives for the treatment of the waste, or to promote recycling.	Flanders is an autonomous region of Belgium. To inhibit waste tourism an export tax on waste to Wallonia was introduced.	Challenging minimisation and recovery rates. Landfill bans. Incineration tax.

Country	Waste Types	Tax Rates, £	Rate of Evolution	Performance Related	Regional Variation	Supporting Policies
France	Household Waste Municipal Solid Waste Mixed Industrial Waste	1993 – £2.67 1995 – £3.34 1998 – £5.27 1999 – £8.02 2003 – £32 for non-authorised landfills / £6.57 for sites with EMAS or ISO 14000 certification.	 1993 - 2010	N/A	None.	Ban on untreated waste from 2002.
Italy	Inert waste (industrial) Other waste (urban and assimilated) Special waste	£8.75 - £22 for MSW (Northern and Central) £17.50 - £44 for MSW (South, where a critical waste situation exists) £0.9 - £9.03 (Inert) £4.50 - £9.03 (Special)	N/A – regionally defined	Some regions have established – through regional acts – an increase in the tax if targets for separate collection are not achieved.	Yes. Regional administrations in Italy can set the tax level within upper and lower bounds set by national Government.	Landfill diversion and recycling targets.
Ireland	All waste at authorised and unauthorised treatment facilities.	2002 – £13 2010 – £26 2011 – £44 2012 – £66	 2002 - 2012	N/A	None.	Incineration tax.

Country	Waste Types	Tax Rates, £	Rate of Evolution	Performance Related	Regional Variation	Supporting Policies
The Netherlands	Waste <1,100kg/m3 and certain waste streams (e.g. dangerous waste & shredded waste) Waste >1,100 kg/m3 (inert & non-combustible waste)	Combustible waste (low density) 1995 – £12 2000 – £56 2008 – £77 Non-Combustible waste (high density) 2008 – £13	 1995 -2010	N/A	None.	Ban on landfilling of recyclable and combustible waste (regulated by density measurements only).
Norway	All wastes delivered to landfill. Higher rate for wastes with dispensation from the ban on biodegradable wastes.	1999 – £35 2010 –£28 / £47	Constant until 2010 when rates diverged.	Tax rebates for landfill operators who recover and sell energy generated from the methane gas captured	None.	Incineration tax Ban on biodegradable wastes
Slovakia	Hazardous waste Inert waste MSW Other waste Green waste	Rates in 2004: Haz. – £23 Inert – £0.23 MSW – £3.46 to £6.92 Other – £4.61 Green – £9.23	Not known.	The level of taxation for MSW decreases as components are removed for recycling.	None.	None relevant.

Country	Waste Types	Tax Rates, £	Rate of Evolution	Performance Related	Regional Variation	Supporting Policies
Sweden	All hazardous waste All other waste once a threshold of 50 tonnes per annum is exceeded Tax element refunded if waste is removed within 3 years	2000 – 250 SEK / £24 2001 – 288 SEK / £27 2008 – 370 SEK / £35 2008 – 435 SEK / £41	 2000 - 2010	N/A	None.	Landfill bans on sorted combustible wastes and all organic wastes.
Switzerland	Residual waste Combustion residues Export to disused salt mines	£8.50 – £28	Unknown.	N/A	None.	Ban on landfilling of combustible wastes.
UK	Active waste Inert waste	1996 – £7 2007 – £24 2010 – £48 2014 – £80 Inert: £2.50	 1996 - 2014	N/A	None.	Landfill Allowances Scheme.

Sources:

Umweltbundesamt (2000), Management of contaminated sites in Western Europe, Report for the European Environment Agency. http://reports.eea.europa.eu/Topic_report_No_131999/en/topic_13_1999.pdf

Bartelings, H., P. van Beukering, O. Kuik, V. Linderhof, F. Oosterhuis, L. Brander and A. Wagtendonk (2005) Effectiveness of Landfill Taxation, R-05/05,

Report Commissioned by Ministerie von VROM, November 24, 2005

Agencia de Residus de Catalunya website (2008) Waste disposal tax, Accessed on 23rd October 2008, http://www.arc.cat/en/municipals/canon/index.html

Swedish Tax Agency (2006) Landfill Tax: Tax rates, Accessed 8th November 2010, http://www.skatteverket.se/foretagorganisationer/skatter/punktskatter/allapunktskatter/avfallsskatt.4.18e1b10334ebe8bc80002886.html?posid=1&sv.search.query.allwords=avfall

EIONET: European Topic Centre on Resource and Waste Management (2007) Waste Factsheets, Accessed 16th October 2008, http://waste.eionet.europa.eu/facts/factsheets_waste

Finnish Ministry of Environment website (2008) Waste taxes and charges, Accessed 10th October 2008 http://www.environment.fi/default.asp?contentid=180501&lan=en

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European Commission (2008) "Taxes in Europe" database, Accessed 12th October 2008, http://ec.europa.eu/taxation_customs/taxinv/welcome.do;jsessionid=LZJpKGQB7ZRrngVLZhhS5cx7wCkJBrCFL21f5r9t65bYTG6JhKQ5!-966966153

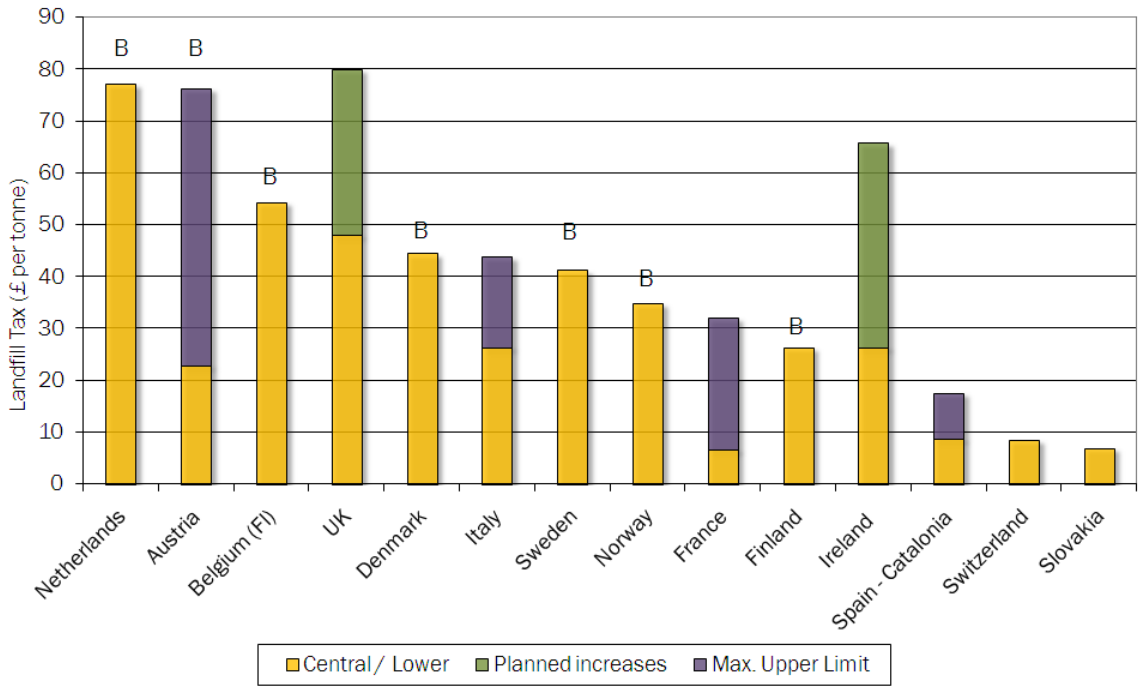
Eunomia et al (2007) Household Waste Prevention Policy Side Research Programme, Final Report for Defra

OECD (2004) Environmental Performance Reviews: Sweden. Paris: OECD

Avfall Sverige (2008) Swedish Waste Management, http://www.avfallsverige.se/se/netset/files3/web/P01.m4n?download=true&id=2371_94867351

The table above provides a useful insight into the range of structure and rates other European countries have. For comparison the active rates of tax for each country are summarised below in Figure 3-4.

Figure 3-4: Landfill Tax Levels across Europe (Non-Inert Wastes)



B – indicates where a country has a ban in place with the intention of diverting the residual waste stream from landfill.

Note, the higher rate in Austria is no longer relevant as untreated wastes are banned from landfill.

Source: Eunomia

Regional Variation in Structure or Rates

The Catalonia region of Spain is one example of where the landfill tax varies regionally. The Catalan authorities were contacted to request any information relating to issues with regional implementation. No response has been received, however, some information from regional consultants has been obtained..

> *"As regards MSW, according to the Catalan waste agency, there is no waste travelling at all. Municipal waste is very much under control.*
>
> *This might happen for industrial waste (especially hazardous waste), but Catalonia is not taxing this waste stream."*[27]

The regional Authorities in Italy have powers to set the level of the landfill tax. Limits are set by central Government, but, within these, the Authorities have used the

[27] Personal Communication with Ignasi Puig (ENT Environmental - Spain)

powers to increase tax levels if regional recycling targets are not met. Our understanding is that regions can impose export taxes if waste moves from one region to another. However, the mechanism for this is unclear. The Italian Environmental Agency was contacted, but no response was received. We also used our own contacts but again, the mechanism was not made clear.

The Flanders and Wallonia regions of Belgium both have differing landfill taxes. It is already known that an export tax was introduced to inhibit waste-tourism. Again the authorities have been contacted but no response has been received thus far.

Supporting Policies

Some countries resort to bans on the landfilling of specific waste streams. In the Netherlands and Denmark, landfilling of municipal waste is banned other than in exceptional circumstances and most organic household waste is separately collected for composting, whilst Austria and Germany have set a maximum fermentability threshold for landfilled wastes. The interaction between landfill bans and landfill taxes is further described in Section 3.5.1 below.

Given the aims of the Zero Waste Plan include a desire to restrict certain materials from entering energy from waste (EfW) plants, on environmental grounds, it seems important to highlight that several countries also have taxes on incineration. This is set either as a dedicated tax on EfW or, including the landfill tax, as part of a more general waste-tax. If relevant powers were available to the SG, a tax on EfW could also be promote the shift to recycling and act as an additional means to generate revenue (as is the case in Denmark, and to a lesser extent, the Netherlands).

3.4.2.4 Administration of the Tax

A limited variety of mechanisms are used to collect and administer the tax. In the UK and Finland, the Customs and Excise Authorities administer the tax. In France the tax was originally collected by ADEME (French Agency for Energy and Environment), although changes to the tax regime now mean the responsibility has moved to the Excise and Duty Directorate General, within the Ministry of Finance. In Sweden and Norway, waste taxes are paid to the National Tax Authorities.

There is limited evidence available of the relative efficiencies of different administrative systems. Moreover, the administration of tax receipts would most likely stay with HMRC so it was not deemed necessary to undertake a length analysis on this matter.

3.4.2.5 Use of Revenue

The majority of waste taxes are directed straight into the general budget. Table 3-4 below summarises how the revenue is used in the countries considered in this review.

Table 3-4: Use of Landfill Tax Revenues

Country	General Budget	Fund Waste Management Schemes etc.	Clean up contaminated sites	Other
Austria			✔	

Country	General Budget	Fund Waste Management Schemes etc.	Clean up contaminated sites	Other
Catalonia (Spain)		✔		
Denmark	✔			
Finland	✔		(✔)*	
Flanders	✔ (Now)	✔ (At the start, Environment & Nature Fund)		
France		✔ (At the start, Modernisation Fund for Waste Management)		✔ (Now, revenue neutral with reduced VAT on collection)
Ireland		✔		
Italy				n/a
Netherlands	✔			
Norway	✔			
Sweden	✔			
Switzerland			✔	
UK		✔ (ENTRUST)		✔ (NIC reductions)

** Note: Although the revenue becomes part of the general budget, the Ministry of Environment made a 'gentleman's agreement' with the Ministry of Finance when the tax was introduced that more money would be made available to fund contaminated land remediation.*

3.4.2.6 Exemptions from the Tax

In this section the various exemptions from the landfill tax are identified. Exemptions can be a useful tool to steer appropriate behaviour of waste generating actors. There are clearly wide ranging reasons for exempting certain activities, some of which are driven more by economic than environmental arguments. The structure of exemptions

will cause rational economic agents to follow the path of least cost, without strict regulation *per se*.

The details of the system of exemptions in a number of countries are set out in Appendix A.3.0, and Table 3-5 on the following page highlights the various emphases of waste tax exemptions across European countries. It should be noted that alongside these formal exemptions from the tax, different countries may allow different exemptions from waste permitting (for example, where activities are defined as recovery). Hence, the system of exemptions from tax would properly be considered in the context of each country's approach to specifying exemptions from permitting, but this is beyond the scope of this study.

Table 3-5: Focus and Rationale of Landfill Tax Exemptions

	Environmental			Economic		
Country	Protect materials being used in landfills (e.g. inert)	Stimulate remediation and clean up *	Stimulate waste recycling industry	Protect unavoidable wastes **	Protect indigenous industry	Protect on-site landfills at private production facilities
Austria			✔ 1			
Denmark	✔			✔		
Finland			✔ 1, 2	✔		✔
Flanders – n/k						
France			✔ 3			
Italy – n/k						
Netherlands		✔	✔ 1,2,4			✔
Sweden	✔	✔	✔ 1,2	✔	✔ 5	
UK	✔	✔				
Norway			✔ 6	✔ 7		

Switzerland – n/k						

** e.g. contaminated land, river sludges, asbestos etc.* *** e.g. power plant ash, fly ash, clinical/hospital waste, sewage sludges, radioactive waste*

Notes

1 Various exemptions for materials destined for composting

2 Waste from deinking of waste paper

3 Industrial waste recovery facilities and community waste return

4 Waste from plastic recycling

5 Metal slags, foundry sand, sludges for certain chemical manufacturing processes

6 Waste destined for recycling

7 Hazardous waste only

3.4.2.7 Performance of Tax Mechanisms

Where the rationale for the tax was simply to divert waste from landfill, or perhaps to EfW, the effect is more clearly linked to the policy, but to what extent the tax has a direct link to high levels of recycling is not certain. What is likely is that the market will respond to increased costs of disposal. The effect of landfill taxes on waste prevention, recycling and disposal were discussed previously in Section 3.3, and Appendix A.3.0.

3.5 Summary of Landfill Taxation Policies

We can conclude that landfill taxes can be used is a variety of ways to arrive at a desired outcome, be it securing supply for EfW plants or helping to further incentivise recycling. What the final outcome will be depends on the design of the tax (which ought to reflect the intention of the implementing authority), and also, on what other policies contribute to the mix of policy instruments.

In the case of Scotland, therefore, the whole suite of relevant policies would ideally be in the control of Scottish policy makers. The Zero Waste Plan hints at the inclusion of many of these policies already, such as requirements to source segregate waste and pre-treatment requirements for both landfills and EfW plants. The Government might also have powers to implement pay-as-you-throw (PAYT) mechanisms if the political will existed. In short, most of the tools of waste management policy that might be usefully deployed to support a tax are already within the competence of the Scottish Government.

In 2009 Eunomia carried out an international review of waste policy for the Irish Government. It was considered prudent to highlight the key lessons learned from this extensive study to the Scottish Government.

The main lessons learned from the study can be summarised as follows.

For the policies to have a positive effect on waste prevention they must:

- *Increase the benefits 'of preventing' waste (by increasing both disposal and recovery costs);*
- *Ensure that the price signal is passed through to the waste producers themselves; and*
- *Allow for engagement with the relevant stakeholders.*

For the policies to have a positive effect on recycling they must also:

- *Be implemented concurrently with initiatives to promote the source separation of materials. This will make collection feasible and more cost effective.*

For the policies to have a positive effect on disposal they must also:

- *Give enough time for alternatives to become available in the market so that there is enough treatment capacity;*
- *Increase the gate fee of the disposal operation (be it landfill or incineration) so that alternatives can provide a more cost effective*

'substitute'; and

- *As evidence suggests that the demand for waste disposal services is inelastic, the level of a tax must increase to a significant level to have any effect on the supply of waste.*

Furthermore, if the policies are to decrease pollution they must incentivise the shift to a better performing alternative method of treatment (via the substitution price effect) or make it more cost effective for plant operators to include a high level of abatement equipment in their facilities.

3.5.1 Interaction of Taxes with Bans

As discussed in Appendix A.3.0, the consequences of landfill bans are difficult to separate out from the effects of other instruments in place at the same time, not least, landfill and waste taxes, but also other instruments. A ban on landfill does not dictate where the material which can no longer be landfilled will be sent. Other policies, and market conditions, will dictate how this material is managed.

In the absence of alternative interventions, the effect of a ban will, most likely, be determined by the costs of the competing options for dealing with a given waste stream. In very basic terms, the ban rules out the option of landfilling for the banned waste stream. A tax might have a similar effect for given materials if it is set at such a rate that under reasonable assumptions regarding how low pre-tax gate fees could fall, landfilling is no longer, from the perspective of costs, a viable option economically.

The evidence considered in this review suggests that where taxes are concerned, in principle, it would be possible to structure levies so as to 'rig' the waste management market and make specific options more desirable than others, as landfill bans do. Especially where a ban's primary aim has been to achieve a shift from landfill to incineration, there seems to be little reason to believe that a tax could not, or that it does not, achieve the same (or very similar) objective in a more efficient manner.

One of the effects of landfill bans appears to be that unless the supply of residual waste matches the available treatment capacity, then unless exports are a realistic option, there is likely to be a need for some form of 'exemptions system'. In these cases, waste carriers would make special cases as to why 'banned' materials should be allowed to be landfilled. The danger is that such exemptions can be over-used (or resorted to on a frequent basis). In terms of the proposed landfill ban in the Zero Waste Plan Regulations, it might be appropriate to raise the landfill tax in support of the proposed ban. This will tend to reduce any economic incentive there might still be to resort to landfill as opposed to other treatments. The tax could also act as an additional incentive to capture recyclate before landfilling as long as the cost of other treatments lies above that of landfilling, inclusive of tax.

Furthermore, if the aim of the ban is to ban materials which have not met a specified fermentability threshold, then as was the case in Austria, it may be appropriate to set a lower rate of tax for the treated waste. This would act as a fiscal incentive for operators to ensure that it had been through a pre-treatment plant to reduce the biodegradability of the waste before being landfilled. It would also provide greater certainty to investors to support the financing of the required plant if there was any

uncertainty around the nature and timing of the ban, or the extent to which time limited exemptions from the ban could undermine its effectiveness.

3.6 Stakeholder Interviews

A round of interviews with a range of relevant stakeholders was undertaken. The aim being to gain some views on the need for changes to the tax and what impacts may results from such changes. Telephone interviews were held with the following people:

- Michael Tracey (William Tracey Waste Management)
- Kenny Lang (Inverclyde Council)
- George Eckton (COSLA)
- Ian Lorimer (Director of Finance - Angus Council)
- Bill Weir (Barr Industries)
- Mark Everett (JJE Contractors)
- Adrian Bond (SEPA)
- Paul Ellis (Biffa)
- Martin Cracknell (SITA)
- David Lonsdale and Iain McMillan CBE (CBI Scotland)

Written responses were received from:

- Kenny Boag (SEPA)
- Stephen Freeland (SESA)

A questionnaire was developed and sent out to each person prior to the interview. The responses have been summarised and amalgamated under the same question headings in Appendix A.4.0. These have again been summarised below for the main report.

1) *What is your experience of the implementation of the existing UK landfill tax?*

   A) *How well regulated is it?*

      General feeling that the tax was well regulated overall, but at the same time, it was acknowledged that regulators cannot continuously monitor sites.

   B) *How efficient is the administration?*

      No major concerns over current administration of the tax.

   C) *Are current and anticipated changes as they should be?*

      The increases in the landfill escalator were considered appropriate by most interviewees, and were viewed positively, stating that new markets for recycling, for example, have become cost effective. Interviewees had differing views on the level of landfill diversion that will be achieved. Some suggested that the £80 per tonne tax will drive most waste from landfill, and others argued that it was still not high enough.

2) *What changes to the existing system (UK wide first, then Scotland only) would you recommend, in terms of:*

   A) *Levels*

      It was generally felt that levels should not be reduced, as this would send mixed messages to industry. Reflecting 1) C) above, some argued that the level should stay at £80 per tonne (or that is should always be harmonised with the rest of the UK), and others suggested it should be increased.

   B) *Structure (lower / standard rates)*

      A number of changes were proposed, ranging from combining the standard and lower rates, to changing the way in which specific waste streams were taxed were indicated by the stakeholders.

   C) *Classifying Exempt Sites*

      Some comments around how exempt sites are managed and taxed were made.

   D) *Other*

      Other comments were made, including that tax system should be kept simple, it should encourage markets for ash recovery, and also having tax free quotas for the use of material on landfill sites for temporary engineering and the like.

3) *How do you perceive the significance of current cross-border movements of residual waste?*

   In general people believed that cross-border waste movements were low. Some suggested that there was some transfer of commercial waste to northern England, but the quantities were unknown. Some hazardous wastes also travels south for treatment and processing.

4) *How do landfill gate fees vary across Scotland and national borders, and why? What is the current state of Scottish landfill void space?*

   Gate fees are somewhere between £12 per tonne and £20 per tonne for landfills to the south and in the central belt. Fees are slightly higher in the north of the country. Gate fees were generally felt to be lower than in England because of operators trying to fill large remaining void spaces. The general view was that landfill was a business that is '*on its way out.*'

5) *What issues might arise if a Scottish specific landfill tax was implemented? Including:*

   A) *Change in gate fees*

      It was felt that operators had little margin left to reduce gate fees. In fact if the landfill tax drives more waste from landfill, operators may have to increase gate fees to cover costs. Any increases would have to be considered proportionate for Authorities in the North where landfill is more scarce.

   B) *Cross-border movements of waste*

      The interviewees generally agreed that disparities in the level of landfill tax would cause waste movements as businesses will continue to look at their

bottom-line, and if a cheaper alternative is available they will seek it out. The extent of any movements was not clarified but the relationship between avoided cost and distance was agreed as fairly linear.

C) *How far hauliers will transport waste as price differential increase*

Some suggested that a £10 per tonne increase in disposal costs could see lorries moving waste over 100 miles, though others said that this was too far. Inert materials would not travel as far as the transportation costs are higher.

D) *Regulation and administration*

Most interviewees raised concern about the proportionality of any changes. A UK wide system with the same level of administration is simpler, cheaper and easier for businesses.

E) *Other*

There was some concern that Local Authorities simply don't have the money to invest in alternative treatments. Other comments around the hypothecation of revenue and the impact of landfill bans were made.

Some other key points that were raised:

- Some interviewees suggested that the Scottish Government should publish a 'green paper' on their proposals for the landfill tax as soon as possible to give certainty to the industry.
- Non-landfill operators use the tax as a baseline to structure charging tariffs. They aim to set fees just below the total landfill disposal cost.
- Landfill tax is a very relevant tool when making an investment decision.
- If quantities of waste going to landfill fall gas capture will drop off to below threshold levels. Therefore, in order to maintain high enough degradation rates to enable gas capture, the landfilling of waste might benefit from being planned more strategically. Larger quantities arriving at smaller numbers of sites might be more preferable to smaller quantities being distributed more widely.

3.7 Review of Modelling Approaches

Our review of international approaches to modelling found limited examples. It does appear as though the implementation of, and changes to, landfill taxes in many Member States has not relied heavily on *ex ante* evaluation. Instead the approach seems to rely more on evaluating and responding to changes in the market, and following implementation, making any adjustments in order to meet the desired objectives.

In the UK, the situation is somewhat different. Government requires Impact Assessments for most changes in policy. A number of modelling approaches was researched. These include:

- REEIO – Regional Economy Environment Input Output model. The waste section of the manual was considered in the review. There were a number of parameters and equations that describe the functionality of the model. No

price response functions or parameters could be seen in the REEIO model. It mainly models changes in arisings and appears to keep the pattern of waste management (i.e. the proportion being sent to landfill, being recycled, etc.) constant. Therefore, as this study is primarily concerned with price, it appears to be of little relevance. It must be stated, however, that we were not privy to the model itself so could not be certain whether this was the case in the model.

- LAWRRD – Local Authorities Waste Recycling Recovery and Disposal model. This model seeks to anticipate the approach which will be adopted by each local authority in England. It covers only municipal waste. The approach used in LAWWRD has a high level of complexity that makes performing sensitivity analysis quite difficult. Given the uncertainties in a large number of the variables, it is not necessarily clear that this more complex approach will give more accurate answers than a more simple one.
- HMRC Landfill Tax Model. The HMRC model did provide some useful information. However, the rationale for some of the calculations was not clear. Moreover, the model did not model changes for Local Authority collected waste (partly because such modelling appears to rely on LAWRRD) and nor did it predict where waste would end up when it is diverted from landfill (or prevented). It only appeared to be concerned with calculating the reduction in waste sent to landfill and the associated tax receipts.
- Eunomia Landfill Tax Model for Landfill Bans Work. This simplistic approach considered the historic relationship between the price of landfilling in real terms and the estimated quantity of C&I waste landfilled. This was used to derive a demand elasticity for landfill services, and again used to estimate the reduction in landfill based upon future changes in price (mainly from the landfill tax).

Following this review there did not appear to be any obvious choice of approach to take. In fact, the amount of research undertaken specifically looking at landfill tax, appears to be small. On balance it was felt that the more complex approach of constructing cost curves, as opposed to using own- and cross-price elasticities, would be a more interesting approach to take in this piece of research. Demand elasticities would, perhaps, have been simpler to model and could provide similar results. However, a problem with using demand elasticities to model responses in the market for landfilling is that the changes in the price being considered are not marginal ones. At the commencement of this report, landfill tax stood at £48 per tonne and was due to rise to £80 per tonne. The change in the real price of landfill, on a gate fee of £16 per tonne, would be around 40%. This magnitude of change in price is large enough for one to question whether the response of the market could be characterised by a single, constant price elasticity of demand (or a set of own- and cross-price elasticities).

3.8 Summary of Landfill Tax Review Section

The following points summarise the findings from the literature review:

- Many countries within the European Union have utilised landfill taxes since

around the mid-1980s;

- The rationale of most landfill taxes was to stimulate waste minimisation and reuse/recycling. This is realised by increasing the cost of landfilling, and thus making alternative management methods more cost competitive, and waste prevention more financially rewarding. In addition some countries specifically seek to raise revenue, or internalise the externalities of landfilling;
- The revenue can be used for a number of purposes, including being directed to the national budget, funding environmental projects and supporting waste management activities;
- Most landfill taxes covers all waste streams, rates are often split between active and inert wastes, and in many cases, the rates have increased significantly over time;
- Most countries exempt some materials from the tax when they are landfilled;
- With the UK landfill tax at £80 per tonne, however, it will be one of the highest rates in Europe. Only the Netherlands has a comparable level of tax (which is used to support a policy banning many waste streams from landfill);
- Spain, Belgium and Italy each have regional variations in landfill tax policy;
- In Belgium and Italy, there are mechanisms in place to effectively apply a form of border tax adjustment between regions when waste is moved from one region to be landfilled in another. The details of these mechanisms have, however, been difficult to obtain;
- Many countries with higher landfill taxes include supporting policies to help drive whatever behaviour is required by the national waste management plans. These include policies directed at increasing recycling, and measures to ensure residual waste does not simply switch from landfill to incineration. In some countries, however, where recycling policies have not been so strong, landfill taxes have, alongside landfill bans, had the effect of shifting residual waste from landfill to other treatment routes (typically, incineration);
- In terms of the link between landfill taxes and landfill bans, some countries have noted the need to have higher taxes to dissuade companies from having repeated recourse to exemptions from a ban (which may be necessary in some contexts). In Austria, where a ban on landfilling biodegradable wastes was implemented, this was incentivised through offering a lower rate of tax for wastes that had been pre-treated such that their tendency to generate methane when landfilled was significantly reduced;
- There is a complete dearth of ex ante analyses of landfill taxes in other countries as far as we could discern. Most countries appear to have taken a much more pragmatic approach to the design of their landfill tax, and we could find no country where there was some officially sanctioned model of the workings of a landfill tax (which does not mean to say that this does not exist); and
- Finally, there is a tendency, which appears to be gathering pace, for countries to establish taxes on other waste treatments too, notably incineration. Several

countries – Denmark, Austria, Belgium, Sweden and Catalunya among them – have 'waste taxes' which cover incineration as well as landfill, albeit that the tax rates for incineration are generally much lower than for landfill.

A range of stakeholders within Scotland were consulted regarding their experiences with the tax, how it was currently working, and for their views on whether or not the tax should be changed (and if so, how). The key observations drawn from these consultations are offered below:

- It was generally felt that the administration and regulation of the existing tax mechanism was good;
- The current and proposed structure and levels of the tax were considered 'about right' and it was generally accepted that the tax was a key driver in changing waste management behaviour. Indeed, there was a view that 'landfill' was certainly not the best industry to be in today;
- There were mixed opinions in regards to whether the level of the tax should remain at £80 or be increased further;
- There was some concern expressed regarding the possible fracturing of waste policy within the UK and of the possibility of 'unlevelling the playing field' for industry. Some commentators considered that a UK wide system was considered to be easier and cheaper to administer. It was also believed that any change to the tax mechanism should be simple;
- Differences in the level of tax are likely to cause waste to move across borders as in the current economic climate industry is very closely watching 'the bottom line'. The magnitude of the flow is uncertain but the distance waste travels is directly related to the difference in price.
- The current level of waste movements across the Scottish border was considered to be low, though exact figures were not generally known; and
- The current level of landfill gate fees was also reported to be low in the southern and central areas of Scotland, closest to the border with England. This was offered as one of the explanations for the (presumed) low level of export of waste for landfill outside of Scotland.

An additional area of work concluded that there is no 'easy choice' when considering how to develop a model of 'waste management' which gives a clear indication of how much might be landfilled in future. One key problem – which own-price elasticity models conveniently sidestep – is that even if all one is interested in is 'the quantity of waste landfilled', it is difficult to ignore the fact that the price of the most important (and in the ideal world, all other) waste management alternatives needs to be factored in, in some way, to the model. On balance the more complex approach of constructing cost curves for key recycling alternatives, as opposed to using own- and cross-price elasticities (which could only be guessed at), was chosen for this piece of research. In reality, the model also includes some elements which are modelled using an elasticity approach, typically where we have insufficient evidence to develop the relevant marginal cost curves for the alternatives.

4.0 Choice of Policy Options for Assessment

So far in this report, a large body of evidence has been highlighted to show the basis of how the policy options were chosen. It has also looked at what type of approaches could be taken to model some of the required options. In essence, the process thus far has been to:

1) Ascertain the environmental justification for landfill taxation;
2) Assess the nature of the resulting benefits;
3) Describe the whole range of different mechanisms in place internationally;
4) Consult with key stakeholders about the existing system, recommended changes and potential impacts; and
5) Review the types of approaches taken to assess changes in landfill taxation policy.

With this understanding the process, then, was to develop a set of policy options that could be modelled as part of the project. The options were guided by the following general principles, which followed from the reviewing stage of the study and discussion with the project steering group:

- No major changes to the landfill tax system were required;
- Standard and lower rate structure was to be maintained, and levels could increase, but probably not by a significant amount, and should not decrease;
- Any options should be feasible, practically enforceable and politically acceptable;
- Any options should be proportionate, reflecting the difficult economic circumstances currently being felt by both the public and private sectors.

It is not the aim of this study to report on the relative efficiencies of economic or other instruments, however, the authors note that taxes are, in principle, efficient and transparent instruments for ensuring that policy goals are met. Hence, no option was considered that would have substituted for the landfill tax system. This is noted to provide some context as to the scope of the options that were developed.

The full list of options along with the pros and cons of each option is in Appendix A.5.0. The final set of chosen options and those excluded are summarised in the Sections below.

4.1 Final Set of Policy Options

The final set of options that were taken forward to the modelling stage is described in the Sections below. Some options were conducive to quantitative modelling techniques, similar to those discussed in the review stage of the study. However, some are not far enough advanced in conceptualisation, or rely upon data that has not yet developed to a sufficient degree. Therefore, these policy options have been appraised through both quantitative analysis and qualitative discussion. This is reflected in how the final options are presented in the following list:

Options for Quantitative Modelling;

- Increase Level of Standard Rate Tax;

Options for Qualitative Appraisal:

- Increase Level of Lower Rate Tax;
- Lower Rate for Stabilised Wastes;
- Introduce Incineration Tax;
- Revenue Used to Incentivise Recycling Activities;
- Combustion Residues Classified at Standard Rate;
- Export / Border Adjustment / Equalisation Tax to discourage cross-border waste movements;

4.1.1 Increase Level of Standard Rate Tax

This option would see an increase in the standard rate of tax.[28] The literature review suggests that at £80 the UK's landfill tax will be one of the highest in the world (only the Netherlands appears to be higher). The evidence in terms of environmental justification suggests that this level of tax will most likely internalise the environmental externalities associated with landfilling, and potentially exceed the readily identifiable externalities (insofar as one can say these are quantifiable with any level of certainty).[29] However, the valuation of impacts shows a tendency to increase over time, so the total monetised externalities may also increase.

The stakeholder interviews also suggested that the current escalator will have a significant effect on waste management in Scotland. It was thought that a large majority of the waste landfilled at the active rate would be diverted to recycling and recovery operations. However, some took a different view, suggesting that higher rates of tax would be required to generate more diversion of waste to recycling or recovery. Many of the stakeholders also indicated that if there were significant differentials in the tax between England and Scotland this could stimulate cross-border waste movements.

Taking all these factors into consideration, one might suggest that the level of standard rate tax could be raised, but that the justification for significant increases over and above those already announced is not especially strong, particularly if one takes the view that the principle objective of the tax should be the internalisation of externalities. There may, however, be justifications for higher levels of the tax depending upon the specific objectives which are given to the instrument, and it

[28] The Scottish Government have the ability to reset the tax level to any level once it is reinstated. The assumption is that it will be at least the same level of the existing UK tax level i.e. £80 per tonne.

[29] A range of factors are important as discussed above, amongst the most important being the capture rate of methane at the landfill, and the unit damage cost for climate change-related emissions.

seems clear that the UK tax has long since departed from its initially stated purpose (which was to internalise landfill-related externalities). Landfill tax, it could be argued, might reflect the 'differential externalities' between recycling and landfilling, recognising that 'recycling subsidies' are unlikely to be attractive as a means to acknowledge the external benefits from recycling.

For this option, two potential scenarios are suggested:

1) Extend £8 per tonne escalator by one year (so the tax rises to £88 per tonne in 2015/16); and
2) Extend £8 per tonne escalator by two years (so the tax rises to £96 per tonne in 2016/17).

In all cases, we assume that the tax stays constant in real terms once it reaches its highest level (i.e., its value is not eroded by inflation). It is also noted that increases in landfill tax will have a greater impact on authorities where the cost of landfilling is high – generally in the north of Scotland. Variations in the level of tax across Scotland have not been modelled in this study, however.

Increases in the standard rate have been restricted to £16 per tonne partly because the movement of waste across borders is likely to be driven by cost differentials on either side of the Scottish border. With much higher differentials, it is anticipated that the movement of waste across the border to landfills (and other available treatments) could become significant, though probably only in the period during which alternative infrastructure was being developed.

A third option which could be discussed is the possibility that a single higher increase is implemented at £16 per tonne. We take the view that this might not have the same outcome as a two-stage increase of £8 per tonne per year (we believe the behavioural response might be greater under the one—step scenario). However, we have very little hard evidence upon which to base our view that the response may be different.[30] The principle change in outcome, therefore, is that in the short-term, if one uses a single increase of £16 per tonne after two years instead of two successive increases of £8 per tonne after one and two years, the tax take would be lower. For those facing the tax, the lower tax burden in the short term might be welcome.

4.1.2 Increase Level of Lower Rate Tax

The responsiveness of those landfilling waste relates to the rate of change. As the tax and gate fees levied on inert materials are currently low, one would not have to implement a significant change in absolute terms to see a relatively significant change in behaviour. Large quantities of inert waste, not used for engineering

[30] The view is based upon previous work on the charges paid for water abstraction and discharge consents (see Ecotec Research & Consulting Ltd. (1998) *Effectiveness of Cost Recovery Charging*, A Final Report for the Environment Agency). In this work, it became clear that some companies control the cost of specified budget items through understanding the variance from one year to the next. Smaller increases attract less attention than larger ones, and so, are less likely to trigger a behavioural response.

purposes (and hence, not exempt from tax), are still being landfilled. In addition, there are significant quantities being recovered at activities exempt from environmental permitting. The suggestion is that a proportion of this material could be managed through processes higher in the waste hierarchy. Increases in lower rate tax could stimulate this change. On the other hand, it might also stimulate further resort to use of exemptions from permitting, where suitable options exist.

Given that the changes in lower rate tax have been low, and so as to not be disproportionate, the following two scenarios were modelled:

1) Increase in lower rate tax by £1 per tonne; and

2) Increase in lower rate tax by £2.50 per tonne.

This seems a sensible range to test in the analysis.

One of the issues highlighted in the review was that of illegal activities at exempt sites. Increases in the lower rate may stimulate a greater level of sham recovery, for example.[31] We suggest that both options allow for enhanced regulation of sites by SEPA, paid for by ring-fenced funds derived from the increase in lower rate tax.

4.1.3 Lower Rate for Stabilised Wastes

According to previous research by Eunomia, there is a strong environmental argument for lower rates of tax for stabilised waste than for active wastes.[32] This is because waste that does not have a high propensity to degrade in landfill does not produce as much methane – a potent greenhouse gas. Therefore the externalities associated with landfilling stabilised waste are somewhat lower.

Wastes that have been through a process that was certified to stabilise the waste stream would be subject to a reduced rate upon arrival at landfill sites. This would be clearly indicated on the waste transfer note. The implementation of this option would have to be in-line with the approach agreed following the consultation on the ban on landfilling of biodegradable wastes.[33]

4.1.4 Introduce Incineration Tax

Some countries with incineration taxes in place have levied the tax on each tonne of material incinerated (this is the case in Austria and Denmark, though in Denmark, rates differ between facilities which do and do not recover energy). Others, such as Norway, have sought to differentiate the tax according to the performance of the

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[31] This was the experience when the tax was first introduced – see ECOTEC (2001), Study on the Economic and Environmental Implications of the use of Env. Taxes & Charges in the EU

[32] Eunomia (2008) *'Biostabilisation' of Waste: Making the Case for a Differential Rate of Landfill Tax*, January 2008, http://www.eunomia.co.uk/shopimages/Eunomia%20Landfill%20Tax%20Paper%20Final.pdf

[33] See Scottish Government (2011) *Regulations to Deliver Zero Waste: A Consultation on the proposed Zero Waste (Scotland) Regulations 2011*, available at: http://www.scotland.gov.uk/Publications/2011/02/09135833/0

incinerator in terms of its emissions, an approach which was also proposed in Ireland.[34]

A tax on energy from waste is seen as a complimentary instrument to landfill taxes, especially when specific policy aims are being sought. The concern is that as landfill tax levels increase residual waste simply shifts from landfill to incineration, and increased opportunities to recycle are missed. With high recycling targets under the ZWP, this concern is valid.

4.1.5 Revenue Used to Incentivise Recycling Activities

In some jurisdictions where landfill levies are applied, some or all of the revenue generated is refunded to support specific changes. The Catalunya case is probably the most interesting case of this nature. In Slovenia, the tax has recently been revised such that a refunding mechanism is in place to reward the performance of local authorities in terms of their recycling. This is, in principle, close to what might be deemed an efficient approach to managing waste, in which taxes on disposal are supported by 'subsidies' for recycling of material.

The justification for such a mechanism as modelled here is to further incentivise recycling and provide some financial certainty for Local Authorities, and potentially businesses also, in their requirement to fund recycling infrastructure.

It was concluded that this option should not be modelled at a detailed level at this stage of development. There are a number of potential ways in which revenue refunding could be achieved. It was felt that simply describing a number of options, which may have critical elements, would be better at this stage of the process. Full consultation with Local Authorities could be sought in the future by the Scottish Government. Moreover, the existing Concordat which constrains the ability for funds to be ring-fenced needs to be considered.

4.1.6 Combustion Residues Classified at Standard Rate

There is increasing evidence to suggest that some combustion residues, notably ashes from municipal waste incinerators, may not be as benign as is sometimes suggested. To reflect the environmental damage they may cause higher rates of landfill tax could be levied on these waste streams.

4.1.7 Export / Border Adjustment / Equalisation Tax to Discourage Cross-border Waste Movements

The justification for this related instrument is, potentially, to inhibit cross-border movements of waste, which might tend to increase in the wake of a change in landfill tax. In Belgium, for example, those involved in transferring waste between regions of the country have to notify the relevant authorities. If the waste is passing to a region

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[34] See Eunomia (2009) *Section 60 Policy Direction Capping Incineration of Municipal Waste and Other Matters*, Environmental Report to the Irish Department of the Environment, Heritage and Local Government, June 2009.

with a lower disposal or recovery tax the central Government administers a tax equal to the difference. The waste operator then has to pay the additional tax above and beyond what is paid on receipt of the waste to the disposal or recovery site. This then negates the financial incentive for intra-regional shipments of waste. Our understanding is that a similar mechanism exists in Italy, though we have been unable to obtain full details of this. It seems reasonable to suggest, in light of these precedents, that a similar mechanism could be implemented in Scotland.

4.2 Policy Options Eliminated from Initial List

Several options were eliminated from the initial set of feasible options. These are set out below, along with a brief description of why they were not carried forward for further analysis:

- **Delay anticipated increases in the current landfill tax escalator:**
  The aim of this option would be to free up revenue for businesses and Local Authorities by reducing their disposal costs. They could then use the additional revenue for procuring the required infrastructure to increase recycling and recovery. However, the Scottish Government does not actually take control of the setting of tax levels until 2014/15. This, therefore, is too late for this option to be possible, ands so this option was not included in the list for further analysis;
- **Higher rate for Automotive Shredder Residue (ASR):**
  The rationale for considering this option was to help stimulate the market for non-landfill recovery and recycling of ASR. The material is currently subject to the standard rate of tax, so the avoided disposal cost will rise in line with the tax escalator. This may make some recovery options competitive with landfill, but not necessarily advanced sorting processes.
  The environmental justification for a 'higher than standard rate' does not obviously exist, however. Other policy mechanisms could, in fact, be used to stimulate the development of plant for sorting and recycling of material from ASR.[35] Therefore, this option was excluded from the list for further analysis;
- **Reclassify some biodegradable materials as active e.g. dredging spoils:**
  The suggestion for this option came from stakeholders who believed that all biodegradable waste should be liable to tax at the standard rate. It was suggested, however, that there may be good reasons why such wastes are classified under the lower rate. Raising the rate for such wastes, especially where there is no immediately obvious alternative, may be disproportionate. This option was, therefore, excluded from the list for further analysis;
- **Re-evaluate exemptions from tax relating to material used for engineering purposes such as road building:**
  This option was suggested by landfill operators. However, given the history of

[35] Arguably, the already existing producer responsibility approach for end-of—life vehicles would be the more suitable instrument through which to achieve this objective.

this element of the tax, and the relatively recent clarifications from HMRC regarding which materials, under which conditions, would be exempted from tax, it was deemed prudent to allow the changes to take their effect rather than re-opening the discussion. The HMRC approach has a relatively clear rationale and reviewing this might lead to much additional work for minimal (if any) change / benefit. Therefore, this option was also excluded from further investigation;

- **Define sorting residues at Standard Rate:**
  Although this was raised in the interviews as an issue, clear evidence of a problem (let alone one which is widespread) could not be said to exist. The data available for any modelling would also have to be caveated with significant assumptions. Given the absence of clear evidence of the issue raised, this option was also excluded from further investigation; and
- **Decrease Standard / Lower Rate of Tax:**
  This option was considered as a mirror of the increases being carried forward for further investigation. It had been mooted in interviews as a means to reduce the burden on businesses and Local Authorities at a difficult time for the economy. It was not carried forward for further analysis because it would generate uncertainty regarding the general thrust of policy.

5.0 Key Contextual Issues

5.1 Residual Waste Treatment Market

One of the important assumptions relates to the effect of the landfill tax on the management of wastes under the BaU Baseline. The effect of the rising tax has been modelled as implying, essentially, an increase in recycling and a reduction in landfill, with some additional residual waste treatment where this is already in the process of construction.

In reality, at the level the tax will reach in 2014/15, it is very difficult to model, with great certainty, the behaviour of the residual waste treatment market. At lower rates of landfill tax, a range of recycling options are available at lower cost than landfill, and for some wastes, there are also treatment options which are either 'necessary' or lower in cost. For much of the remaining residual waste, however, at low rates of tax, few residual waste treatments can compare with landfill on cost alone. The exception appears to be older incineration facilities, which are able to treat waste at a cost of around £40 per tonne, but such facilities are not to be found in Scotland.

At £80 per tonne tax, several alternative residual treatments are of a comparable cost. It is, by and large, reflected in the costs from survey work for WRAP regarding gate fees for such facilities, and financial modelling of the costs of residual waste treatment processes.[36] This is highlighted in Table 5-1 and Figure 5-1. It is not clear what the gate fees charged by proposed facilities will be as operators are generally reluctant to give out information (on existing facilities also) due to commercial sensitivities. The gate fees are expected to be higher, not lower, than for existing facilities with some possible exceptions (such as a gasifier successfully operating with a gas engine – as opposed to a steam turbine - and benefitting from double ROCs, a solution which has hitherto proven elusive on a commercial basis for mixed residual waste, even when a global view is taken).

[36] Eunomia has carried out four consecutive gate fees surveys for WRAP over the last four years.

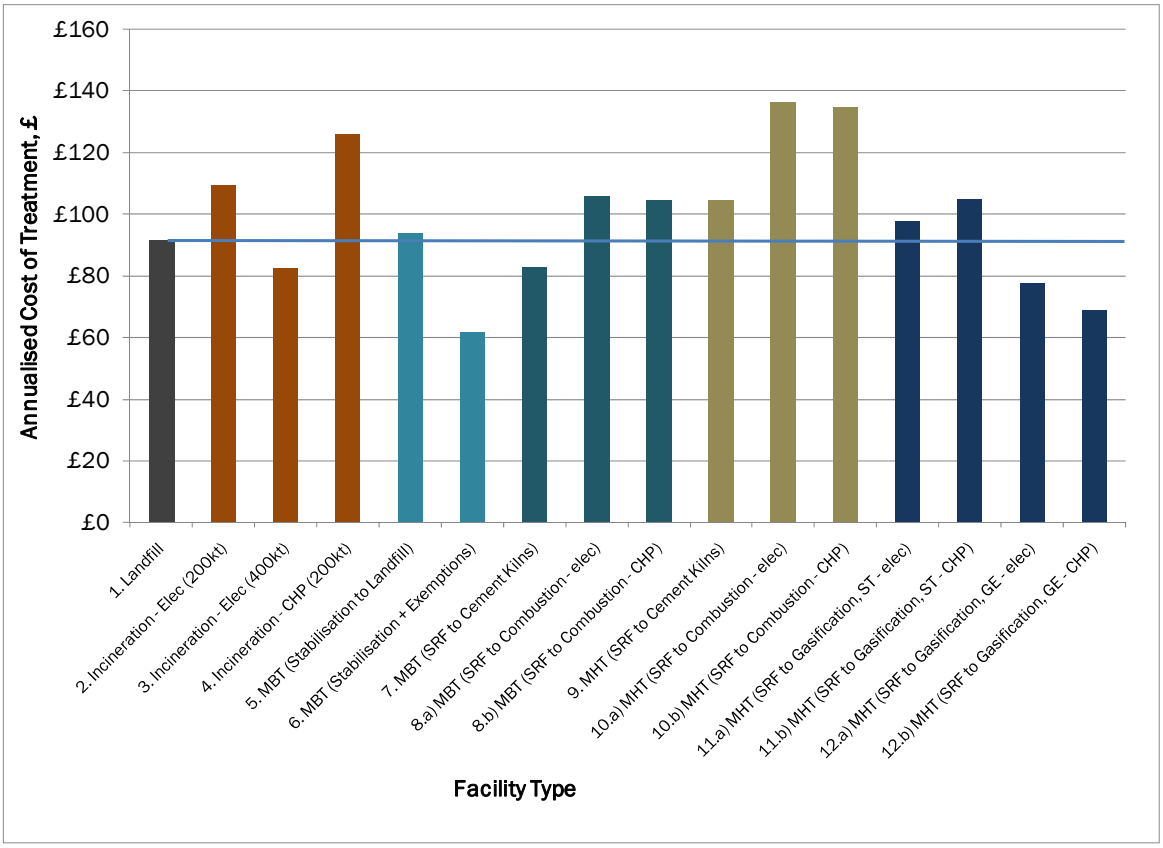
Table 5-1: Summary of Current Market Gate Fees (WRAP Study and Internal Financial Modelling)

Treatment Process	WRAP Study – median (max/min)	Financial Model (new facilities)
Landfill	£70[1] (£59 - £92)	£92[2]
Incineration - Small	£115 (£78 - £151)	£120
Incineration - Large	£85	£93
MBT (Stabilisation to Landfill)	£75	£84
MBT (Stabilisation + Exemptions)		£61
MBT (SRF to Cement Kilns)	£79 - £109	£81
MBT (SRF to Combustion - elec)		£110
MBT (SRF to Combustion - CHP)		£111
MHT (SRF to Cement Kilns)	n/a	£101
MHT (SRF to Combustion)		£139
MHT (SRF to Gasification, ST - elec)		£99
MHT (SRF to Gasification, GE - elec)		£82

Notes:

1) Median gate fee £22 + current landfill tax at £48.
2) Modelling includes tax at £80 in 2010 real terms.

Figure 5-1: Likely Gate Fees for Residual Waste Treatment Processes with Landfill Tax at £80, £ 2010 Real Terms



Source: Eunomia internal financial models

In addition to the cost of alternative treatments, the cost of landfill could also change over time. The research in the study has shown that the gate fees in the central belt of Scotland are some of the lowest in the UK. However, to further fill void space operators may further drop gate fees to ensure the supply of waste to the landfill. A contrasting view is that operators may have to raise costs in the medium term to cover costs as the supply of waste falls (operators need to fund operation and aftercare from revenues generated in the operational phase).

Additional factors affecting the market include the potential to export residual waste to other EU Member States for recovery. The treatment markets in Northern Europe are experiencing somewhat chronic over-capacity, and gate fees have fallen in recent years, with operators from Germany, Netherlands and Sweden, amongst others, actively marketing capacity in the UK. The gate fees offered are sufficiently low that even allowing for transfer (and double handling within that) some facilities may look quite attractive from some locations in Scotland. At £80 per tonne tax, the costs of shipping residual waste for recovery on the continent may well be lower in real terms than landfilling in Scotland.

These factors do not simply affect the way residual waste is treated. They also affect the extent to which materials are recycled / re-used (as well as the strength of any incentive for waste prevention). Our modelling of Baselines and Scenarios is predicated upon increases in recycling owing to rising levels of avoided disposal cost.

If residual waste treatments are available at costs lower than the landfill gate fee plus tax, then the costs of residual waste management which are avoided by the competing 'higher in hierarchy' activities are reduced. This would have the effect of depressing recycling rates. There is in fact some tentative evidence that this may well be happening in Germany, where the excess capacity for residual waste treatment is of the order 4.5 million tonnes.

To illustrate the potential significance of these points, we seek to outline below

1) What we have assumed occurs under the £80 per tonne tax (BaU baseline); and

2) The effect of changing these assumptions.

5.1.1 Approach Used in Baseline Modelling

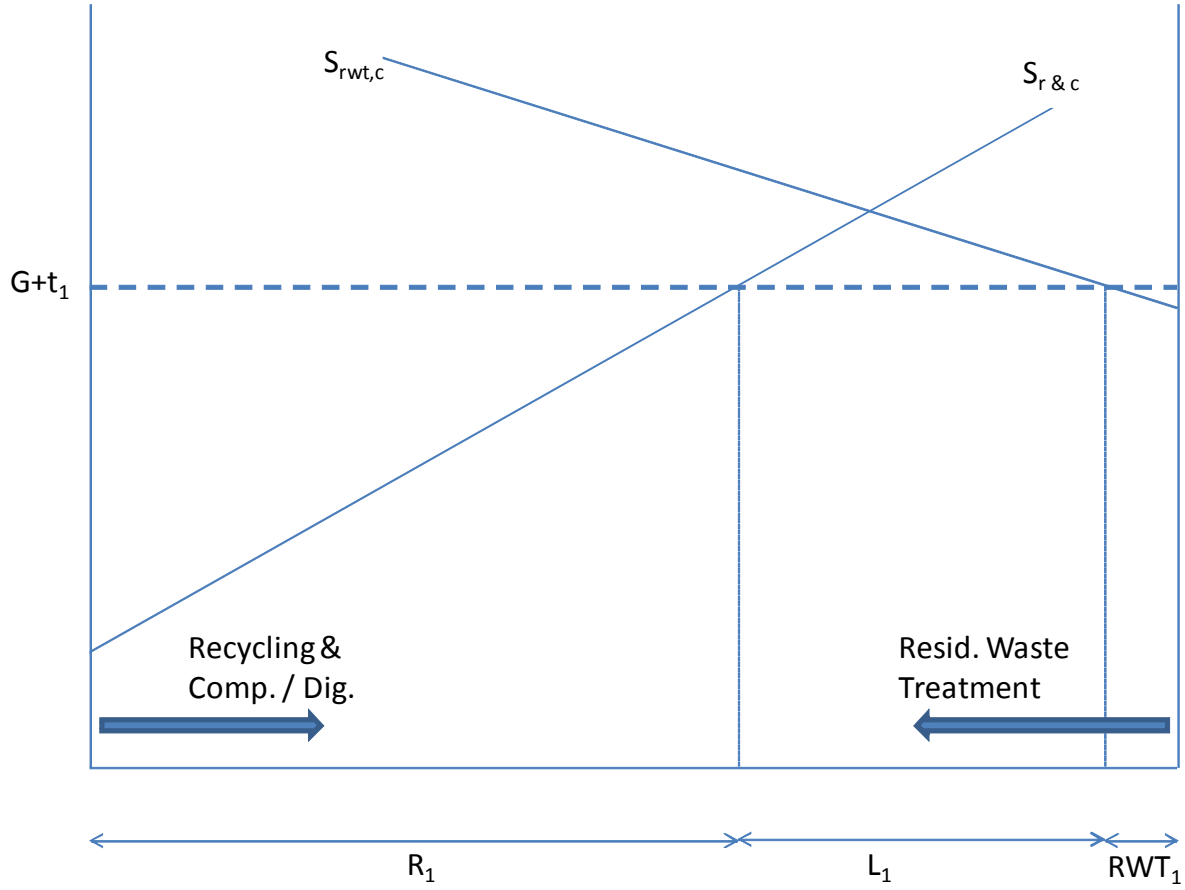
In the existing approach, we have assumed that those who are seeking to offer residual waste treatment capacity at costs competitive with landfill on a merchant basis are already likely to be in the planning process. Due to the extended periods of time these facilities can take to become fully operational (over 7 years in some cases), then given also the period already elapsed between the announcement of the tax rising to £80 per tonne and the current period, we have taken the view that, in terms of household and commercial waste, the only increase in treatment capacity which is motivated by the level of the £80 per tonne tax is what is already known about. For household waste, this amounts to an additional capacity of around 320,000 tpa, or 16% of Scotland's household waste.[37]

Other than these facilities, therefore, we have assumed that landfill tax is the benchmark figure for 'avoided disposal' which drives increases in recycling under BaU. The current situation, therefore, resembles the one depicted (albeit in simplified form) in Figure 5-2. Here, the supply curve for recycling ($S_{r\&c}$), composting and digestion is drawn from left to right, with the usual upward sloping form. The supply curve for non-landfill residual waste treatment is drawn from left to right ($S_{rwt,c}$). The 'c' denotes the assumption of a 'closed' waste economy (i.e. one not affected by the prices offered overseas).

The demand for both types of service is effectively depicted as the pre-tax gate fee landfill (G) plus the tax level (here shown as t_1). At this level of tax, the outcome is that R_1 percent of waste recycled / composted / digested, and RWT_1 percent of waste dealt with through non-landfill residual waste treatment. The balance ($100 - R_1 - RWT_1$) percent, or L_1, is assumed to be landfilled.

[37] Scottish Futures Trust (2011) *Untitled* http://www.scottishfuturestrust.org.uk/docs/262/File%206%20-%20Copy%20of%20Project%20Data%20-%2014%20Dec%202010.pdf

Figure 5-2: Current Approach to Modelling Supply and Demand for Recycling / Composting / Digestion and Non-landfill Residual Waste Treatment

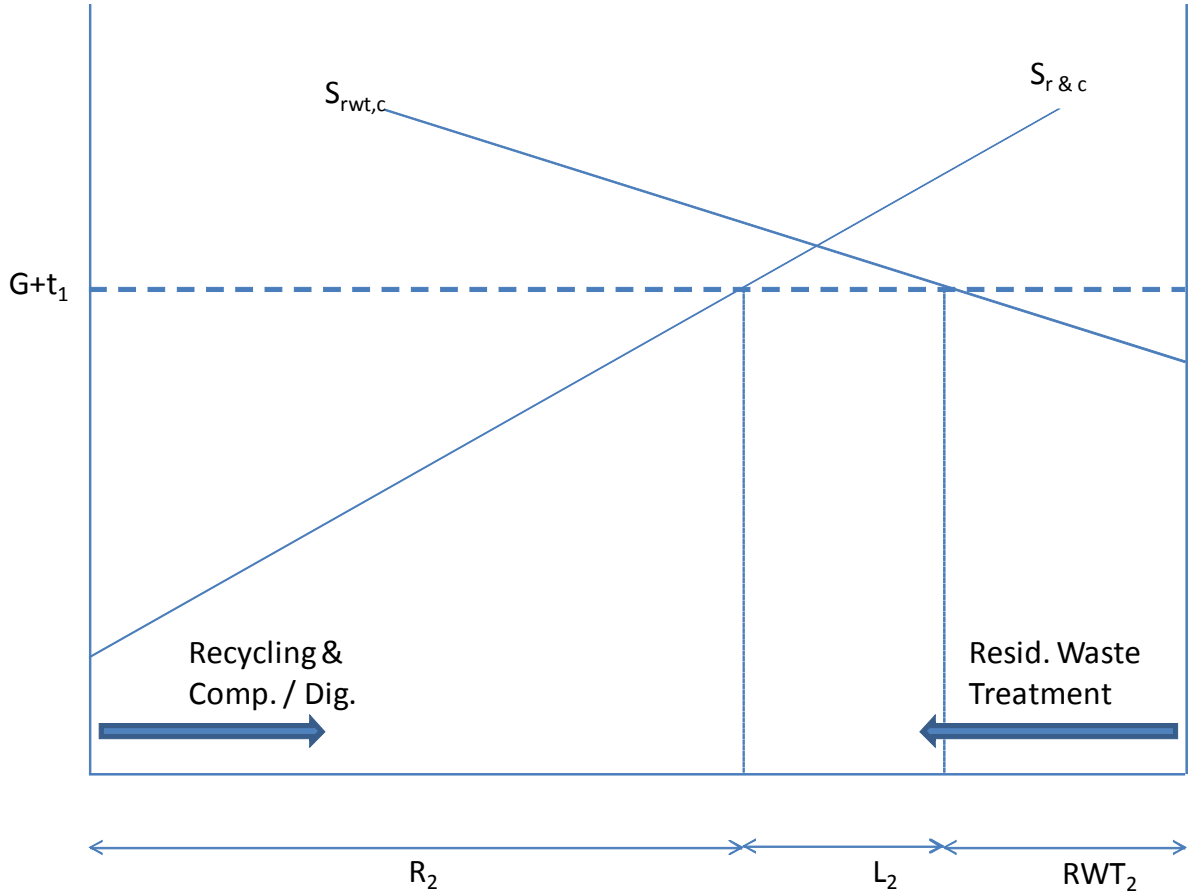


Source: Eunomia

5.1.2 Relaxing the Assumption – Costs of Residual Waste Treatment are Lower than Expected

Suppose that our assumptions have over-stated the costs of non-landfill residual waste treatment. What might this mean for the modelling of the BaU Baseline? In principle, it means that the proportion of residual waste treated through residual waste treatment in response to the tax is too low. In terms of the economic description given above, if the supply curve for residual waste treatment is lower than has been assumed, then the quantity dealt with through such means would be higher, and consequently the landfilled quantity would be lower. In the case depicted below, however, the recycling / composting / digestion remains as before, at R_1. This is because, in the case depicted below, the two supply curves do not cross below the value of landfill plus tax ($G + t_1$).

Figure 5-3: Supply and Demand for Recycling / Composting / Digestion and Non-landfill Residual Waste Treatment (RWT), Reduced Costs for RWT, Closed Economy



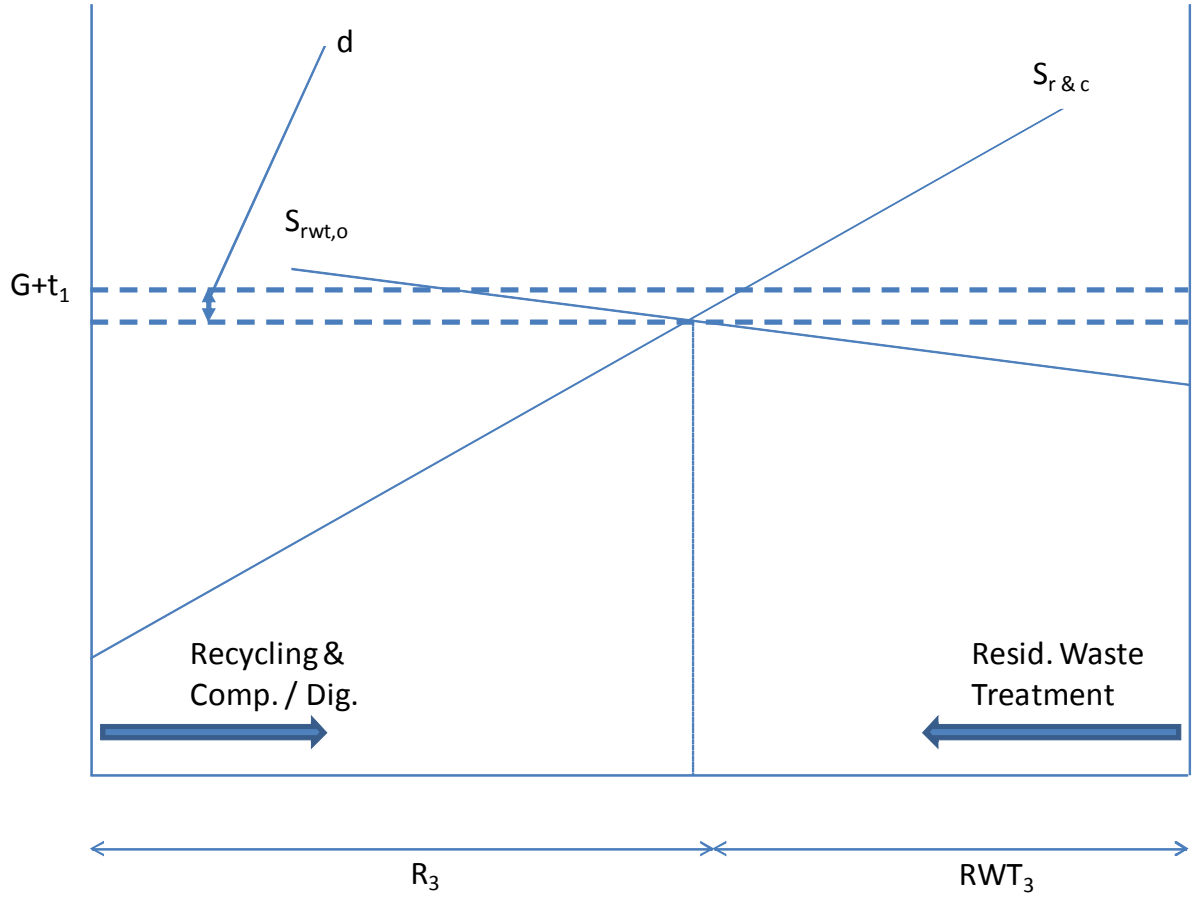
Source: Eunomia

5.1.3 Relaxing the Assumption – Supply Curve for Residual Waste Treatment Flattens

The significance of the effect of relaxing our assumptions is made more significant where the supply curve for recycling/composting/digestion and the supply curve for residual waste treatment cross below the value of landfill plus tax ($G + t_1$). This could be the case, for example, where one assumes that the residual waste treatment market is effectively an open one, and where exports to third countries can happen at competitive prices. In this case, we denote the supply curve with a suffix 'o' instead of 'c' to denote the open economy assumption.

Effectively, the supply curve for residual waste treatment rotates anti-clockwise. The key observation here is not only that the quantity of residual waste treatment increases further, but that the increase in non-landfill residual waste treatment is such that there is a reduction in the quantity of waste which is sent for recycling / composting / digestion. Effectively, what happens is that instead of landfill providing the benchmark figure for the avoided cost of residual waste management, this benchmark is supplanted by the cost of residual waste management, reducing the avoided costs of residual waste management by an amount 'd'.

Figure 5-4: Supply and Demand for Recycling / Composting / Digestion and Non-landfill Residual Waste Treatment (RWT), Reduced Costs for RWT, and Open Economy



Source: Eunomia

As can be seen there are many factors affecting the residual waste treatment market. The sensitivity of outcomes to the assumptions made is likely to be quite important not least since at £80 per tonne landfill tax, the incentive to build residual waste treatment facilities is not 'utterly compelling' (in the face of the commercial risks involved) but neither could it be considered completely foolish. There is a general feeling that the market is (depending upon who one speaks with) at, or close to, or beyond, a tipping point where waste will switch from landfill to other residual treatments.

5.2 Cross-Border Waste Movements

During the data gathering stage of the project it was determined that very little waste currently crosses the border with England, or other countries. Some hazardous waste is transported to find appropriate treatment facilities, but non-hazardous waste, such as residual waste, is nearly all treated or disposed of in Scotland. Therefore, it has been assumed that current waste movements are zero in the Baselines. Using data on costs of transport, and the locations for waste disposal in Scotland and the UK, some analysis follows that seeks to show the possible extent to which waste may travel as a result of changes in the level of the tax.

Raising the Scottish landfill tax to levels above that found in England could result, under certain conditions, in the increased migration of waste as waste operators search for cheaper disposal opportunities across the border. In order to determine what additional distance waste might move to take advantage of a given price differential, a model was developed to consider the likely cross border movements of Scottish business waste. At the margin, this waste stream is much more problematic for the Scottish Government to control. Local Authority contracts and waste movements are well reported on, and are in the public domain. If the Scottish Government were to introduce legislation requiring Local Authorities to dispose of waste in Scotland, it is unlikely that many authorities would wish to contravene this requirement and risk penalties or reputational loss. However, private sector waste movements tend to be more 'foot-loose', and tend to be more responsive to market signals. Therefore, it is expected that business waste is the main subject of this analysis.

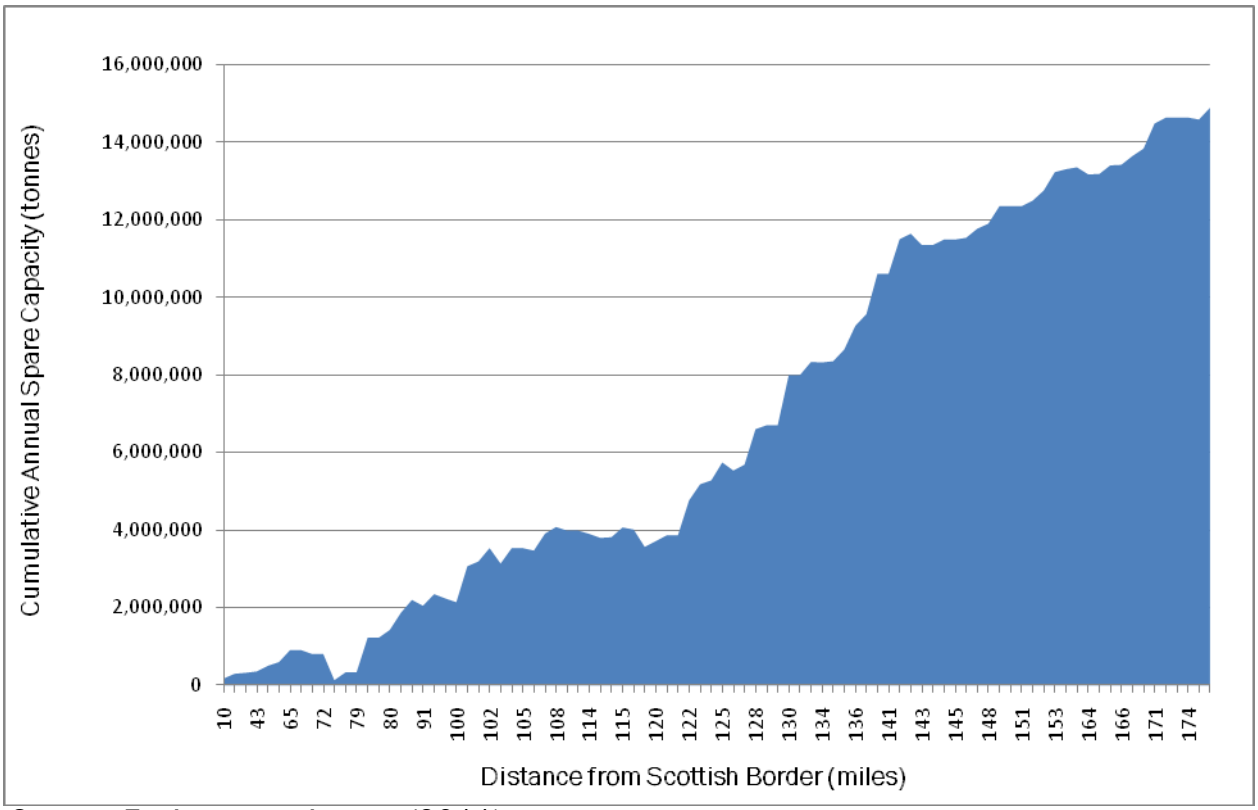
In summary the approach taken is to estimate:

1) The location of hotspots of waste generation and distance to the Scotland / England border;
2) The average annual unused capacity of landfills in England (permitted capacity less throughput);
3) The cost per tonne per mile of residual waste transport; and
4) The likely scale of waste movements from Scotland to landfills in England which might result from a given increase in the tax in Scotland.

Waste data was taken from the SEPA 2008 business waste survey for each waste management area. The distance from the main centre of population to the English border was then estimated.

The Environment Agency was contacted to obtain site return data and a list of all landfill installations in the EA's North West and North East Regions of England. The permitted capacity of these facilities was compared to the reported site return data provided by the individual landfills to determine the annual spare capacity within the different facilities. The distance, from the Scottish border, to each of these facilities was determined and the cumulative spare capacity with increasing distance was calculated, and plotted in Figure 5-5. It should be noted that the spare capacity reported here only provides a rough estimate of actual free capacity based on Eunomia's ability to match permitted capacities with the site return data. In a number of instances it was found that site return data exceeded the permitted capacity and in others no inputs to landfill were reported. The EA was contacted to confirm this and said that the discrepancy could be due to more recent changes in permitted capacities which had taken effect after the 2009 site returns data had been submitted (permit data was updated to April 2010). These data would have to be interrogated further, and individual discrepancies followed up with the EA, before an accurate assessment of the spare capacity in the North of England could be made. However, it is believed that the data presented in Figure 5-5 provides a reasonable reflection of the available spare capacity within 180 miles of the Scottish border. From this Figure it appears that significant spare capacity only becomes available after approximately 80 miles.

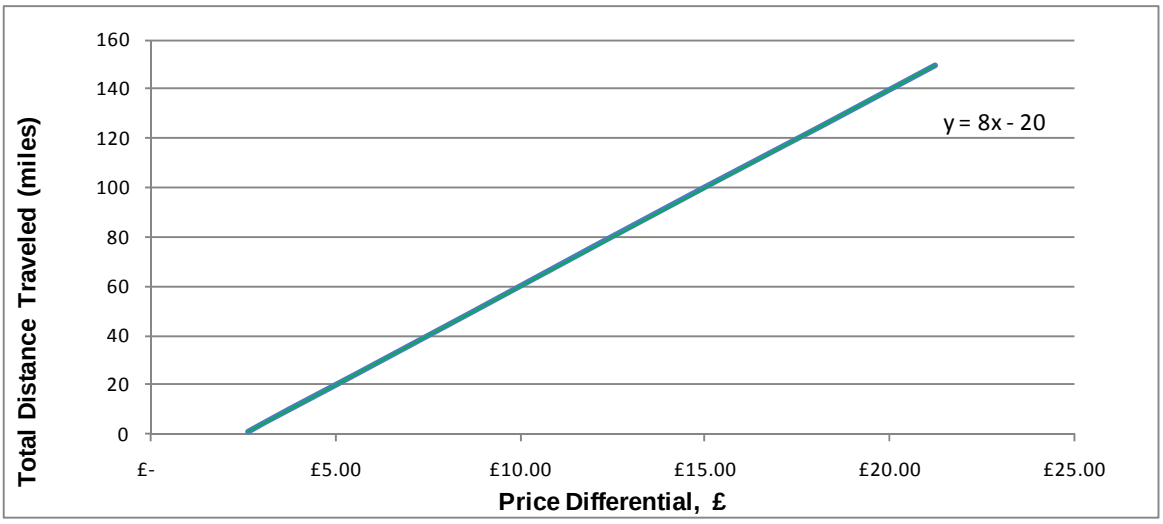
Figure 5-5: Cumulative Annual Spare Landfill Capacity with Increasing Distance from the Scottish Border, tonnes



Source: Environment Agency (2011)

Based on extensive internal experience and consultation with a number of local authorities Eunomia has estimated that the transport of this waste in an ejector trailer with a 20 tonne payload will be on average £2.50 per mile (or £0.13 per mile per tonne). Thus, for every £1.00 increase in the landfill tax, waste destined for landfill could travel an additional 4 miles (8 miles round trip) to take advantage of cheaper taxes. Taking into account a one off average bulking charge of £2.50, for every tonne of waste transported, the relationship between transport distance and cost was determined (Figure 5-6).

Figure 5-6: Relationship between Cost and Transport Distances



Source: Eunomia

Based on existing knowledge of gate fees, the stakeholder interviews carried out in the early part of the study and some more targeted interviews with landfill operators it can be shown that on average gate fees for significant proportions of Scottish waste landfilled in Scotland are a few pounds cheaper than those of northern England. However, the range in gate fees is much higher in northern England compared with the central belt. Any existing disparity in the price of landfill would be included in the economic incentive for businesses to transport waste to England for disposal or recovery, but this differential is uncertain. Median figures suggest a slight difference in the cost of landfilling though the costs of non-landfill treatments may alter this balance the other way. Therefore, it was assumed that other price influences resulted in a net zero balance of costs between Scotland and England.

The average distance of each Waste Strategy Areas to the Scottish border was then fed into the model.[38] Based on these figures and the above transport costs it was determined, for example, that a higher level of tax in Scotland, in the order of £11 per tonne, would enable waste from Dumfries to reach the border (50 mile round trip). Any increase above this value would assist in shifting the waste further into England: up to 25 miles at £17 and as far as 85 miles if the difference in taxes were raised to £32.

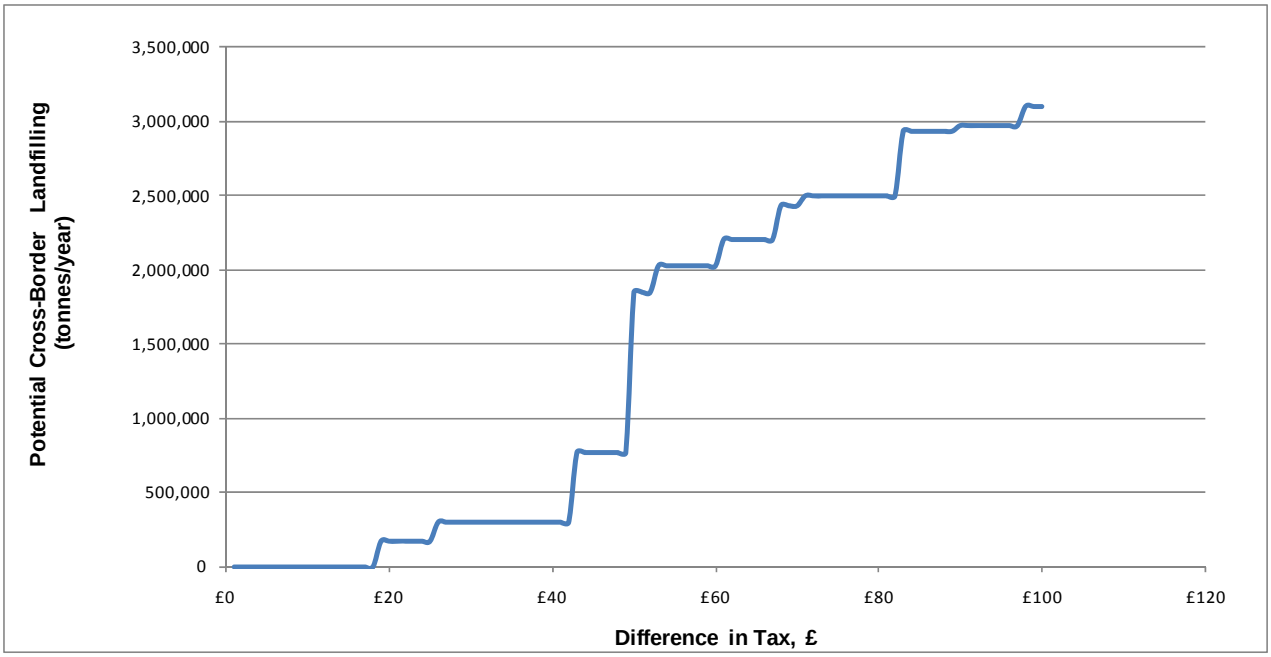
The Scottish business waste arisings were analysed in the model and a worst case scenario was assumed where all the arisings would be exported if it became economically viable to do so. In such an instance the waste will be used to fill all void capacity before being forced to move further afield. The potential rate of cross-border landfilling, as the price differential between Scotland and England's landfill tax and gate fees increases, is shown in Figure 5-7 (based on 2008 business waste arisings

[38] This was taken to be the distance between Gretna on the M6/M74 corridor and the central major city of each area, i.e.: Lochgilphead, Dumfries, Glenrothes, Stirling, Glasgow, Inverness, Edinburgh, Aberdeen, Stormness, Dundee and Stornoway.

and assuming that around 40% of C&I waste is landfilled). From this Figure it is evident that there will have to be a price difference in excess of £16 before void space in sufficient proximity in England makes it economically viable to shift waste into England.

As the differential increases an increasing amount of void space comes into play, but only if the price differential exceeds £40 per tonne does the quantity which is likely to move across borders increase significantly. This is due to the fact that only limited capacity is available in close proximity to the border (Figure 5-5). Even at £40 per tonne only waste arising in Dumfries can economically be transported beyond 60 miles of the border. Any waste arising in Stirling, Glasgow or Edinburgh will only make it 50 to 60 miles over the border. However, if the differential increases to close to £80 per tonne, then virtually all of the mainland business waste arisings destined for landfill may potentially leave the country.

Figure 5-7: The Potential Cross-Border movement of Scottish Business Waste Destined for Landfill, tonnes per year



Source: Eunomia

There are of course some uncertainties with this kind of modelling. The accuracy of the waste data, the potential for landfills to expand beyond their permitted capacities, local and national contractual arrangements, the relative pricing and availability of alternatives, the capacity of rail transport and the propensity to export waste to other EU Member States for recovery, amongst others. Notwithstanding rail transport and UK export, which are discussed below, there does not appear to be a significant amount of waste that would cross the border at low levels of increase in the tax. It is a question for the Scottish Government to decide what level of cross-border waste movements, if any, is politically acceptable, and therefore what other interventions may be required. One potential option, in the form of a border tax, is discussed in Section 6.3.6.

5.2.1 Transportation by Rail

This is much more difficult to understand. Costs are considerably less, per tonne mile, than road transport, but they heavily depend upon access to rail-heads. If the rail-head is available then distance is less of an issues then, so significant remaining landfill capacity across England and Wales could become available. Rail-heads clearly do exist but the location of them, and any operational and contractual arrangements, are not known. In addition, some road transportation would also be required adding complexity to the modelling.

Personal communication with Freightliner Heavy Haul Limited resulted in obtaining some estimates of the costs of rail transport. Table 5-2 shows that there is a fairly linear relationship between cost and distance travelled, and that the cost per tonne decreases as the contracted tonnage increases. These costs do not include loading and unloading costs at the rail head. We were told that these range from insignificant to significant depending on the contract. No additional information could be provided because of the large variation in potential arrangements. For the purposes of considering the up-take of rail haulage, as a result of differential tax rates between Scotland and England, high and low figures can be taken. For rail head costs low would be near zero and would be the same costs per tonne as the rail haulage itself. Thus the costs per tonne of waste haulage could vary between around £7 and £60, depending on the distance travelled. Even at the low end (50 miles) there is some potential spare landfill capacity in England (Figure 5-5). Thus even low tax differentials could stimulate the migration of waste from Scotland to England.

Table 5-2: Potential Variation in Rail Haulage Costs by Size of Contract and Distance, Cost per tonne, £ 2010 Real Terms

	Tonnage				
Miles	50,000	100,000	300,000	500,000	1,000,000
50	£11.94	£8.89	£7.78	£7.64	£7.38
100	£14.26	£11.21	£10.11	£9.97	£9.71
200	£17.91	£14.86	£13.75	£13.61	£13.35
300	£23.45	£20.40	£19.30	£19.16	£18.90
400	£29.29	£26.24	£25.14	£25.00	£24.74

It goes beyond the scope of this study to undertake a detailed assessment of the rail infrastructure in Scotland. The costs vary considerably between contracts depending on the ownership of infrastructure, and the like. Therefore, it is not possible to comment with any certainty on the potential for rail-hauled waste to be landfilled in England as a result of the tax. One could estimate that the resulting flows of waste may be similar in pattern to that described for road transport taking all factors into consideration.

5.2.2 Summary

In summary, at tax differentials of somewhere around £15 to £20 there is not likely to be any significant migration of wastes by road. Once the differentials increase above this level waste exports may find cheaper alternative routes by being transported by road to landfills in England, and at above £40 per tonne the movements could become significant. For rail transport the situation is more finely balanced. At differentials of maybe even £5, some waste transport to England could be cost effective. One important caveat needs to be added at this point. There may be non-landfill residual waste treatments which become competitive at prices below the level of landfill plus tax, once the tax reaches £80 per tonne. There are a number of planning applications made, some successful, others being determined, in the North of England, and it is not impossible that these regions may be over-supplied with capacity in the future. If this happens, then of course, the price differential between Scotland's landfills and England's treatment facilities may be wider than has been predicted here, and waste may well flow not to English landfills, but to English incinerators and other non-landfill treatments. Low cost exports have similar effect to differences in price between Scottish landfills and English treatment facilities.

A full quantitative analysis of the latter points is not currently possible because of the lack of data required to undertake such an analysis. The key message is that if there are any differentials in tax there is some potential for waste to migrate from Scotland to England. If policy makers are keen to ensure that this movement is restricted then options to inhibit this practice are recommended. Some potential options are discussed in Section 6.3.6.

5.3 Data

Developing the two Baselines has proved to be challenging and time consuming. The quality of data, especially regarding the wastes not collected by local authorities, appears to remain low and margins of error are still high. Whatever the level of accuracy of site returns for landfilling of these wastes (and we suspect that this data is not entirely accurate to the extent that it might capture some wastes which are not actually landfilled), we note the following issues:

1) The different datasets on commercial, industrial and construction and demolition wastes are extremely difficult to square against each other. These datasets would benefit from cross checks as to their internal consistency;
2) There is little data which is available for use regarding the composition commercial, industrial and C&D wastes. We have had to rely on other sources for compositions, but this data is also difficult to make consistent with the other information available regarding the quantity of waste available and the supposed pattern of its management (which is generally not well known);
3) There appears to have been no attempt (ever, in any part of the UK) to square the figures from HMRC from tax returns with the figures from the relevant agencies, in this case, SEPA, regarding site returns from landfill operators;
4) Related to the above, it is not clear to what extent which specific materials are being landfilled, but are being exempt from the tax. HMRC returns suggests that almost a quarter of all waste landfilled at sites for which a return is required is

landfilled without tax being paid, so that a large proportion of waste is simply not affected by any changes in tax other than those which change the existing rules for exemptions from tax. Obviously, this problem is compounded by the paucity of any decent composition data regarding some key waste streams, but the problem would remain even if the composition data was accurate because we simply do not know which materials, in which quantities and in which form are being landfilled but are being exempted from tax. There may be other material which is landfilled, but at sites which are not required to register for tax. None of this information is available in a relevant and useful form, still less for Scotland specifically.

However, it is also noted that the Climate Change (Scotland) Act 2009 included the basis for increasing the quality of waste data reporting, especially in the C&I and C&D sectors, and that the Scottish Government are therefore seeking to address some of the data issues discussed above.

5.4 Behavioural Responses in the Baselines

The Baseline modelling requires some estimation to be made of the way in which actors will behave in response to either the landfill tax alone, or the landfill tax as well as the policies proposed under Scotland's Zero Waste Plan. Modelling these Baselines requires a projection into the future of the behaviour of different actors in respect of their waste management activity. The basis for making these projections is not well established. Our review of models used to estimate the effects of landfill tax shows that in principle, only two approaches are used:

5) The first (used in the HMRC model) is based upon an estimate of changes in the quantity of waste landfilled, and is not especially concerned with the fate of the waste diverted from landfill. There is one model which extends this and is based upon a matrix of own- and cross-price elasticities, but this matrix needs to respect different waste streams, which are governed by different relative prices; and
6) The second (used in LAWRRD, but only for local authorities) is based upon synthetic cost curves. The outcomes are strongly influenced by the relative prices of the options being modelled.

The evidence base for either approach is not completely clear. We have sought to use a combination of these approaches. However, reflecting the above discussion, it is not always clear exactly to which wastes the tax is likely to apply (because of the exemptions from the tax, and other reasons for difference between the information in site returns and tax returns).

Another complicating factor is the way in which the market for residual waste treatment is likely to affect the modelling. Much of the modelling is based upon trying to understand the extent to which the changes in landfill tax drive change in recycling behaviour. The complicating feature is the supply curve for residual waste treatments. There is a generally held view that the landfill tax will – at £80 per tonne – be at a level where other residual waste management options become cost-competitive. Although, in principle, it might appear straightforward to model such a supply curve, the reality is that:

a) The range of such treatments is becoming broader by the day, and some of

the technically more challenging solutions may well be the less costly if they can be shown to deliver reliable performance in future; and

b) The costs for the treatments are not so well known, and whilst there is a presumption that economies of scale do exist, the fact remains that there are a wide range of other factors which affect costs.

The position of these supply curves is important in understanding the likely outcomes, especially under the BaU Baseline, but also under the changes in tax examined.

6.0 Description of Scottish Landfill Tax Model

In this section of the report the principal quantitative tool developed for this study is described. This tool enables us to model the following policy option:

- Increase Level of Standard Rate Tax;

Some of the data that would help to understand aspects of the following options are also provided in the model:

- Increase Level of Lower Rate Tax;
- Lower Rate for Stabilised Wastes;
- Introduce Incineration Tax.

As discussed throughout this report, the current policy environment creates significant levels of uncertainty in modelling the effects of changes in landfill taxes. Therefore, the three additional policy options indicated above cannot be modelled with much accuracy, and as such a qualitative approach to assessing the policy options is preferred.

The model is described further in Section 6.1. In Section 6.2 the baseline modelling is described, and finally in Section 6.3, a description of how the option to model increases in the Standard rate of tax is given. The results from this model are then given in Section 7.0. Following this, in Section 8.0 the final set of policy options indicated in Section 4.0 are described further and in a qualitative fashion.

6.1 Introduction to Scottish Landfill Tax Model

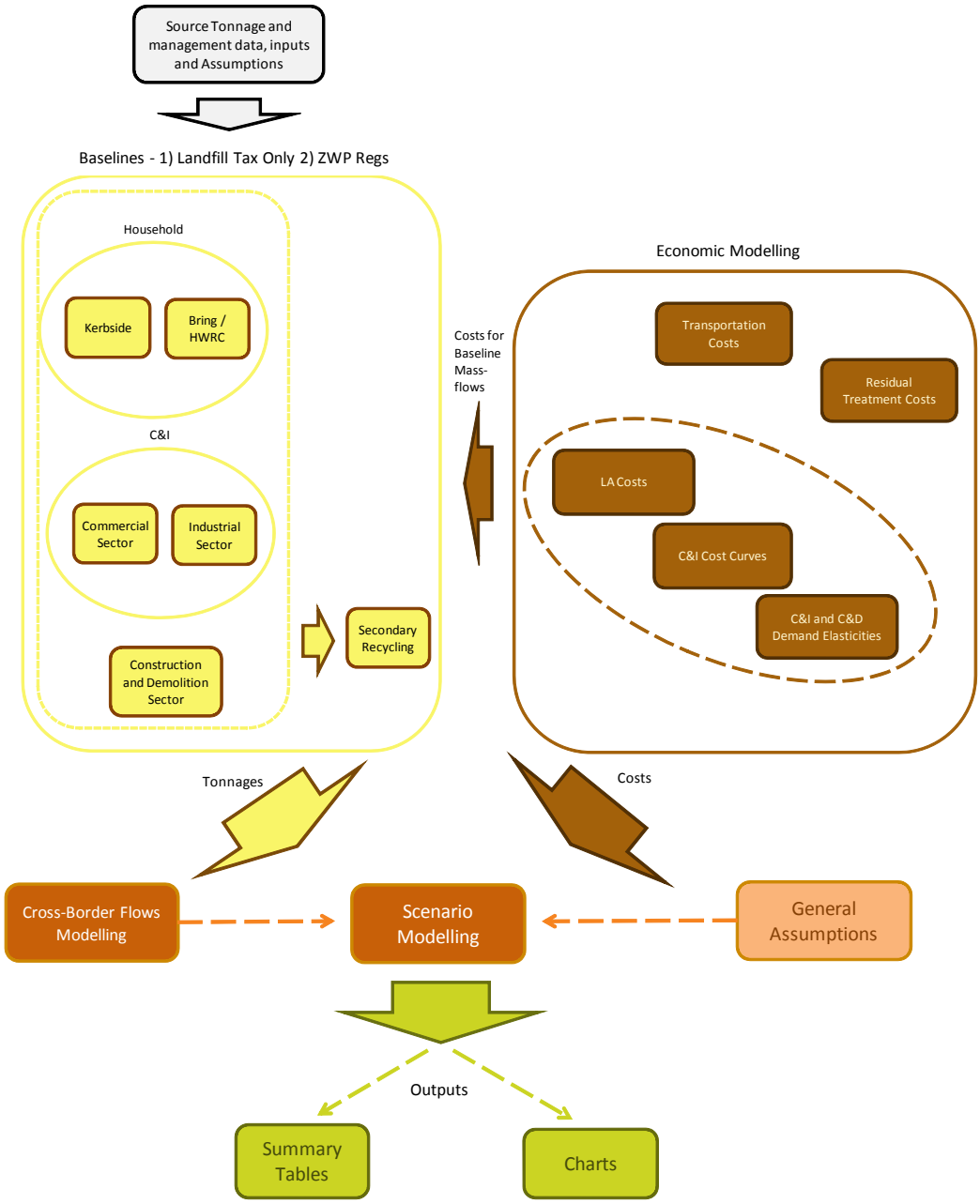
6.1.1 Overview of Approach

The approach to building a Scottish specific landfill tax model has been to produce an Excel© based spreadsheet model from first principles. An overview of the model is given in Figure 6-1. The key elements are then described in the text below.

All options have been modelled against two baselines. One is where the landfill tax is the key driver, and in the second baseline the Regulations being developed to underpin Scotland's Zero Waste Plan (ZWP) are assumed to be in force.

The primary aim is to ascertain the effectiveness of any of the proposed policy interventions against the *status quo* situation and the full Regulations of the ZWP.

Figure 6-1: Landfill Tax Model Flow Diagram



Source: Eunomia

In essence, the model comprises source data sheets, general assumptions, mass flow baselines, economic modelling (to drive the baselines and scenarios), cross-border waste flows modelling, scenario modelling and reporting outputs.

The historic data is used to provide a basis for forecasting waste quantities and management from 2008 to 2025. Different approaches have been used to model the projected waste flows and management routes for the business as usual (BAU) and Zero Waste Plan baselines (ZWP), and for the different waste sectors.

The key elements of the projections, in terms of the quantity of waste, and how it is

managed in future, are:

1) the current situation with regards to waste management practices;
2) expected waste growth; and
3) the modelled change in waste management practices in response to the policies that are expected to be in place.

To model the effect of the existing landfill tax escalator in the baseline, and in the policy options, multiple economic approaches were taken. In essence there are three main elements:

1) macro level modelling of Scottish Local Authority waste using an in-house kerbside collection model, to understand how the overall service cost changes as recycling rates increase;
2) cost curves constructed from bottom-up analysis of the commercial waste sector; and
3) the use of the own-price elasticity of demand for landfill services for other wastes.

For the cost curves the approach will be used to estimate a function such as that indicated in Figure 6-2. The basis of the principle is that behaviour is driven by the price of goods and services, in this case the cost of disposal (landfilling). As the cost of landfilling increases, and when it becomes cost effective for them to do so, economic actors (businesses) will sign-up to recycling services. The baselines are used to provide the current recycling rate (R_0). P_0 is known, so this point on the curve can be 'benchmarked', to some extent. To estimate future recycling rates, either resulting from changes in the current escalator, or the policy scenarios, the approach then is simply to increase the cost of disposal (from P_0 to P_1) and use the function of the curve to calculate R_1.

The Price Elasticity of Demand (commonly known as just price elasticity) measures the rate of response of quantity demanded due to a price change. The formula for the Price Elasticity of Demand (PEoD) is:

PEoD = (% Change in Quantity Demanded)/(% Change in Price)

The demand elasticity approach to estimating the changes in waste management resulting from increases in the standard rate of tax is as follows:

- Select demand elasticity;
- Calculate % Change in Quantity (of landfill) Demanded;
- Estimate destination of non-landfilled waste (i.e. recycling or residual treatment).

To understand this approach, an example is given below in Figure 6-3. As the price of landfill increases (blue line) the elasticity equation calculates the demand for landfill (red line). The change is then apportioned to either recycling or residual treatment.

Figure 6-2: Example Cost Curve and Approach to Estimating Relationship between Price of Landfill and Recycling Rate

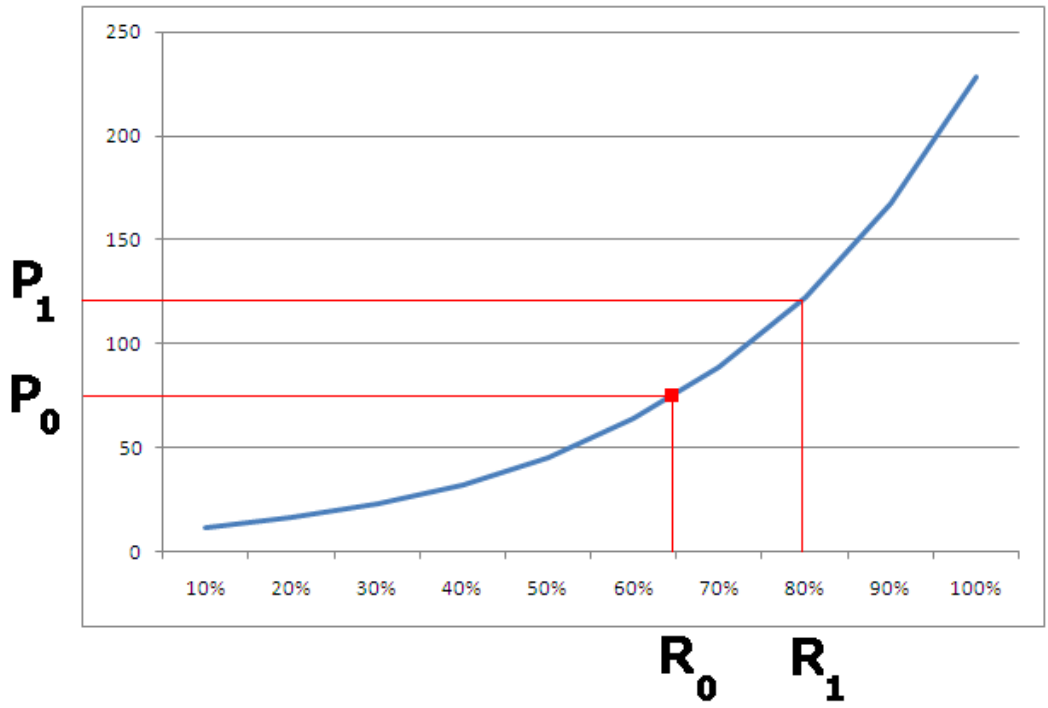
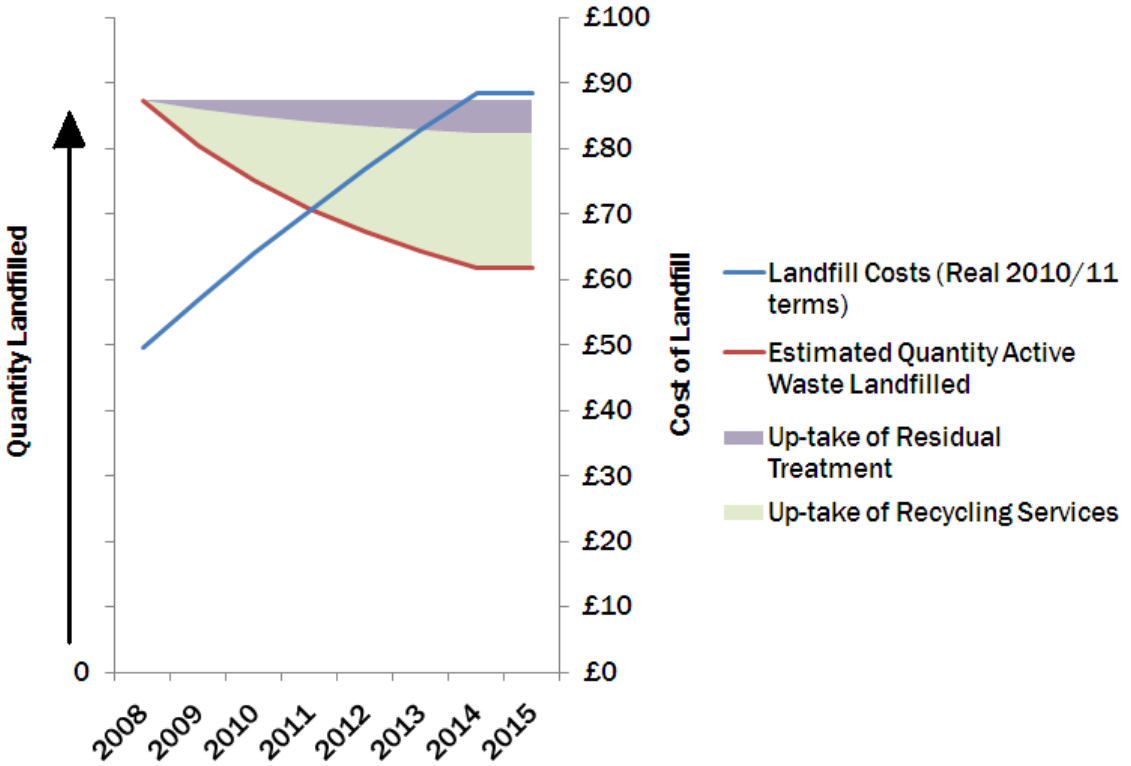


Figure 6-3: Example Demand Elasticity Approach to Estimating Relationship between Price of Landfill and Waste Services



The current situation is described forthwith, followed by a description of the approach to modelling waste growth, and finally, insight into the approach to modelling how the policies under the two baselines affect the behaviour of the waste management industry.

Once the description around how the baselines have been modelled is complete, further detail on modelling the policy option to increase the standard rate of tax is given.

6.1.2 Current Waste Management Situation

The mass flow modelling undertaken for this work is split between household waste, commercial waste, industrial waste and construction and demolition waste. Local authorities collect household waste as well as some commercial waste. In this work, it is assumed that local authorities deal principally with household waste, and that non-household waste collected by local authorities is dealt with as commercial waste.

Municipal waste is deemed to be composed of household and a proportion of commercial waste (i.e. the 'other similar waste), in line with the revised definition of municipal waste which the UK has been asked to adopt by the European Commission. Some manipulation of data was required to ensure the data being used is consistent with the figures now being used by Scotland as targets for the quantity of biodegradable municipal waste landfilled in future years. This approach was agreed with Scottish Government.

6.1.2.1 Household Waste Data

The household waste arisings for the year 2008 and the recycling rates have been taken from the SEPA Waste Data Digest 10. Waste composition has been taken from the most recent compositional analysis of household waste in Scotland in 2009.[39] Further details are given in Appendix A.6.0. Combining the two gives information regarding the quantity of each of the different materials in the household waste stream, as well as the proportion of each of these materials which is being recycled. The fates (i.e. how waste is managed) in the current situation were also taken from the SEPA Waste Data Digests.

6.1.2.2 C&I Waste Data

Due to the distinct composition of the waste within the sectors, their differing growth rates and the different approaches to treatment, the commercial and industrial sectors were modelled separately. The data regarding waste quantities was taken from SEPA Waste Data Digest 10 and the recently published SEPA 2009 business waste survey. [40]

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[39] WasteWork and AEA, on behalf of Zero Waste Scotland (2009) *The Composition of Municipal Solid Waste in Scotland*, available at: http://www.wrap.org.uk/downloads/Scotland_MSW_report_final.54690ac2.8938.pdf

[40] WRc plc (2011) *Statistical Analysis of Scotland Business Waste Survey Data for 2009*, Final Report for SEPA, March 2011

To calculate the compositions of commercial and industrial waste two Welsh studies were used.[41] These provide a much greater level of detail than the Scottish Business Waste Survey. The waste fates were taken from the C&I waste survey. The composition of mixed waste being landfilled was then taken from the SLR study and used to break-down the mixed categories, and then re-aggregate to give overall sector compositions by material.

It should be noted that C&I tonnages are reported in calendar year so were converted to financial year using the following methodology:

$$FY_{n/n+1} = CY_n \times 0.75 + CY_{n+1} \times 0.25$$

where FY = Financial Year and CY = Calendar Year.

6.1.2.3 C&D Waste Data

C&D waste arisings data is taken from SEPA Waste Data Digest 10. More detailed composition and management data has been taken from a study by the Environment Agency in Wales.[42]

6.1.2.4 Uncertainties in Quantities Landfilled

We note that there has been some difficulty in matching the levels of landfilling predicted by the modelling in the baselines to landfill site returns submitted to SEPA. Detailed data by site and EWC Code was supplied to Eunomia. For 2008, with the arisings data from the published Waste Data Digests, and realistic recycling and recovery rates, the quantity and waste landfilled in Scotland is around 1.2 million tonnes higher than the site returns suggest (see Table 6-1).

[41] SLR (2007) *Determination of the Biodegradability of Mixed Industrial and Commercial Waste Landfilled in Wales* and Urban Mines (2007) Survey of Industrial and Commercial Waste Arisings in Wales

[42] Building the future (2005-06) *A survey on the arising and management of construction and demolition waste in Wales* 2005-06

Table 6-1: Variation between Modelled Landfill Quantities and SEPA Site Returns, tonnes

Sector / Waste Stream	Eunomia Baseline	SEPA Site Returns Data	Variation - Tonnage	Variation - Percentage
Household	1,782,716	n/a		
Commercial	3,027,568			
Municipal Categorisation	4,810,284	3,551,519	-1,258,765	-26%
Industrial	587,791	565,637	-22,154	-4%
C&D	515,599	548,976	33,378	6%

Source: Eunomia & SEPA Site Returns Data

One can see that the industrial and C&D categories match up to within acceptable error margins. However the quantities on mixed municipal waste differ to around 25%. In terms of waste data the error margin is relatively normal, especially when business wastes are included, however, the large quantities will have a significant impact on the projected revenues thus it is important to note.

There are a number of possible reasons why there is a discrepancy:

1) The site returns data is incorrect;
2) The household baseline data (from WasteDataFlow) is incorrect;
3) The waste is being exported to England; or
4) The generation, or non-landfill management rates, for commercial waste is incorrect.

The latter of these points seems the most likely. The error margins in the business waste survey are also large, and the management rates are not Scotland specific. Some waste may also be, currently, exported to England. Although the interviews with the stakeholders during the review stage of the project suggested that the baseline levels of cross-border waste movements are minimal. Notwithstanding the possibility that the stakeholder's interviews may not have had the whole picture, it is unlikely that over a million tonnes of waste is being transported to landfills in England without much knowledge of these quantities. For commercial wastes the baselines in the model have been left with the waste arisings data from the Waste Data Digests, and the recycling rates equivalent to those seen in England and Wales. The consequence is that the tonnages and revenues generated in the baseline are not accurate, but there was no obvious approach to squaring the different sets of data.

In terms of the inert materials, the site returns claim that is significant quantity of waste is landfilled at active landfills. This has been assumed to be landfilled at the lower rate, but the extent to which this is actually occurring is uncertain because of

the possibilities to further sort material, especially inert waste, prior to landfilling. Known as Landfill mining, operators can sort waste on tax-exempt areas at the entrance of landfills and remove certain materials that go on to recovery not landfilling.

The approach to estimating the quantity of taxable waste landfilled is as follows:

1) The proportion of UK municipal waste generation accounted for by Scotland is around 10%;
2) The same proportion of UK landfill tax revenues is taken to be equivalent to the tax take in Scotland only – this was approximately £100 million in 2009, which is aligned with the central estimate being used by Scottish Government and HMRC;[43]
3) Factors to represent a) waste landfilled with no tax receipts, b) active waste mixed in inert (and therefore not taxed at the standard rate) and c) waste exempt from tax for engineering purposes etc, were set for 2009 so that the model out-turns were equivalent to the estimated tax take for Scotland only.

It should be noted that the above assumptions may, in our view, underestimate the revenue-take accounted for by Scotland (there is no Scotland-specific figure for landfill tax revenues available from HMRC as the revenue receipts are based upon reporting a company level rather than by landfill site). The proportion of waste UK municipal waste *landfilled* in Scotland appears higher (15%) than the contribution to the total UK municipal waste arisings (10% - see point 1) above) , so basing estimates of tax take on contribution to (municipal) waste arisings will not necessarily give the best basis for estimating the likely tax take in Scotland.

6.1.3 Growth Rates

The following forward projections were applied under both the BAU and ZWP baselines (and were agreed with the Steering Group):

- **Household waste:**

  A 0% growth rate in total household waste was applied;

- **Commercial waste:**

  There is considerable uncertainty about the quantity of commercial waste generated in landfill (and its management). Two data sources have been available: The SEPA Waste Data Digest, and the data from the 2009 business survey. We have used the data from the Data Digests. The most recent data shows a significant drop (14%) in commercial waste arisings for 2009 relative to 2008. This is likely to be attributable, in large part, to the decline in economic activity in Scotland in this period. We believe that the background trend in commercial arisings – to the extent that this can be known with any

[43] The HMRC Landfill Tax bulletin includes two sets of figures 1) Net Tax Declared on Trader Returns and 2) Total Receipts. The former was used as it reflects what should be paid, not what receipts operators have managed to submit at the time of publication.

certainty - is broadly stable (or with a small annual increase), but have assumed that post 2009, arisings increase to a level between the 2008 and 2009 figures by 2014. Thereafter, we have assumed a 0% growth in commercial waste arisings;

- **Industrial waste:**

  The Waste Data Digests record a significant (20%) drop in industrial waste arisings between 2007 and 2008, and a further (13%) reduction between 2008 and 2009. This is likely to be attributable, in large part, to the decline in economic activity in Scotland in these years. We believe that the background trend in industrial waste arisings – to the extent that this can be discerned – is a decline of around 0.7% per annum. We have modelled a recovery in waste generation post-recession, but only to levels (by 2014) where they would have been with an annual 0.7% per annum reduction. Thereafter, we have modelled a decline of 0.7% per annum;

- **Construction and demolition waste:**

  The data used for 2008 comes from SEPA Waste Data Digest 10. The Data Digests record a significant decline in C&D wastes of 20% between 2006 and 2007 (i.e. pre-recession). A further 9% decline was recorded between 2008 and 2009. We believe that the potential for waste prevention in the C&D sector is significant, and have modelled a reduction of 0.7% from 2009 onwards.

6.2 Modelling the BaU and ZWP Baselines

In modelling the effects of BaU and ZWP Baselines, as discussed above, base data for the most recent year for which data is available were used and arisings were projected forward at the growth rates discussed in Section 6.1.3. The key issues in the modelling of projections relate to how the wastes generated would be managed in the years after that for which data was most recently available / estimated.

It is important to note that the BaU Baseline implies something beyond 'what happens today'. It actually demands the development of a projection for the management of waste which runs out to 2025/26, the final year for the analysis. This has to take into account the effect of a range of policies that have already been announced, such as the landfill tax. The approach and key assumptions made to develop the Scenarios is described in the following Sections.

It will be appreciated that there are limitations in the quality of the data even for current years. The development of projections into the future is, therefore, an exercise which requires some considerable judgement, and evidently, the projections are unlikely to be perfectly accurate.

6.2.1 Business as Usual (BAU) Baseline Projections

In developing the BaU baseline projections the key policy driving behaviour is the landfill tax. The tax is set to increase year-on-year by £8 per tonne until 2014/15, at which point, it will have reached a level of £80 per tonne. Therefore, some mechanism is required for estimating the effect of this policy. The way in which the policies affect the management of waste also form the basis for the estimation of the

costs of the scenarios.

6.2.1.1 Household Waste

For simplicity, household waste is effectively split into kerbside collected waste, and waste collected at bring sites / HWRCs. This implies that the overall service costs might be understated since they do not consider the relatively high unit costs of collection of waste as litter, or street sweepings, or bulky waste. We pick up again on this towards the end of this sub-section.

For household waste, a range of models were developed for the kerbside collection of waste. The modelling approach is described in Appendix A.7.0, and was designed to reflect a plausible evolution in the development of kerbside collection services, based upon what appeared to be 'typical' schemes in operation in Scotland. Models were developed for Urban, Rural and Mixed authorities and were based on systems described in Table 6-2.

Table 6-2: Collection Systems Modelled

Nature of Authority	Type of System (current)	Performance (% kerbside recycling)	Type of System (future)	Performance (% kerbside recycling)
Urban	Fortnightly dry kerbside sort / fortnightly comingled Free fortnightly garden in 33% of hhlds Weekly refuse in wheeled bin	25%	Weekly dry kerbside sort / fortnightly comingled Free fortnightly garden in 33% of hhlds Weekly refuse in wheeled bin	46%
Rural	Fortnightly dry kerbside sort / fortnightly comingled Weekly refuse in wheeled bin	14%	Weekly dry kerbside sort / fortnightly dry where comingled Food waste collected weekly on same pass where dry is kerbside sort, or on separate vehicles where dry is comingled Charged garden waste collection	56%
Mixed	Weekly dry kerbside sort / fortnightly comingled Free fortnightly garden in 70% of hhlds Fortnightly refuse in	32%	Weekly dry kerbside sort / fortnightly dry where comingled Food waste collected weekly on same pass where dry is kerbside sort, or on separate	60%

	wheeled bin		vehicles where dry is comingled Free fortnightly garden in 70% of hhlds Fortnightly refuse in wheeled bin	

The models were run to seek to identify, under the range of services modelled, what level of recycling was likely to be 'optimal' under the £80 per tonne tax rate. This took into account the expected response from households under well designed schemes, and reflected also the nature of the housing stock. It also had to account for waste composition: the composition from the study used includes a high proportion of wastes which cannot easily be targeted for recycling so that achieving high rates of recycling becomes more challenging.

Under the models investigated, the optimal level of recycling is the highest one achieved under the services implemented. In other words, where services are operated efficiently, then once the tax reaches £80 per tonne, the optimal level of recycling is effectively the highest one that can be achieved (within reason) using the services modelled. Additional recycling requires additional services, which we have assumed will not be introduced under BaU (but effectively have to be introduced under the ZWP Scenario).

In the BaU Baseline, however, it is assumed that not all local authorities achieve this level of recycling. The reason for this is that they are deemed to be constrained in what the recycling rates they are likely to achieve by their existing, or firmly developed plans, for the development of residual waste treatment facilities. This constraint has been applied in the following manner:

1) We have reviewed, using information from SEPA, the existing waste treatment facilities and the sources of their waste;
2) We have taken information from Scottish Futures and have identified those projects that are already in procurement. We have assumed that the capacities reported by them are a faithful reflection of what would be procured in the absence of the ZWP (i.e. under BaU);
3) We have assumed that (partly reflecting views that HWRC recycling will increase anyway – see below) under BaU the material likely to be delivered for treatment is residual waste from kerbside collections;
4) We have estimated the proportion of the kerbside collected waste that would be accounted for by the treatment facilities concerned (call this X%);
5) We have constrained recycling rates at local authorities such that they can reach a maximum of (100-X%) in future; and
6) These rates are assumed to be achieved in 2014/15 reflecting the view that the levels which landfill tax is expected to reach have been announced well in advance of this date.

These are somewhat simplistic assumptions, but they reflect the view of the Scottish Government that in the absence of the ZWP Regulations, there is an increased

likelihood that local authorities will opt for approaches which are less focused on recycling and waste prevention, and more focused on simply 'not landfilling'.

For each authority, the recycling rate achieved under the £80 per tonne landfill tax was then multiplied by the kerbside collected waste to give a recycling rate for all Scotland. The costs for kerbside waste collection for each authority were taken from the 'bottom up' modelling. The figure chosen for each authority was that which most closely resembled a) the system currently used by the authority concerned, and b) the rate which the authority is assumed to achieve (depending upon the constraint applied) in 2014/15. Again, this is a simplifying assumption. This gave the costs for each authority, and hence, the costs for all Scotland in the year 2014/15. The recycling rates and associated costs were assumed to remain constant in real terms, rising only with changes in the number of households.

The HWRCs and Bring materials are dealt with differently. It is expected that this material comes mainly from HWRCs. Under the BaU, approach, the existing capture rates for different materials have been estimated (from Waste Data Digest data and the composition analysis carried out for Zero Waste Scotland). A problem here is that we did not have access to recycling data that was split across Bring and HWRC routes. In the Waste Data Digests reporting recycling from bring banks and HWRCs as 'bring' has become a common way of reporting data, but we would encourage reporting of this data in more distinct categories in future. As such, we had to estimate the proportion of waste from Bring and from HWRC sites.

Under the BaU Baseline, we have assumed modest improvements in capture of the key materials generally targeted at HWRCs, especially where these looked low compared with what we have come to expect. This increases recycling rates of Bring / HWRC waste up to 2014/15, but not thereafter.

For the cost of managing this material, we have used figures for Bring and HWRC waste management from previous work for the GLA, and have added a 'marginal cost' of additional recycling at HWRCs reflecting improved performance and operation of HWRCs.[44] This figure has been based upon previous work for WAG, where we based the incremental cost of additional (over and above BaU) recycling on a model of investment of existing HWRCs.[45] This figure was updated to 2010 Sterling Values.

Regarding residual waste management, we are aware of facilities in place, those in construction and those with planning consent. However, with the LAS suspended, there are no incentives for local authorities to develop non-landfill residual waste treatment capacity other than the landfill tax. The tax is due to reach its highest known level in 2014/15, and actors have been aware of this for some time. We have assumed, therefore, no additional residual waste treatment other than that already being taken through active procurements. This assumes, effectively, that there is no

[44] Eunomia (2010) *Economic Modelling for the Mayor's Municipal Waste Management Strategy*, Final Report for the GLA, April 2010

[45] Eunomia (2007) *Scoping New Municipal Waste Targets for Wales*, Report for Welsh Local Government Association

meaningful merchant market of which local authorities avail themselves. There are reasons why this might indeed be expected (not least, the restrictions which apply EU-wide to local authority procurement) but the market might be less encumbered by the rigidities we have assumed. We have also assumed no major increase in export of residual household waste. The implications of this assumption are discussed in Section 5.1.

By 2014/15, Scotland's household recycling rate reaches 44% under these assumptions. By way of comparison, the figure for 2009/10 for local authority collected municipal solid waste was 37%, and for July 2009 to June 2010, they were 37.2%.[46]

6.2.1.2 Commercial Waste

For the commercial waste sector, the emphasis of the modelling has been on the changes in the costs of collecting and recycling the materials targeted by the ZWP. Under the BaU, we have used a model developed in house of the costs of recycling marginal tonnes of waste from the commercial sector, using data on Scotland businesses, to estimate how much commercial waste will be recycled at a given disposal cost. This allows us to estimate the recycling rate at £80 per tonne tax in 2014/15.

These models have been used for systems that collect:

1) paper and card, metals and plastics;
2) glass; and
3) food waste.

Clearly, other configurations for collecting commercial waste do, and will continue to, exist. The aim was to model a representative approach to collecting commercial waste, and to focus on those materials generally included in collections, and targeted for mandatory collection under the ZWP. The only material not being modelled which is targeted under the ZWP is textiles. This material is important in the context of the Carbon Metric, but under our estimation, textiles account for only 0.9% of commercial waste. As such, its role is not so significant. This is not to say that recycling of commercial textile waste is not important. Rather, it is to highlight the fact that the collection of such material is unlikely to be through the same types of service as paper and card, etc.

The first step in the process was to understand the business waste landscape. At the time of undertaking this piece of the research the 2008 SEPA business survey was the most up-to-date. From this the proportions of each business type, both commercial and industrial, were determined.

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[46] SEPA (2010) *Scotland Recycling Rate Rises Again as Less Waste is Sent to Landfill*, November 2010 http://www.sepa.org.uk/about_us/news/2010/scotland_recycling_rate_rises.aspx

Table 6-3: Waste Generation by Business Type in Scotland

Business sector	Percentage
Fishing	0.3%
Mining and quarrying	0.7%
Food and drink	7.2%
Textiles and leather	0.6%
Wood and paper	4.9%
Chemicals	4.1%
Mineral products	1.1%
Metal and metal products	1.3%
Machinery, vehicles and equipment	1.3%
Coke, oil, electricity, gas, steam	3.7%
Water, sewerage and waste management	4.4%
Miscellaneous industrial	0.5%
Retail and wholesale	22.9%
Transport and storage	2.3%
Hotels and restaurants	8.5%
Information and communication	2.1%
Finance and insurance	1.0%
Professional, scientific and technical activities	5.0%
Administration, real estate and other service activities	11.8%
Public administration	3.0%
Education	4.1%
Human health and social work	7.0%
Arts and recreation	2.4%
Total (tonnes)	100.0%

Source: SEPA (2008) Table 3: SEPA Commercial and Industrial Waste Producer Survey 2008

The total tonnages of waste potentially requiring collection for recycling for a reduced set of business types were then calculated. The same dataset was then used to calculate the quantity of waste arising per business per week, in kgs and litres, along with data on the number of businesses in Scotland.[47] Some adjustment was also made to factor in the number of sites a particular business has, and therefore the number of collections required, giving the relevant quantity per collection, as opposed to per business (which would have included collection from multiple sites in one go). Compositions for the different business sectors were derived from a number of different studies into C&I waste.[48,49] This then allowed the calculation of the generation of different types of waste per business sector. Reflecting the fact that not

[47] P. Wetherill (2008) *UK Business: Activity, Size and Location – 2008: Table A2.1*, Report for Office of National Statistics, September 2008

[48] Urban Mines (2007) *C&I Waste Survey 2007*, Report for WAG

[49] ERM (2003) *Carbon Balances of the UK Waste Sector*, Report for Defra

all waste is likely to be captured, maximum captures on the potential for recycling were set (see Table 6-4).

Table 6-4: Maximum Captures of Waste for Recycling (all business sectors)

Waste Stream	Maximum Capture
Paper	90%
Cardboard	90%
Metal	90%
Plastic	60%
Glass	90%
Food	80%
Garden	90%
Residual and other	0%

Source: Eunomia

At this point different waste streams were considered separately based upon the type of collection systems that would be used. Separately collected food waste, separately collected glass and comingled collection of paper, card, dense plastic and mixed cans, were modelled. For each collection type the following approach was taken.

1) Likely bin sizes were chosen based upon the volume of material requiring collection per week and a limit of 3 bins per site. This resulted in a calculation that determined how many bin lifts were required, per week, to collect all the material. This approach results in a realistic scenario where, on average, bins are not filled to high levels. The average fill rate for the different collection systems is around 50-60%.

2) To ascertain the likely costs for a business per lift an internal C&I collection cost model was used to determine the cost per lift per container for each of collections. The following assumptions were applied to estimate the cost per lift:

    i) The number of customers in each of the identified categories using a register of total VAT paying businesses;

    ii) The waste arisings, capture rates and compositions for different customer categories;

    iii) The type of container used by each customer determined by the amount of waste produced;

    iv) The frequency of collection for each service; and

    v) The typical time taken to move between customers and time taken to lift a container.

3) These costs, combined with an understanding of the tonnage collected, allowed the collection cost, in terms of cost per tonne of material, to be calculated per business type and size (measured by number of employees). A weighting factor was used to inflate the costs of collection based upon a non-marginal saving on

the avoided collection of refuse. For example, removing food waste from the refuse stream and requiring 1 additional collection does not necessarily mean that 1 whole collection (or bin) of refuse will be saved. In fact, only a proportion of the saving is expected for companies generating lower quantities of waste. If the company has 1, 2, or >2 lifts per week the avoided saving on the refuse is 30%, 50% and 100% respectively.

A cost curve was developed based on the assumptions and calculations discussed above. In essence this was achieved by ordering the business types and sizes from least to most expensive collections (based upon these, per tonne, collection costs). The relevant quantities of recycling that could be achieved for the different levels of costs were then plotted against the per tonne costs. This allowed the modelling to reflect the assumption that collections will happen in an economically efficient manner, collecting the 'cheapest' tonnes from easy to reach businesses initially, followed by the more 'expensive' tonnes. The trend of this relationship, or function, was then used to provide the relationship between tonnage recycled and cost of recycling. An example of this approach for glass recycling services is as follows.

The methodology described above is used to provide an estimation of the cost per tonne of glass recycling for a range of business sectors and site sizes (in the model, this results in 44 discreet costs and associated tonnages of glass – 11 sectors x 4 site sizes). For a range of avoided disposal costs a logical function is used to calculate whether each of the 44 quantities of glass will be recycled or not. In other words if the disposal cost is lower than the recycling collection cost the glass *will not* be recycled, and if it is higher then the glass *will* be recycled. The outputs of these calculations (Table 6-5) show, then, a relationship between landfill tax and recycling rate. These figures were then plotted, and the curve of best fit function mapped using the chart functionality in Excel. On can see the 'step-wise' nature of this calculation in Figure 6-4. The curve of best fit function is also presented on the chart along with the R^2 value.

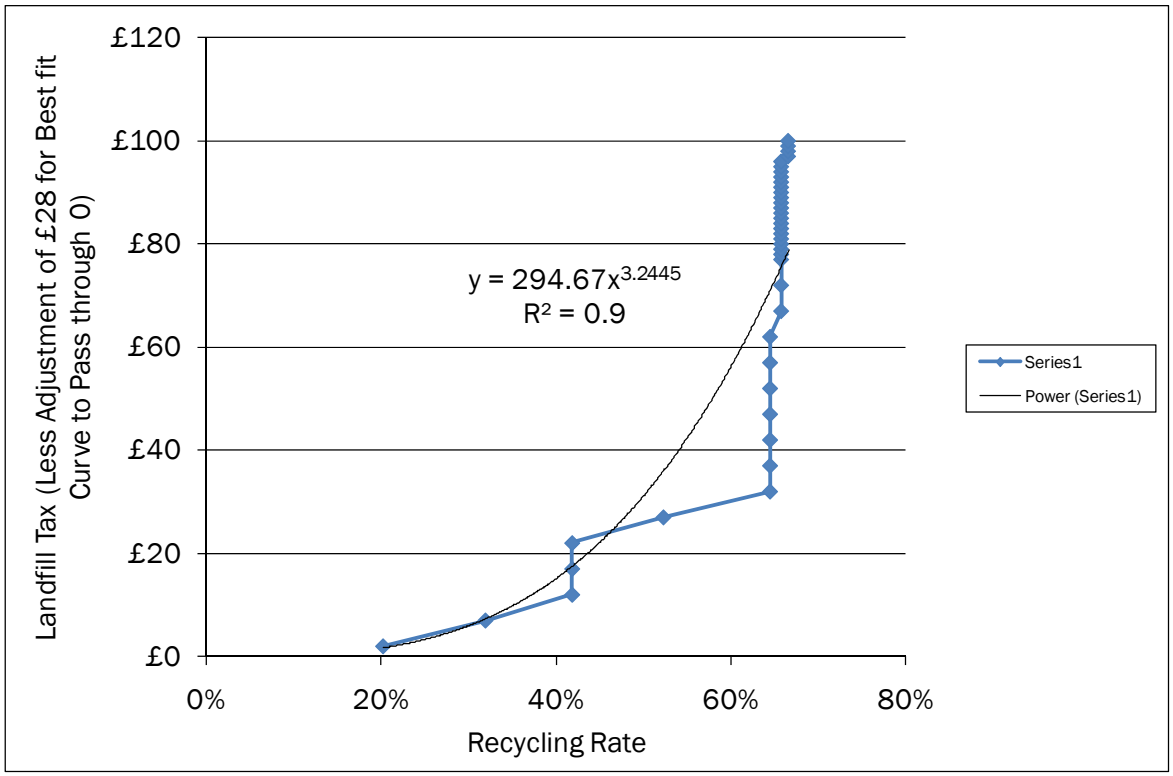
Table 6-5: Total Disposal Cost, Tonnes of Collected Glass Waste and Recycling Rate relative to Landfill Tax

Landfill Tax, £ 2010 Real Terms	Total Disposal Cost per Tonne, £ 2010 Real Terms	Tonnes of Collected Glass Waste	Recycling Rate
£30	£86.82	3,120,878	20%
£35	£91.82	4,934,044	32%
£40	£96.82	6,470,738	42%
£45	£101.82	6,470,738	42%
£50	£106.82	6,470,738	42%
£55	£111.82	8,086,835	52%

Landfill Tax, £ 2010 Real Terms	Total Disposal Cost per Tonne, £ 2010 Real Terms	Tonnes of Collected Glass Waste	Recycling Rate
£60	£116.82	9,976,085	65%
£65	£121.82	9,976,085	65%
£70	£126.82	9,976,085	65%
£75	£131.82	9,976,085	65%
£80	£136.82	9,976,085	65%
£85	£141.82	9,976,085	65%
£90	£146.82	9,976,085	65%
£95	£151.82	10,172,393	66%
£100	£156.82	10,172,393	66%

Source: Eunomia Landfill Tax Model

Figure 6-4: Cost Curve Function for C&I Dry Recycling Collections (Landfill Tax £ 2010 Real Terms



Source: Eunomia Landfill Tax Model

The costs of landfill plus tax effectively determine, in our model, the level of recycling achievement under a rationally functioning market for commercial waste collection. At that level of recycling, the models concerned give a cost per tonne for the recycling. This enables a cost for commercial waste recycling to be established from the quantities generated, and average cost per tonne figures.

This approach is based upon a number of assumptions, notably:

1) That the modelling is accurate (and even with best endeavours, it is probably only approximately correct);
2) That the market for waste collection follows a strongly 'economistic' rationale (it might not – decisions to have some materials collected might follow a different set of principles); and
3) That there are no market failures in the provision of, and uptake of, services (there are likely to be several, related to network effects, and information / search costs).

We have chosen to address the last of these through reducing the level of recycling which might otherwise occur in a market with no such failures. Effectively, this is achieved through reducing the level of tax which is assumed to drive the change in performance. Note that we have allowed this level to decline over time as we judge there are reasons to believe that information-related market failures are likely to become less important over time (this is likely to be especially under the ZWP Baseline, where the requirement to sort ought to induce actions on both suppliers and would-be users of a service to improve the quality and richness of the information available.

Evidently, the above approach does not account for all materials in the commercial waste stream, some of which may well be recycled with increasing success in future. For these materials, we have assumed that as the landfill tax increases, so there will be a corresponding reduction in the quantity sent to landfill (modelled through applying a suitable demand elasticity for landfilling waste, the figure used here being -0.5), and an associated increase in recycling and non-landfill treatment. In the central case, we have made a simplifying assumption that at levels of tax below £80 per tonne, recycling is still the dominant alternative for managing commercial waste. In other words, we assume that at these levels of tax, most residual waste is still landfilled. The implications of matters being other than is implied by this assumption are discussed in more detail in Section 5.1.

6.2.1.3 Industrial Waste

For the industrial sector any remaining landfilled waste is deemed to be in two general categories. Firstly, where single stream relatively homogeneous wastes are landfilled because no economic alternative exists, even with the announcement of the £80 per tonne tax, and secondly where mixed wastes are landfilled – the composition of this waste stream is assumed to be very similar to commercial type wastes. Thus any increases in landfill tax, in the baseline, only have an impact on this proportion of industrial waste. The tax does, however, have some driving force on additional thermal treatments of industrial wastes as alternative processes start to become cost effective.

6.2.1.4 Construction and Demolition Wastes

Finally, for the construction and demolition sector increases in recycling are driven using a simple demand elasticity approach. For active wastes still being landfilled, an assessment has been of the extent to which they would be driven from landfill as the tax increases. An elasticity of -0.5 has been used for this waste stream. Of the waste diverted from landfill 80% is assumed to go to recycling and 20% to thermal treatments (of wood for example).

6.2.1.5 Landfill Directive Targets

Included in the BaU Baseline is the assurance that certain European targets are met; such as the Landfill Directive targets which relate to the quantity of biodegradable municipal waste (BMW) landfilled. The revised definition of municipal waste now being used by the UK has required some re-setting of the relevant targets. These targets were not obviously consistent with the quantity and composition of the commercial waste stream used in this model.

An approach to modelling the Landfill Directive targets, using data from SEPA as a benchmark, was developed. A methodology was devised that allowed the calculation of BMW using the SEPA site returns data as a benchmark, whilst also using total C&I arisings from the Waste Data Digest. The issue being, that when the calculations were first performed there was a significantly larger quantity of household or similar waste landfilled in the baselines, compared with the site returns data. This is discussed above. Table 6-6 describes the approach.

Table 6-6: Landfill Directive Targets - Methodology

Variable	Source	Formulae	Notes
Step 1: Tonnes Landfilled			
Total waste landfilled	Quarterly landfill returns	X	This is a known figure for 2008.
Total household waste landfilled	Waste data digest	Y	
Total commercial waste landfilled	Waste data digest + treatment assumptions	C	
Total industrial waste landfilled	Waste data digest + treatment assumptions	I	
% of commercial waste classified as municipal waste	Estimate	A	Due to the discrepancies in the data factors were included that enabled the unresolved baseline data issues to be compatible

% of industrial waste classified as municipal waste	Estimate	B	with the calculation of BMW targets.
Total waste landfill subject to landfill directive target	Calculated	X = Y + (A*C) + (B*I)	This calculation, then, ensures that the modelled tonnages landfilled equals the calculation made using the EWC chapter codes. The relevant factors are then used to make the calculations for future years.
Step 2: Tonnes of BMW sent to Landfill			
Total BMW Landfilled	Calculated	Data in Table 6-7 (below) applied to composition of residual waste.	Following the calculation of the total tonnes landfilled the tonnage of biodegradable waste sent to landfill is determined. Biodegradability factors are applied to each category of residual waste (Table 6-7). This percentage is known for the majority of categories, and is reflected below. The 'other' category is used as a variable to benchmark the baseline total tonnes of BMW to landfill against the total BMW figures calculated from the EWC chapter codes in the data sent to Eunomia. This results in a biodegradability of 20% in the 'other' category.

Table 6-7: % Biodegradability by Material Stream

Waste Category	% Biodegradability
Paper and card	100.0%
Dense plastic	0.0%
Plastic film	0.0%
Glass	0.0%

Waste Category	% Biodegradability
Ferrous metal	0.0%
Non-ferrous metal	0.0%
Textiles	50.0%
Wood	100.0%
Food waste	100.0%
Green waste	100.0%
Furniture	50.0%
WEEE	100.0%
Other	20.0%
Incinerator Ash	0.0%
Soil	0.0%
Aggregate	0.0%
Insulation & Gypsum based materials	0.0%
Hazardous site waste	0.0%

Source: Eunomia

Using this approach, and assuming the above changes and responses, under BaU, the Landfill Directive targets are met.

6.2.1.6 Waste Framework Directive Targets

The BaU Scenario was intended to be one where the targets in the revised EU Waste Framework Directive were met. These are set out as follows:

> *In order to comply with the objectives of this Directive, and move towards a European recycling society with a high level of resource efficiency, Member States shall take the necessary measures designed to achieve the following targets:*
>
> *(a) by 2020, the preparing for re-use and the recycling of waste materials such as at least paper, metal, plastic and glass from households and possibly from other origins as far as these waste streams are similar to waste from households, shall be increased to a minimum of overall 50 % by weight;*
>
> *(b) by 2020, the preparing for re-use, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of*

non-hazardous construction and demolition waste excluding naturally occurring material defined in category 17 05 04 in the list of waste shall be increased to a minimum of 70 % by weight.

The RWFD also includes a requirement for separate collections for the same wastes to be implemented by 2015. The Scottish Government's proposition on how this will be achieved is inclusion of separate collections in the ZWP.[50]

It is important to recognise that the first of these targets is ambiguous (does this apply to each material individually, or to the collective of the materials?), whilst the second target does not apply to all construction and demolition waste, as traditionally defined. For the first, we assume the target applies to the group rather than to each material individually. For the construction and demolition waste target, we have worked with the available data to ensure the calculations are made on the basis of the correct waste arisings.

In the BaU, the 50% (tonnage-based) target is met for the materials as a group and for household waste as a whole. It is met for all individual materials other than plastics, for which the material reaches a 31% recycling rate. It is worth noting that a 50% target specifically for plastics is quite challenging. In Scotland, 6% of plastics are considered to be dense plastics and 3% are plastic film. Household films will not be so easy to recycle, and they may increase the costs of recycling. If the 50% target is to be achieved largely from dense plastics, the implied capture required is 75%. The C&D waste target is exceeded by some margin in the BaU Baseline.

6.2.2 Zero Waste Plan (ZWP) Baseline Projections

In addition to the policy drivers considered above under the BAU baseline, there are targets in the ZWP, and regulations being consulted upon which will give effect to the ZWP. The targets include:[51]

1) A carbon based target system for re-use and recycling. Guided by Scottish Government, we have assumed the targets for all waste will be the same as the weight based domestic targets stated in the ZWP. Note weight based rates will still be calculated up until the introduction of the carbon metric in 2013. The targets are, therefore, as follows:
    i) 40% recycling/composting and preparing for re-use of waste from households by 2010;
    ii) 50% recycling/composting and preparing for re-use of waste from households by 2013;
    iii) 60% recycling/composting and preparing for re-use of waste from

[50] Scottish Government (2010) *Consultation Paper on the Consolidation of the Waste Management Licensing Regulations and Amendments arising from the Better Waste Regulation Exercise: Also incorporating Proposals for: The Transposition of the revised Waste Framework Directive*, Accessed 16th May 2011, http://www.scotland.gov.uk/Publications/2010/02/23140430/9

[51] Scottish Government (2010) *Scotland's Zero Waste Plan*, Edinburgh: The Scottish Government

households by 2020;

iv) 70% recycling/composting and preparing for re-use of all waste by 2025.

Note also that, although the 70% in 2025 target applies to all waste streams, the interim targets (2013 and 2020) apply to household waste only.

2) Maximum of 5% of waste to landfill by 2025 for all Scotland's wastes. It is not clear exactly how this will be implemented / enforced. It is not clear yet, for example, whether residues from MRFs, residues from residual waste treatment facilities, ashes (from thermal processes, waste- and non-waste-related), etc., are to be included or not. Given the lack of clarity, we have, by and large, sought to ensure that the pre-treatment requirement is respect, but that ultimately, how the residual waste treatment market unfolds may be determined by how the 5% figure is implemented (if, indeed, it is not more an aspirational target).

As far as the Regulations are concerned, there are 5 Regulations of significance:[52]

1) Source segregation and separate collection of specific materials from 2013 – the intention is that a requirement be introduced to collect the undernoted wastes separately:

A) Food waste, from households and business sectors, such as commercial kitchens, hospitality sector, food retailers and manufactures;

B) Paper/card, metals, plastics, textiles and glass from all sources.

We assume these will be implemented much as the 'requirements to sort' were assumed to be implemented in our earlier work on landfill bans. However, importantly, we assume that the 'requirement to sort' is implemented in such a way that the nature of the sorting infrastructure provided by local authorities is such that systems are efficient, and likely to deliver high captures (which does not, incidentally, demand a full specification of service, rather, a set of principles);[53]

2) A ban on the landfilling of source segregated wastes collected for recycling for the same materials described above from 2015.

We have assumed that this has relatively little effect – once materials are segregated for recycling, it makes little sense to pay to landfill them when the materials have a value. This type of clause is likely to become relevant only where:

- the system for collection / engagement with them is so poor that loads have to be rejected from reprocessors. This, therefore, suggests a need for quality collection systems; and
- the market for materials collapses, leading to issues associated with loss of markets, and potential over-supply in the market

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[52] Scottish Government (2011) *Regulations to Deliver Zero Waste: A Consultation on the proposed Zero Waste (Scotland) Regulations 2011*, available at: http://www.scotland.gov.uk/Publications/2011/02/09135833/0

[53] See Eunomia (2010) *Feasibility of Landfill Bans Research*, Final Report for WRAP, March 2010

Neither of these is especially straightforward to deal with in a high level modelling exercise such as this. We have not incorporated anything specific in the modelling to represent this;

3) *A ban on mixing separately collected recyclable materials from 2015.*

   This regulation is again difficult to model in a high level exercise as this. There are likely to be similar reasons why this would be unlikely to happen on a widespread basis (as discussed above), and much will depend upon the final form of the Regulation as to if, and if so, how, any facilities are affected by this;

4) *Restricting Inputs to Energy from Waste Facilities (Incineration, Gasification or Pyrolysis).*

   This regulation is still in development. The aim, as we understand it, is to have a 'second bite at the cherry' in respect of recycling. In essence, it requires some form of pre-treatment of waste prior to, or during, the process of its being combusted, or biologically treated. Materials of focus are likely to be plastics and metals. As such, we assume that two broad families of process are relevant:

   A) Thermal processes, which require sorting either as a separate step prior to processing, or sorting as part of a fuel preparation process. It should be noted that where plastics are included in this requirement, then quite apart from the recycling benefits which may be obtained, the biomass content of the remaining feedstock would be expected to be enhanced in line with the efficiency of separation of plastics. It should also be noted that some thermal processes consider the issue of plastics separation anyway as a means to reduce the chlorine content of the feedstock so as to reduce the level of corrosion experienced; and

   B) MBT / MHT systems, where no thermal process is involved, and where the recycling element is integrated into the process, and where the remaining materials may be sent to a range of different facility types, including landfill.

   For the purposes of this work, we have not modelled a 'specific' treatment facility of combination thereof. Rather, we have used a synthetic cost and environmental performance to reflect the costs and performance that might be expected of residual waste treatments where they are required to operate in line with the Regulations as loosely described above.

5) *A ban on the landfilling of biodegradable wastes from 2017.*

   This regulation is also still in development. Our understanding from SEPA and the Scottish Government is that this is now unlikely to be implemented through the mechanism suggested in the Consultation on the Regulations. For the purpose of this report, and without prejudice to the nature of a decision which is yet be made, we have assumed the ban would effectively be implemented through the following measures:

   A) A clear 'threshold' being established, in terms of respirometry, which, for the purposes of the measure, denotes the level at which waste is no longer to be considered as 'biodegradable';

   B) A certification scheme being introduced for MBT plants which seek to meet the

threshold;

C) A requirement to specify on the Waste Transfer Notes whether waste had been pre-treated at authorised facilities or was otherwise deemed to satisfy requirements; and

D) Landfill operators would be required to inspect Waste Transfer Notes to check that the waste is compliant. Any 'black bag' type waste would be rejected and directed to either incineration or accredited MBT plants.

This measure is discussed in somewhat more detail in previous work by ourselves.[54] The ban on biodegradable wastes going to landfill is modelled similarly for all sectors by ensuring that, in 2017, all residual waste, less 5% of material (other than where the nature of the material suggests this figure should be higher), is sent to pre-treatment plants such as MBT or thermal processes. If the processes generate energy through a thermal element, then some effort must have been made to remove recyclables before the thermal treatment begins.

The following sections describe how different waste streams are assumed to be affected in the ZWP Baseline. Note that in the Central modelling case, the timing of the Regulations is as stated above. Some consideration is given below to how the costs and benefits may change with a change in the timing of the introduction of the Regulations.

6.2.2.1 Household Waste

The key changes relative to BaU, in terms of recycling, are as follows.

1) At HWRCs / Bring sites (principally assumed to be HWRCs, with the role of Bring assumed to be diminishing over time as kerbside systems develop):

   the performance of the HWRCs is assumed to increase over time. This will be necessary in order to meet longer-term ZWP targets, so we have raised the capture of a range of materials over the period to 2025. There is reason to believe that the relative level of priority accorded to collection of different materials may be influenced by the weightings implied by the carbon-metric. Textiles, in particular, are likely to be targeted for recycling with a growing intensity. It remains to be seen, however, how effective the recycling (as opposed to recovery) of textiles can be, and much may depend upon how 'textiles' are classified. For example, some carpets are effectively multi-material items, and some carpet 'recycling' destinations might not always recycle 100% of the material sent to them. In general, the performance against the carbon metric might depend strongly upon how local authorities choose to report their waste composition (which materials / products are assigned to which categories).

2) For kerbside collected waste, the following approach is taken:

   i) Local authority collection services improve in their design, efficiency and their performance;

[54] Eunomia (2010) *Feasibility of Landfill Bans Research*, Final Report for WRAP, March 2010

ii) The cap which was applied, in respect of kerbside recycling performance, to those authorities with considerable residual waste treatment capacity either planned or already in place, is relaxed; and

iii) The captures of the materials being targeted reaches levels as set out in previous work.

3) Regarding organic waste treatment, we have assumed that the requirement to sort food leads to an increase in the quantity of separately collected food wastes.

4) Regarding residual wastes, we have assumed that all kerbside collected waste is no longer landfilled beyond 2017. We assume 6% of HWRC / Bring waste continues to be landfilled as we believe some residuals from such sites will not be appropriate for treatment because of their nature and / or physical size (or would be rejected, in any case, at the facility). We effectively assume that existing incineration capacity (that already in place) continues to operate. Evidently, these may have to modify themselves appropriately, but given the small tonnage associated with this, we have not modelled the change in costs (not least since it remains uncertain what these might be).

6.2.2.2 Commercial Waste

For commercial waste, we have assumed that captures of the dry recyclables targeted by the requirement to sort, and of food waste, increase to levels suggested in previous work on landfill bans. These captures lead to increases in recycling rates. From the cost curves developed above, it is possible to estimate the additional costs of this additional recycling – this material has a higher marginal cost than that collected under the BaU Baseline.

As for household waste, we assume that existing capacity for incineration continues to be used, albeit in a (perhaps) amended form. All other residual waste, less 5% of total, is deemed to go to non-landfill residual waste treatments.

6.2.2.3 Industrial waste

For industrial waste, we have assumed that as with commercial waste, captures of the dry recyclables targeted by the requirement to sort, and of food waste, increase to levels suggested in previous work on landfill bans. We assume that since much of the industrial waste is already being treated in various ways that the 'above BaU' recycling resembles 'commercial waste' so the same costs apply.

As for commercial waste, we assume that existing capacity for incineration continues to be used, albeit in a (perhaps) amended form. All other residual waste, less 5% of total, is deemed to go to non-landfill residual waste treatments.

6.2.2.4 Construction and Demolition Waste

For C&D wastes, we have assumed that as with C&I waste, captures of the dry recyclables targeted by the requirement to sort increase to levels suggested in previous work on landfill bans.

6.2.2.5 EU Targets

Note that under the ZWP scenario, we still consider whether the following European

Union Directive targets are met:

- EU Landfill Directive targets for BMW to landfill.
- EU WFD Targets for paper, metals, plastics and glass.

As might be expected, because under BaU, these are already met, then as might be expected, they are also met under the ZWP Baseline.

6.3 Modelling the Effects of Increased Levels of Standard Rate Landfill Tax

Similar methodologies used to model the baseline are also used to model those policy scenarios which are modelled quantitatively. As discussed at the start of this section the main policy scenario being modelled using the landfill tax model is that where the level of standard rate tax is increased.

Two main policy scenarios are:

1) £8 Scenario – Increase Level of Standard Rate by £8 per year to £88 in 2015;
2) £16 Scenario –Increase Level of Standard Rate by £8 per year to £96 in 2016.

The same approach is taken to model both scenarios. The approaches for each waste stream, in terms of the mass-flows, financials and environmental impacts, are set-out in the Sections below.

We have assumed that once it reaches its highest level in nominal terms, the real value of landfill tax is held constant. This means that in nominal terms, the tax increases with inflation (the long term trend is set at 2.5%) for each subsequent year. This is shown in Table 6-8. It should be stated that modelling has been conducted in real 2010 Sterling so that the real terms values are the ones used in modelling.

Table 6-8: Nominal and Real Terms Levels of Tax used in Scenario Modelling

Year	Standard rate - £8 Scenario (Nominal)	Standard rate - £8 Scenario (Real 2010/11 Terms)	Standard rate - £16 Scenario (Nominal)	Standard rate - £16 Scenario (Real 2010/11 Terms)
2015	£88	£78	£88	£78
2016	£90	£78	£96	£83
2017	£92	£78	£98	£83
2018	£95	£78	£101	£83
2019	£97	£78	£103	£83
2020	£100	£78	£106	£83
2021	£102	£78	£109	£83
2022	£105	£78	£111	£83
2023	£107	£78	£114	£83
2024	£110	£78	£117	£83
2025	£113	£78	£120	£83

Source: Eunomia Landfill Tax Model

6.3.1 Household Waste Recycling

The methodology used to calculate the effect of the tax on kerbside recycling in the Baselines effectively considered a roll-out of well-designed and relatively high performing collection systems. Without forcing the system design to be 'unusually expensive' (by including materials which are known to be expensive to collect, or by changing frequencies to those which might appear excessive), this showed that such that the £80 per tonne tax would be sufficient to drive Local Authorities (LAs) to invest in such high performing systems, if decision-making was rational from an economic perspective (and as long as the marginal benefits associated with avoided disposal were at, or higher, than those associated with landfill).[55]

[55] Some authorities already with treatment capacity may be confronted with lower marginal benefits, either because the gate fee for treatment is low (older facilities do tend to have lower gate fees), or

Therefore, there was a limit to how the 'cost curve' approach could be used for modelling household kerbside collected wastes. The market functions differently to the commercial waste collection market – householders do not directly 'feel' the changes in price, or indeed, have the choice to subscribe to a kerbside service or not. In our maximum performance scenario of the Baseline all households are already covered by the systems, whereas individual businesses take the decision to sign-up to a collection service or not, for a number of reasons. The modelling actually shows that within reason (i.e. without introducing overly complex systems) the overall costs of waste services will fall as the capture of recyclables increases once the tax reaches £80 per tonne (and in fact, some way before this for many authorities).

It seems reasonable to believe that efforts might intensify further once the tax increases beyond the £80 per tonne level. However, we expect this effect to be limited for the following reasons:

4) In the BaU baseline, the recycling performance is already 'constrained' by the approach to residual waste treatment. The higher tax would not affect this constraint;

5) In the ZWP Baseline, the recycling performance is already very high, reflecting the requirement to sort key materials which are the focus of kerbside collections. If the regulation is specified so as to elicit high capture of these materials (and we have assumed it is, partly because if it is not, then the 70% carbon metric target under ZWP will almost certainly not be met), then it seems unlikely that the increased tax will bring forward more recycling than already takes place under ZWP.

There are of course some additional improvements that could be made, in terms of the recycling performance of these materials, or by adding marginal materials to the collection service such as batteries, plastic films, WEEE etc, but the tonnages are expected to be low, in contrast to the high costs of collection and sorting.

We would still expect some influence on the performance of household waste recycling centres (HWRCs), especially relative to BaU. Local operators are likely to be able to make improvements, up to certain levels, and will be influenced by the cost of disposal. In the BaU baseline the increase in HWRC recycling was estimated to reflect well performing sites now. To model the scenario a simple relationship was obtained between the change in level of tax from 2007 to 2014 (£47 per tonne in 2010 real terms) and the estimated change in HWRC recycling (13%). Thus a factor of around 0.28% recycling per additional £1 increase in tax was obtained. This was used to

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because the nature of the payment mechanism in a contract is such that the authority does not really 'see' those marginal benefits (for example, if the nature of the payment is a combination of a flat fee and a tonnage based unitary payment reflecting only a part of the total cost). Payment mechanisms for residual waste treatment contracts tend to concentrate on the economics of the project under consideration rather than considering what the implication of the payment mechanism might be for the local authority's decision making process regarding waste management as a whole. If forward projections for residual waste are wrong – and historically, they have been radically over-estimated – then local authorities are likely to find themselves paying over the odds, and shunning obvious opportunities for recycling in order to fulfil tonnage based commitments to treatment contractors.

estimate the additional increase in household recycling from the policy scenarios – as discussed above no increase in the capture of materials from kerbside systems was modelled. Under the ZWP Baseline the effect of the tax would only be felt for materials not covered by the requirements to sort under the Regulations. Thus the effect is factored down on a pro-rated basis.

For the cost of managing this additional material, we have used figures for Bring and HWRC waste management from previous work for the GLA, and have added a 'marginal cost' of additional recycling at HWRCs reflecting improved performance and operation of HWRCs.[56] This figure has been based upon previous work for WAG, where we based the incremental cost of additional (over and above BaU) recycling on a model of investment of existing HWRCs.[57] This figure was updated to 2010 Sterling Values. The cost used in the study was £85 per tonne.[58] It has been assumed that there is no saving on the collection cost of the material now recycled, but that there is a saving equivalent to the avoided costs of landfilling (2010 real terms gate fee + landfill tax).

6.3.2 C&I Waste Recycling

In terms of modelling the increases in recycling that result from the policy scenarios the same approach to modelling the baselines was used. This is summarised in the following bullets:

- For commercial food waste the cost curve developed for the collection market was used. The curve estimated the response of the market to the increases in tax. This enabled the performance, and costs, of the commercial waste recycling system to be estimated at a given level of landfill tax;
- The same approach for commercial glass, and mixed dry recycling collections (plastics, paper and cans) was taken.
- For other commercial materials, a demand elasticity based approach was taken. The changes in tax from 2014/15 were used to calculate the resultant shift from landfill using an elasticity of -0.5. Of the proportion removed from landfill, 80% was assumed to go to reuse and recycling, as opposed to residual waste treatment processes; and
- For industrial wastes, much of the mixed wastes being landfilled at the active rate was considered similar in nature to the commercial waste stream. Thus to determine the change in recycling from the industrial sector the same proportional up-take in recycling, as calculated for the commercial sector, is applied to these industrial wastes of a similar nature.

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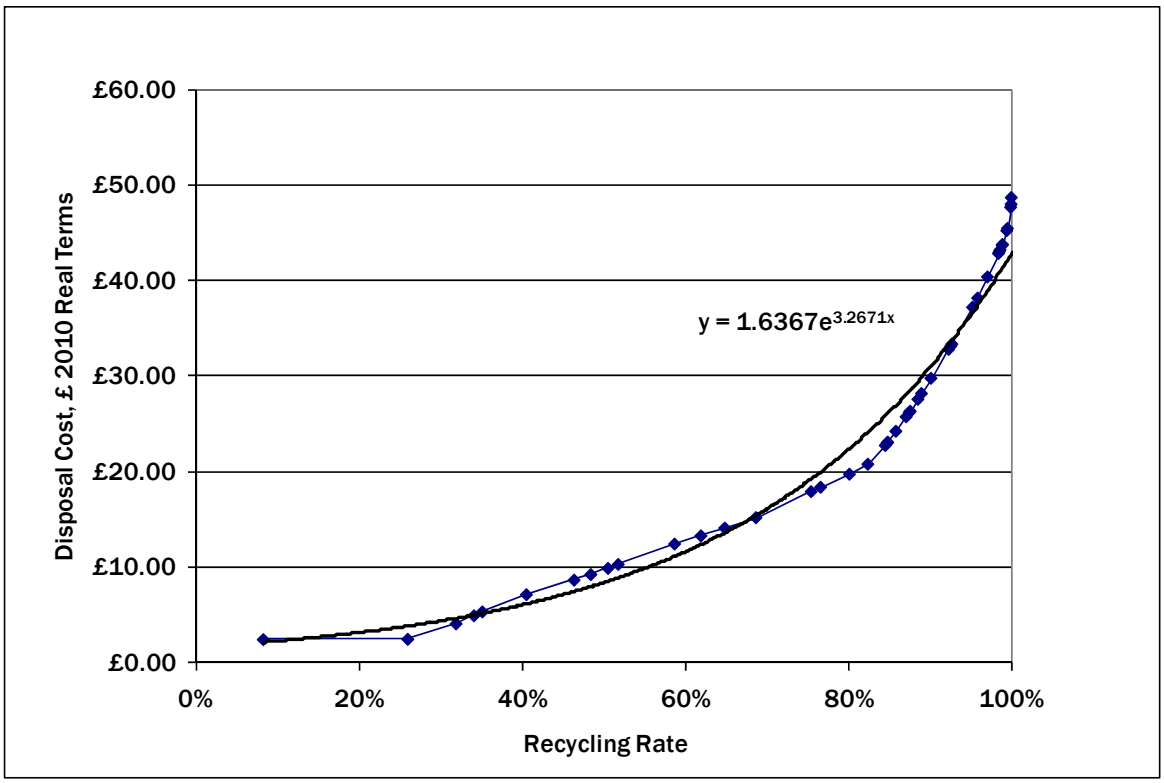
[56] Eunomia (2010) *Economic Modelling for the Mayor's Municipal Waste Management Strategy*, Final Report for the GLA, April 2010

[57] Eunomia (2007) *Scoping New Municipal Waste Targets for Wales*, Report for Welsh Local Government Association

[58] We appreciate that this is a crude approach to the modelling – ideally, the unit costs would increase as the recycling rate increases, more accurately reflecting the likely response to the tax.

To estimate the change in costs of the policy scenarios for businesses, the cost curves were also used. Average costs per tonne were calculated in a separate set of curves and functions, and then multiplied by the tonnage recycled to obtain the total cost of recycling in the baseline scenario, and the policy scenario. The difference in costs between the two was then taken as the cost of the policy. An example cost curve, and set of calculations, is given to demonstrate the approach.

Figure 6-5: Average Cost Curve and Function for Commercial Food Waste Collections



Source: Eunomia Landfill Tax Model

Figure 6-5 shows the cost curve and the representative function. A shift on the Y axis of around £110 was included to ensure the curve of best fit function operated correctly in the spreadsheet program. Thus the actual function that relates average cost to recycling rate is:

$$Y = 1.6367e^{3.2671x} + 110$$

The recycling rate for food waste under scenario 1.A, for example, changes from 42% to 48% as a result of the £8 per tonne increase in tax. Both recycling rates (x) are assessed using the function above to give the average cost per tonne (y). The average cost figures are then multiplied by the total tonnage recycled at 42% and 48% and the difference in costs taken, to estimate the change in costs resulting from the scenario.

For the costs of recycling other commercial wastes and industrial wastes, an estimated figure of £100 per tonne was used in the modelling.

6.3.3 C&D Waste Recycling

For active C&D wastes, a demand elasticity based approach was taken. The changes

in tax from 2014/15 were used to calculate the resultant shift from landfill using an elasticity of -0.5. Out of this change 80% was assumed to go to reuse and recycling, as opposed to residual waste treatment processes.

There is relatively little data regarding the cost of managing C&D wastes. In the absence of better data, we have based the costs of achieving higher rates (than under BaU) through a basic 'skip-based' model of C&D collections. The collection cost of collection of C&D waste has been based on the cost of skip hire. We have based the costs on the hire of a 6 metre cubed skip, containing between 1 and 3 tonnes of material, to be in the order of £150 - £250. This data is based on research carried out during a project for the Welsh Assembly Government.[59] This study found that the cost of C&D skip hire depends upon:

- Haulage costs (time to and from depot / destination of waste);
- Whether the material being collected is mixed or segregated;
- Where segregated, the nature of the material (and hence, the value obtainable for the material net of transport);
- Where mixed:
    - The nature of the material (density, composition etc.);
    - The location of the receiving destination and the fate of the material once it arrives. This is important since:
- Increasingly, mixed waste skips will not, in general, be sent direct to landfill but will be subjected to some form of sorting operation; and
- The efficiency of the sorting operation (and the nature of the mixed waste) will determine the likely quantity that is ultimately sent for disposal, and hence, the exposure of the overall load to landfill tax.

These costs will change in future for mixed waste skips, with the skip hire costs being affected by the unsorted fraction of waste which still needs to be landfilled. We have assumed that once the tax reaches £80 per tonne, a mixed skip sent for recycling will typically be sorted such that 75% of the material is recycled, re-used or recovered (as material, rather than energy). This type of segregation rate is not excessive by international standards and is used as an average rate for Scotland in future in the absence of better knowledge of the country-wide performance of such facilities (either now, or in future).

The nature of the material diverted from landfill is not known. Thus the average collection cost of a mixed skip has been used to estimate the costs. A figure of £70 per tonne of additional waste collected for sorting has been used.

[59] Eunomia (2010) *Site Waste Management Plans Cost Benefit Analysis*, Final report for the Welsh Assembly Government

6.3.4 Residual Waste Treatment Market

As discussed above, in Section 5.0, modelling the baselines, as well as these scenarios (which lead to changes over and above the baselines), is beset by a degree of uncertainty. In terms of the examples given above, it is the RWT supply curves that are difficult to describe and model with any certainty – the recycling/composting/digestion curves have been modelled with more certainty, albeit less so at higher levels of recycling. The uncertainty around the shape of the RWT supply curve means that the likely changes in residual waste treatment are difficult to estimate (both in the Baselines and in the policy scenarios modelled).

Therefore, the approach we have taken to modelling the effects of the tax increases is to take a scenario based method to effectively represent 3 different RWT curves. The change in recycling is firstly calculated by the approaches described in the preceding sections, then the level of residual waste treatment is increased in proportion to the additional quantity recycled. The following ratios then stipulate the additional diversion of waste from landfill to residual treatments. So under scenario i) if 10,000 tpa is diverted to recycling 2,500 tpa additional is diverted to residual treatment and under iii) it will be 40,000 tpa.

Recycling : Residual

i) 1 : ¼

ii) 1 : 1

iii) 1 : 4

The resulting changes in waste management behaviour are captured and the relevant costs calculated.

In terms of the costs of the scenarios, the changes in residual waste treatment were simply multiplied by an average non-landfill gate fee. Under the BaU baseline the backstop cost was assumed to be incineration at an average cost of £93 per tonne, and under the ZWP an average of the costs modelled in the Scotland CBA of the ZWP for MBT and MHT was used. The average figure used was £109 per tonne. As the up-take of different waste treatment processes is uncertain, assuming an average figure for all additional treatment was considered acceptable.

6.3.5 Resulting Changes in Landfilling

Following the calculations used to estimate the likely increases in recycling, the scenario approach to modelling the changes in the residual waste treatment market was then taken for each sector (see preceding Sections). If the changes in recycling were at such a level where the proportion of residual waste treatment estimated exceeded the remaining quantity of waste landfilled, the additional increase in treatment was truncated at this level. This, then, provided the full calculation of changes in landfilling resulting from the changes in tax modelled in the scenarios.

6.3.6 Exports and Border Adjustment Tax

As discussed Section 5.0 it is unlikely that there will be a significant migration of residual waste to landfills in England resulting from £8 or £16 per tonne increases to the landfill tax by road. However, the location and costs of alternative residual waste

treatment plants provides some uncertainty, as does the potential for waste to be exported to other EU Member States.

Thus, if certainty (in terms of *not* generating additional movements of waste) for the Scottish Government was a pre-requisite of introducing additional changes to the landfill tax (such that it differed in level from that set in England), some form of border tax adjustment, or equalisation tax, could be considered as part of whatever Regulations enact the Scottish landfill tax. The potential arrangements for this mechanism are discussed below. The authors note, in passing, that some form of arrangement might well be required as a result of the biodegradable waste bans or other mechanisms considered as part of the ZWP Regulations. If the requirement was for no Scottish waste to be sent to landfill where it exceeds a certain biodegradability threshold then, presumably, the Scottish Government would need to track quantities of untreated residual waste to ensure they were not landfilled outside of the country without any form of treatment.

In essence, this mechanism would be implemented to equalise the landfill tax, differentials between Scotland and England, or indeed other countries where operators could find it economically advantageous to ship waste to in order to avoid paying the increased tax. The detail of the mechanism was not deemed crucial in how the option was modelled: the modelling simply assumed that the border / equalisation tax was either 'on' or 'off', and that it would have the effect of cutting off any waste exports that were modelled in the previous section as a consequence of an increased tax differential between England and Scotland. Some assessment of what this policy option could look like is now given.

There are multiple mechanisms that could be implemented to achieve this aim. One possibility could be similar in nature to the waste taxation policy in Belgium.[60] The owner of the waste pays a fee (including the tax and the gate fee in the destination authority) to the operator of the final installation (landfill or incineration) in Flanders or Wallonia. The final installation in-turn, pays the tax to the relevant regional authority on quarterly basis. So the owner of the waste pays his taxes to the authority in which the plant exists via the receiving installation. However, if the tax in the receiving region is lower than the tax in the region from which the waste was sent, the owner of the waste is obliged to pay the difference between:

1) the tax that would have applied if the waste had been disposed of in the region from which it originated; and
2) the tax which applies in the region to which it is sent.

In essence, therefore, there is no incentive to move waste between regions based upon the tax differentials alone.

For example, if non-combustible waste from Wallonia is transported to Flanders, for disposal in Flanders, and Wallonia is charging, in this case, higher taxes than in Flanders, the owner has to pay the fee + taxes in Flanders to the landfill operator, and

[60] Personal communications with Annemie Andries, Policyteam Europe, OVAM, March 2011.

will have to pay the differential tax to the Walloon authority. This system was created in order to avoid advantages when exporting waste. The total cost for landfilling of exported waste, is thus always the same as if it would be landfilled in the region of generation. This systems works in both directions, both authorities have matched their legislation in this field.

The mechanism for ensuring Scottish waste landfilled within the UK but outside of Scotland could be based upon the system of waste transfer notes. If any waste transfer note recorded the destination outside of Scotland the waste type and quantity could be used to calculate the additional tax the carrier should pay. There are two potential ways of administering a border tax calculated in this way:

1) Require all waste carriers to notify SEPA if they intend to transport waste out of Scotland. These notifications would be used to charge the carriers the border adjustment tax on an annual basis; or
2) Require all waste carriers to send copies of waste transfer notes to a Scottish Tax authority when waste is transported to a landfill outside of Scotland. The carriers would presumably pass the tax on to their customers immediately, but tax payments to the Scottish Government could only be collected on an annual basis, for example, based upon the waste transfer notes received. Some level of inspection and enforcement would be required to ensure that carriers were submitting WTNs when required.

One of the main problems with 1) is that it would be difficult to know the final destination of waste transported to a non-landfill location in England. One may assume that, to avoid paying the border tax, carriers would simply ship waste out of Scotland to a transfer station, or other facility, so that there was no requirement to inform the tax authority, then transport on to a landfill thereafter. The jurisdiction of any Scottish body would most likely not extend to all waste facilities and carriers across the UK. Therefore, the effect may be limited unless the onus was placed on the carrier to prove where the waste was ending up. If no proof of final destination could be provided then the border adjustment tax would still be applied. Equally, the administrative burden of 2) could also be limiting. Further research into the detailed costs and arrangements of implementing a digital waste transfer notes systems is to be recommended.

The costs of implementing and enforcing this option have not been modelled in this study. The legality of any border-adjustment tax was not determined because no specific proposals have been made. Further research would be required to assess them before a fully informed decision could be made.

6.3.6.1 Summary

Export / Border Adjustment / Equalisation Tax to discourage cross-border waste movements

PROs	*CONs*
Supports a Scotland-specific policy implementation of landfill tax.	Questions regarding legal competence arise under some of the possible options.
Initial analysis suggests that the issue might not be a major one anyway unless the tax rates in Scotland and the rest of the UK diverge significantly.	Might impose additional administrative burdens on waste carriers.
Once the tax increases beyond a certain level, the cost of local alternatives to landfill may present themselves before it becomes economic to export to the rest of UK.	May be difficult to enforce.
There are already procedures which have to be followed for trans-frontier shipments, so border tax adjustments related to export for recovery to other EU member states may be easy to track.	

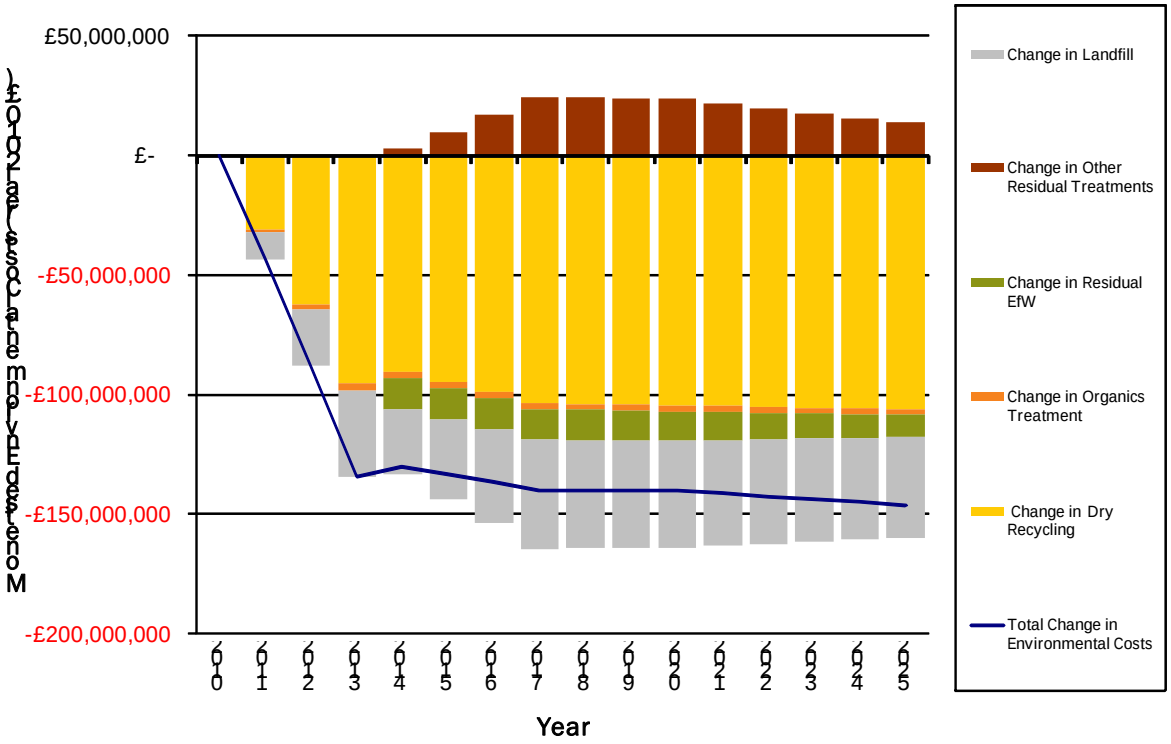
6.3.7 Environmental Impacts

It was agreed with the Steering Group that we would report monetised environmental costs / benefits (i.e. the externalities) associated with the changes where it was possible to do so. It was also agreed that as far as possible, we would base the GHG tonnage figures, from which GHG-related externalities would be calculated, on the Carbon Factors which underpin the carbon weightings which are the basis for the calculation of recycling rates in the carbon metric.

However, the approach taken to modelling the change in quantities of waste landfilled does not allow for a simplistic calculation of the environmental impacts. As the economic approaches are generally based upon mixed waste streams, a number of assumptions would need to be made based upon judgement alone. Given the environmental benefits gained from implementing the ZWP (see Figure 6-6), then one can expect the pattern of the impacts to be the same for small increases in the landfill tax increasing recycling and reducing landfill e.g. the environmental benefits outweigh the environmental costs.

Taking into account the fact that relatively significant modelling assumptions would be required to estimate the environmental impacts, and that other research suggests that the impacts associated with increased recycling and treatment are most likely to be positive, no detailed modelling of the environmental impacts was undertaken.

Figure 6-6: Change in Environmental Costs between BaU and ZWP Baselines, £ 2010 Real Terms



Source: Eunomia (2011) Economic Assessment of the Zero Waste Plan for Scotland, A Final Report for WRAP

7.0 Results from Scottish Landfill Tax Model

This results section describes the results from the policy option appraisal in the following order:

1) Description of the landfill tax model baselines;
2) Outputs from increasing Standard rate of tax scenarios, including:
   A) Uptake of recycling services and residual waste treatment;
   B) Resulting quantities landfilled;
   C) Revenue raised from landfill tax;
   D) Costs to local authorities and businesses;
   E) Potential for waste to cross-borders.

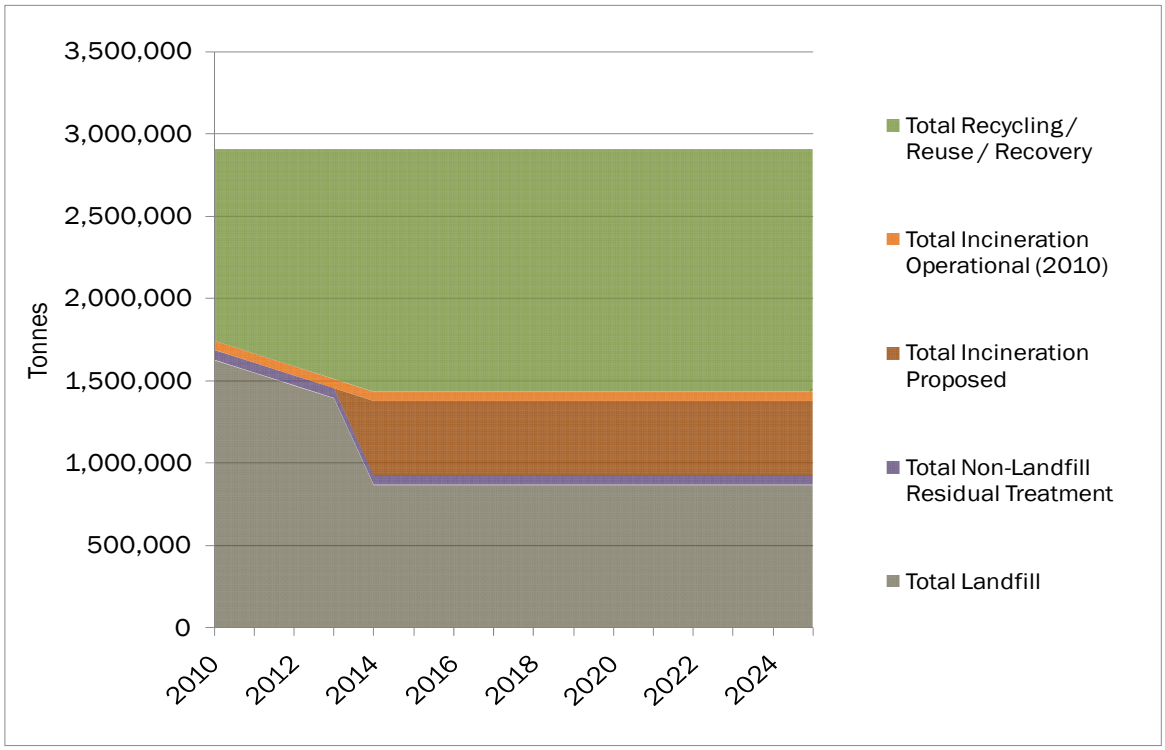
7.1 Baselines

7.1.1 Baseline Mass-Flows

Summary figures are presented in this section showing the management of wastes under the two baseline projections. Tables showing the numbers behind the charts are given in Appendix A.6.0. Note that 'Total Non-Landfill Residual Treatment' includes all residual treatments other than operational and proposed incineration.

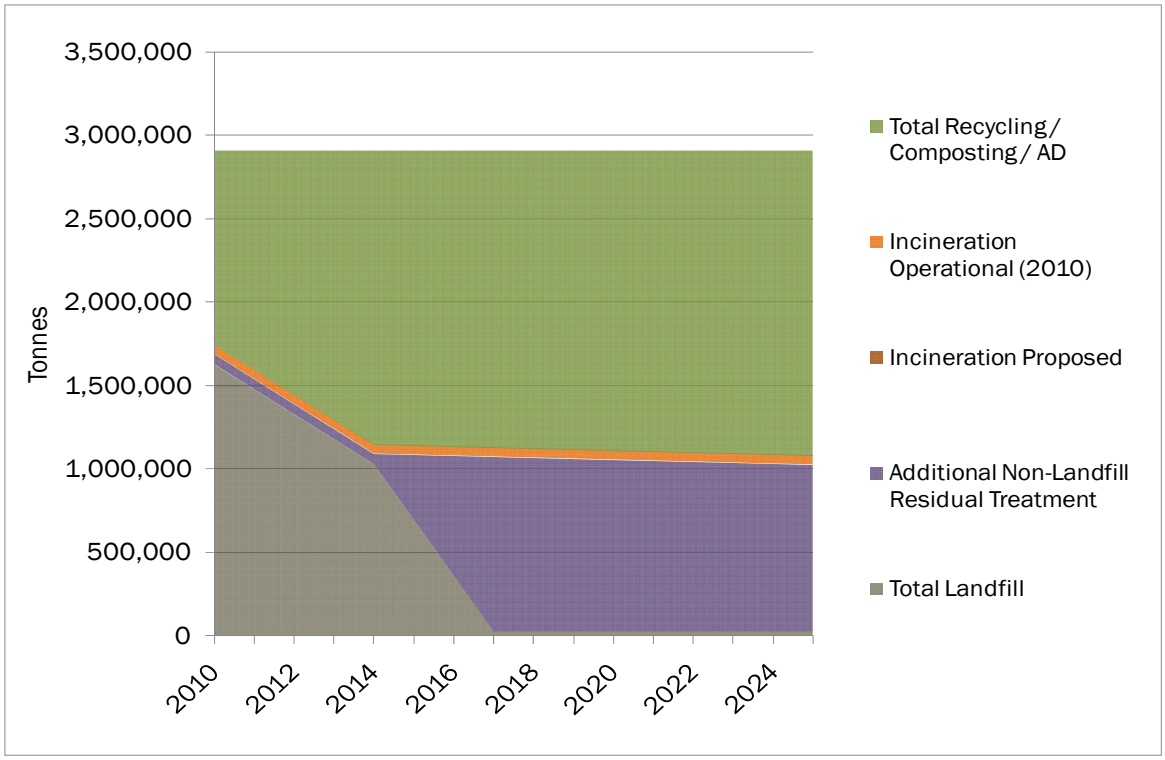
Figure 7-1 and Figure 7-2 show the pattern of household waste management under BaU and ZWP, respectively. The ZWP scenario shows higher rates of recycling / composting / AD, and higher rates of non-landfill residual waste treatment. This leads to lower rates of landfilling.

Figure 7-1: Household Waste Arisings and Management – Business as Usual, tonnes



Source: Eunomia Landfill Tax Model

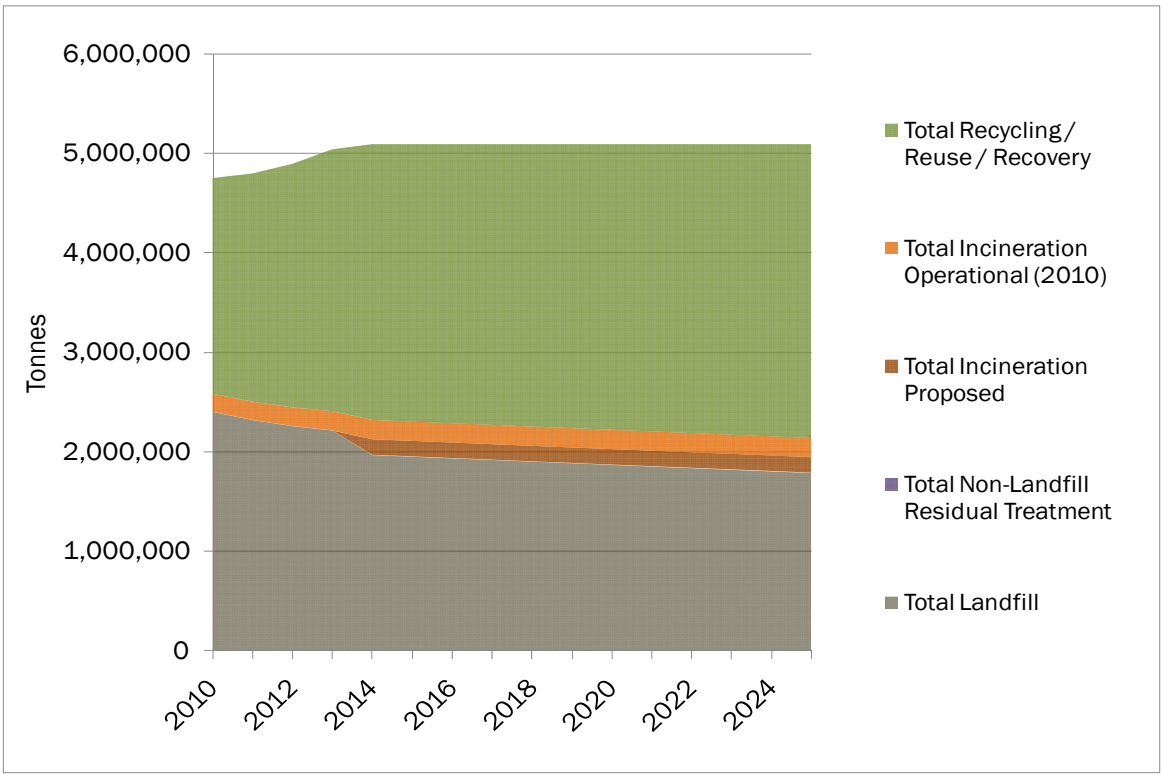
Figure 7-2: Household Waste Arisings and Management – Zero Waste Plan, tonnes



Source: Eunomia Landfill Tax Model

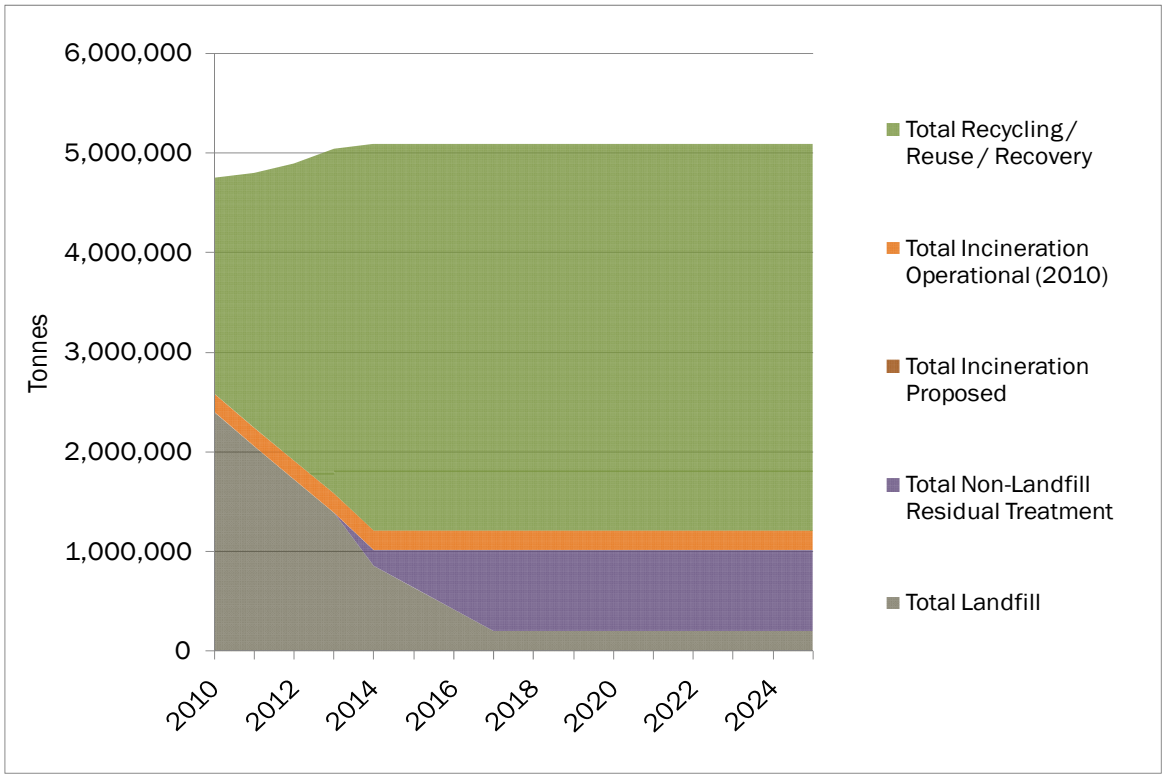
Similar comments can be made regarding commercial waste. Figure 7-3 and Figure 7-4 show the pattern of commercial waste management under BaU and ZWP, respectively. The ZWP scenario shows higher rates of recycling / composting / AD, and higher rates of non-landfill residual waste treatment. This leads to lower rates of landfilling.

Figure 7-3: Commercial Waste Arisings and Management – Business as Usual, tonnes



Source: Eunomia Landfill Tax Model

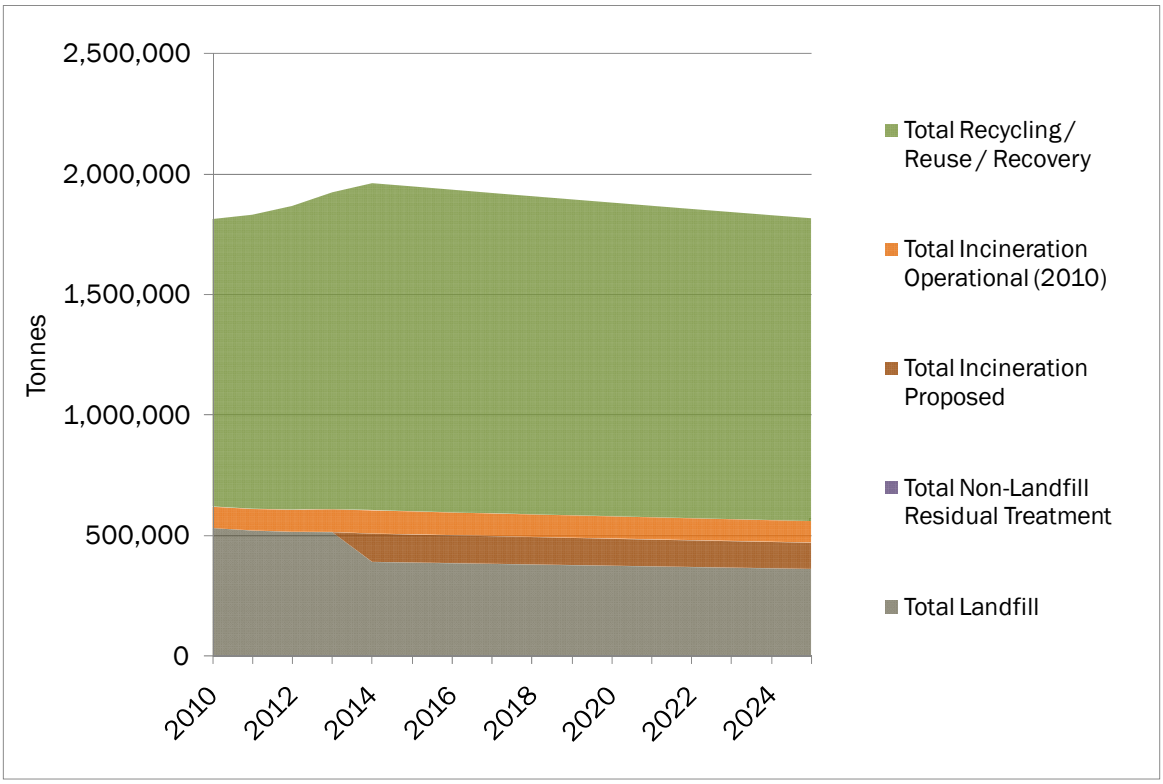
Figure 7-4: Commercial Waste Arisings and Management – Zero Waste Plan, tonnes



Source: Eunomia Landfill Tax Model

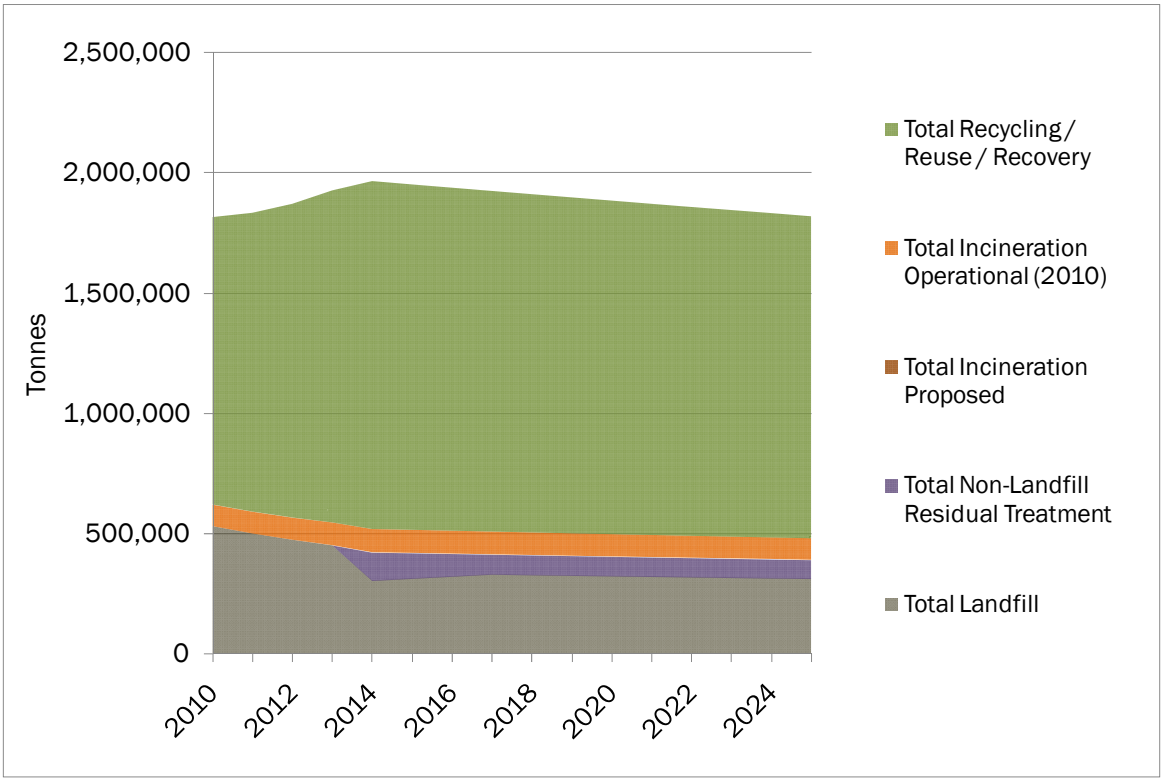
Figure 7-5 and Figure 7-6 show the pattern of industrial waste management under BaU and ZWP, respectively. Unlike the household and commercial sectors, the quantity of waste falls over time following an increase reflecting a 'bounce-back' in economic activity after the decline due to the recession. The ZWP scenario shows higher rates of recycling / composting / AD, and higher rates of non-landfill residual waste treatment. This leads to lower rates of landfilling.

Figure 7-5: Industrial Waste Arisings and Management – Business as Usual, tonnes



Source: Eunomia Landfill Tax Model

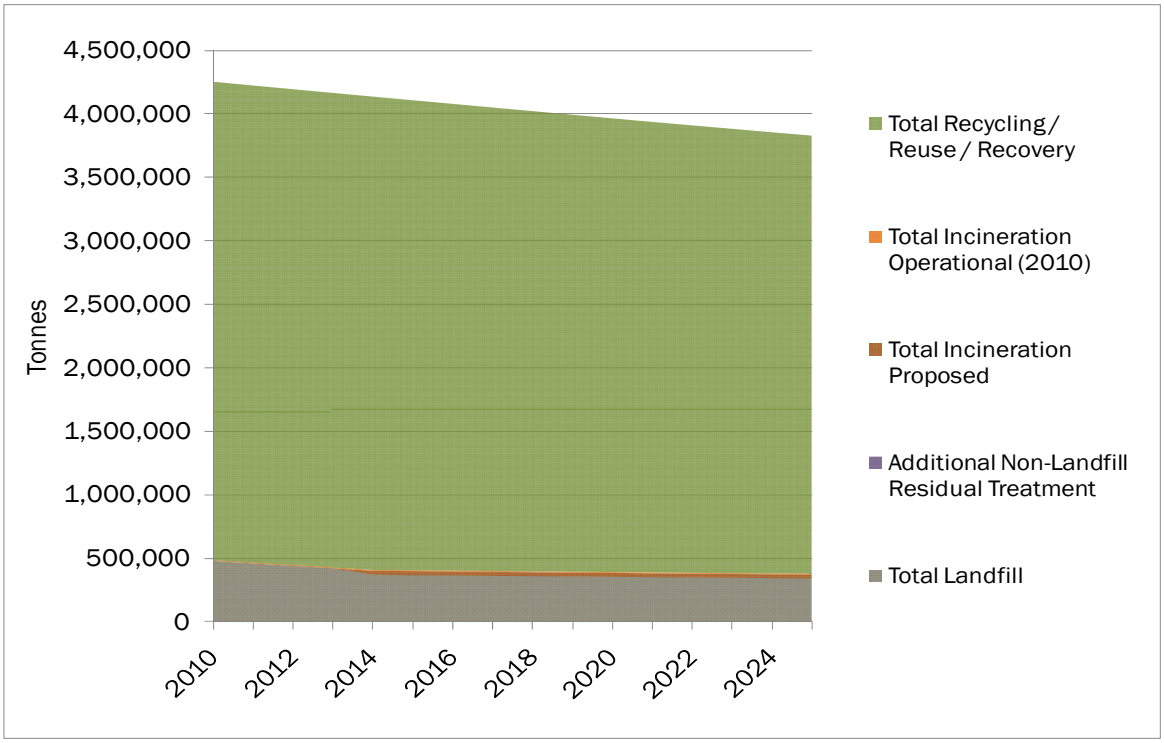
Figure 7-6: Industrial Waste Arisings and Management – Zero Waste Plan, tonnes



Source: Eunomia Landfill Tax Model

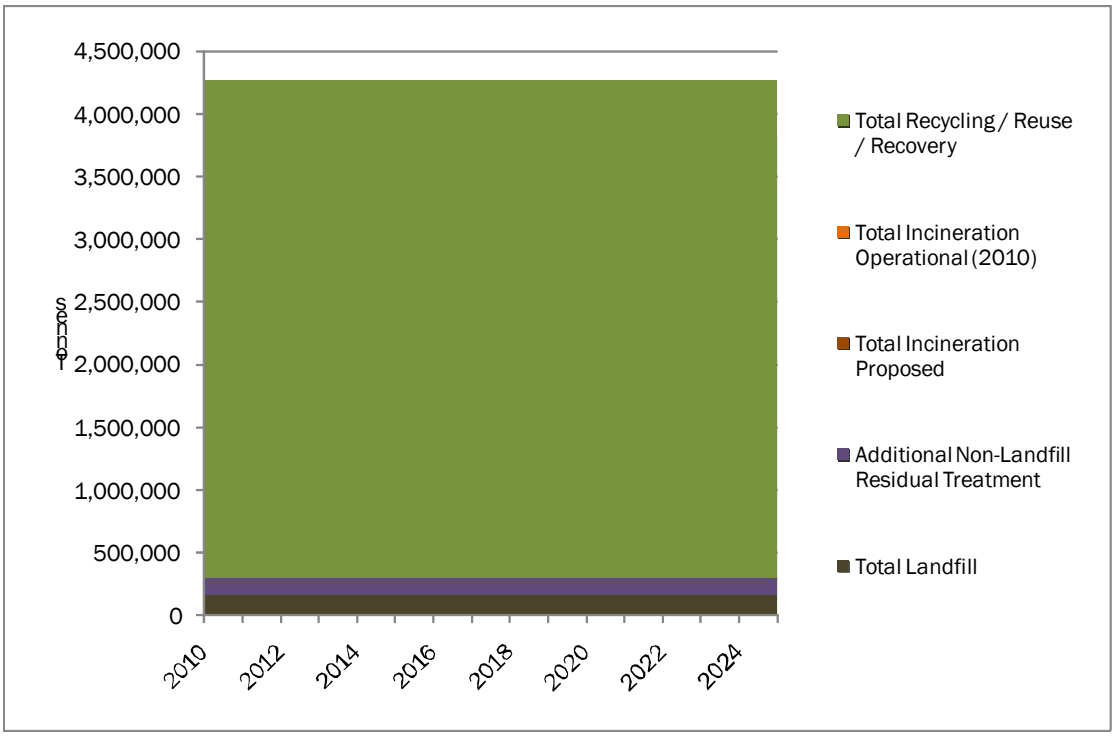
Figure 7-7 and Figure 7-8 show the pattern of C&D waste management under BaU and ZWP, respectively. As with industrial waste, the quantity of waste falls over time following an increase reflecting a 'bounce-back' in economic activity after the decline due to the recession. The ZWP scenario shows higher rates of recycling / composting / AD, and higher rates of non-landfill residual waste treatment. This leads to lower rates of landfilling.

Figure 7-7: C&D Waste Arisings and Management – Business as Usual, tonnes



Source: Eunomia Landfill Tax Model

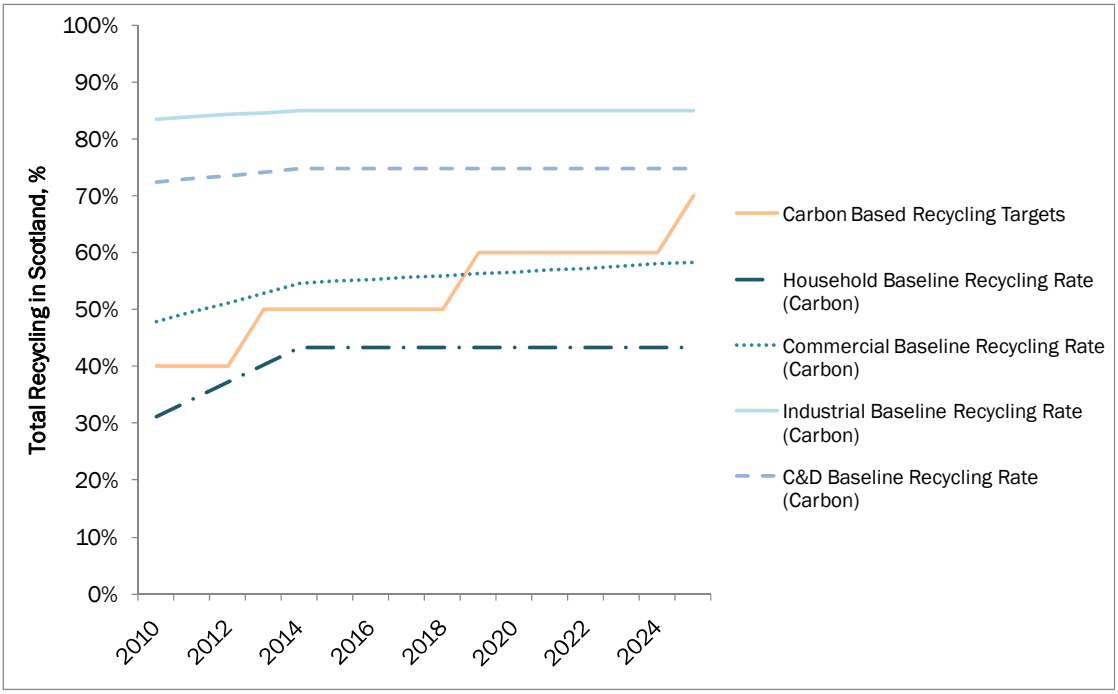
Figure 7-8: C&D Waste Arisings and Management – Zero Waste Plan, tonnes



Source: Eunomia Landfill Tax Model

7.1.2 Achievement of Recycling Targets

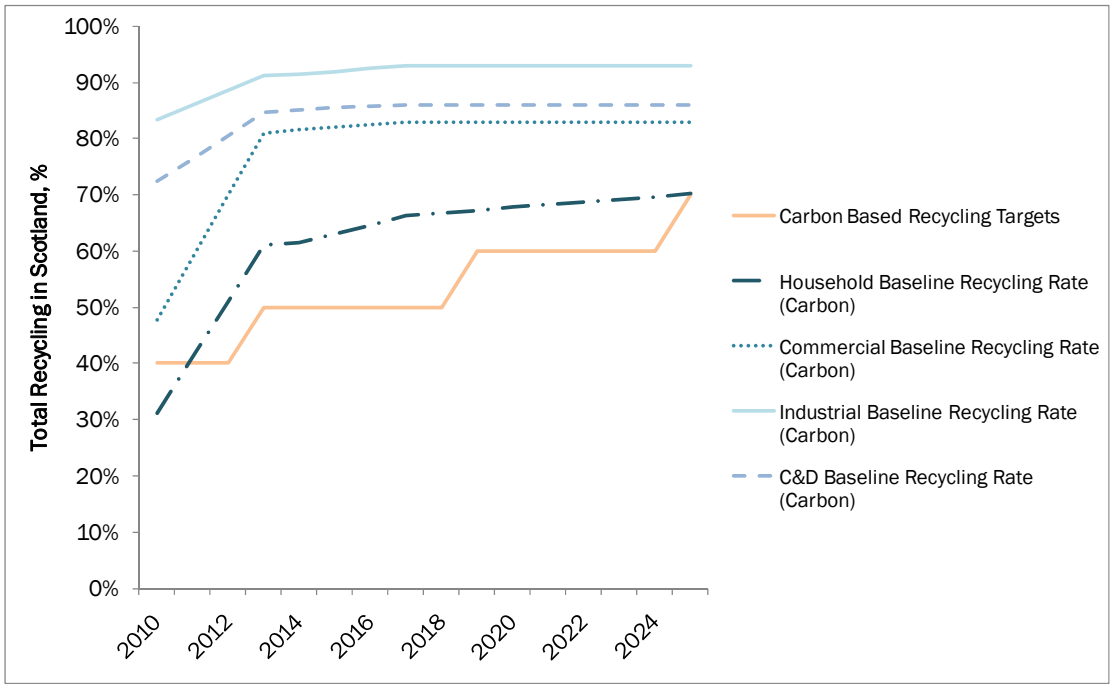
Figure 7-9: Carbon Based Recycling Rates for All Sectors v Time (BaU Baseline)



Source: Eunomia Landfill Tax Model

Note: The carbon based targets prior to 2025 apply to household waste only.

Figure 7-10: Carbon Based Recycling Rates for All Sectors v Time (ZWP Baseline)



Source: Eunomia Landfill Tax Model

Note: The carbon based targets prior to 2025 apply to household waste only.

As a comparison, the carbon based recycling levels, for each sector and baseline, are provided alongside one another in Figure 7-9 and Figure 7-10. Note also that, although the 70% target in 2025 applies to all waste streams, the interim targets (2013 and 2020) apply to household waste only. For household waste none of the carbon targets are met under the BaU baseline. Under the ZWP Regulations the 70% recycling target for 2025 is only just met. We believe that current composition and the current carbon metric makes this target difficult to meet. The rate has to more than double under the carbon metric, and achieving this demands a high capture of textiles and aluminium. Depending upon how textile composition is measured, this may not be straightforward. The data shown here also includes the contribution to the carbon metric recycling rate from material recovered from residual waste (i.e. by MBT facilities), hence the uplift between 2014/15 and 2017/18 under the ZWP Baseline.

The extent of the change between the baselines is not significant for industrial waste. Indeed much of the 'high weighting' material is being captured well already, and 'low weighting' material, such as wastes from thermal processes is still being landfilled. For the commercial sector carbon recycling rates are already higher than for the household, but the 2025 target is still missed under BaU. The ZWP Regulations target 'high weighting' materials so the rates increase significantly, and the target is easily met.

For the C&D sector, the carbon based target (70% by 2025) is met even in the BaU Scenario. The extent of the change between the baselines is not as great as that for household waste. Carbon based rates are more easily exceeded, reflecting the higher proportion of 'low weighting' materials. The recycling rates shown in the figures above are also presented in Table 7-1, along with the 'weight based' recycling rates.

Table 7-1: Material and Carbon Based Recycling Rates for Household, Commercial, Industrial and Construction and Demolition Wastes under BaU and ZWP

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Carbon Targets (2010, 2013 and 2020 hhld only)	40%			50%							60%					70%
BAU HHld Material Based Recycling Rate	40%	43%	45%	48%	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%	51%
BAU HHld Carbon Based Recycling Rate	31%	34%	37%	40%	43%	43%	43%	43%	43%	43%	43%	43%	43%	43%	43%	43%
ZWP HHld Material Based Recycling Rate	40%	47%	53%	60%	61%	61%	61%	61%	61%	62%	62%	62%	62%	62%	63%	63%
ZWP HHld Carbon Based Recycling Rate	31%	41%	51%	61%	62%	63%	65%	66%	67%	67%	68%	68%	69%	69%	70%	70%
BAU Commercial Material Based Recycling Rate	45%	47%	50%	52%	54%	54%	55%	55%	56%	56%	56%	57%	57%	57%	58%	58%
BAU Commercial Carbon Based Recycling Rate	48%	50%	51%	53%	55%	55%	55%	56%	56%	56%	57%	57%	57%	58%	58%	58%
ZWP Commercial Material Based Recycling Rate	45%	56%	66%	77%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%
ZWP Commercial Carbon Based Recycling Rate	48%	59%	70%	81%	82%	82%	82%	83%	83%	83%	83%	83%	83%	83%	83%	83%
BAU Industrial Material Based Recycling Rate	65%	65%	65%	66%	66%	66%	66%	66%	66%	66%	66%	66%	66%	66%	66%	66%
BAU Industrial Carbon Based Recycling Rate	83%	84%	84%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
ZWP Industrial Material Based Recycling Rate	65%	67%	69%	72%	72%	72%	72%	72%	72%	72%	72%	72%	72%	72%	72%	72%
ZWP Industrial Carbon Based Recycling Rate	83%	86%	89%	91%	91%	92%	92%	93%	93%	93%	93%	93%	93%	93%	93%	93%
BAU C&D Material Based Recycling Rate	89%	89%	89%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
BAU C&D Carbon Based Recycling Rate	72%	73%	74%	74%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
ZWP C&D Material Based Recycling Rate	89%	90%	91%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%
ZWP C&D Carbon Based Recycling Rate	72%	76%	81%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%

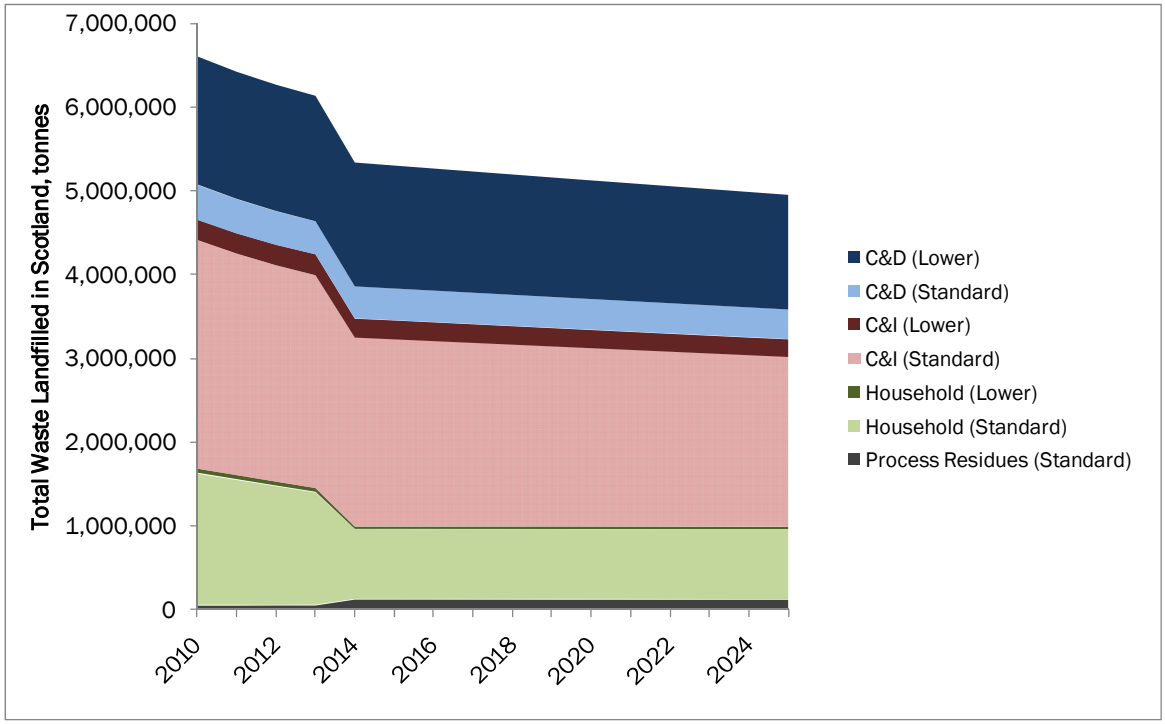
7.1.3 Baseline Levels of Landfilling

The research is primarily seeking to understand the effects of the landfill tax, which are directly correlated to the levels of landfilling in Scotland. Therefore, describing the quantities landfilled is important to understand the revenue streams from the tax. Figure 7-11 and Figure 7-12 show the quantities of waste from all sectors landfilled in Scotland under each tax rate (Standard and Lower). The two most significant contributors to landfilling are active wastes from the commercial and industrial sectors and inert wastes from construction and demolition. We note that a significant proportion of the inert C&D wastes is naturally occurring material such as soils and stones, and as such is not included in recycling rates, but may still attract the tax. Hence why they are included in these calculations.

Note that the quantities modelled are higher than the published SEPA site returns data. This is due to the error margins in the published waste generation data, amongst other factors (this is discussed in Section 6.1.2.4). Consequently, the model out-turns predict a greater level of landfilling compared to the SEPA site returns data. This uncertainty is addressed in the sensitivities section below (Section 7.2.7).

To calculate whether the waste is landfilled under the Standard or Lower rate, the categories in the baseline compositions were assigned to either rate based upon the nature of material fraction (e.g. food – Standard / soils and stones – Lower).

Figure 7-11: BaU Baseline Levels of Landfilling, tonnes



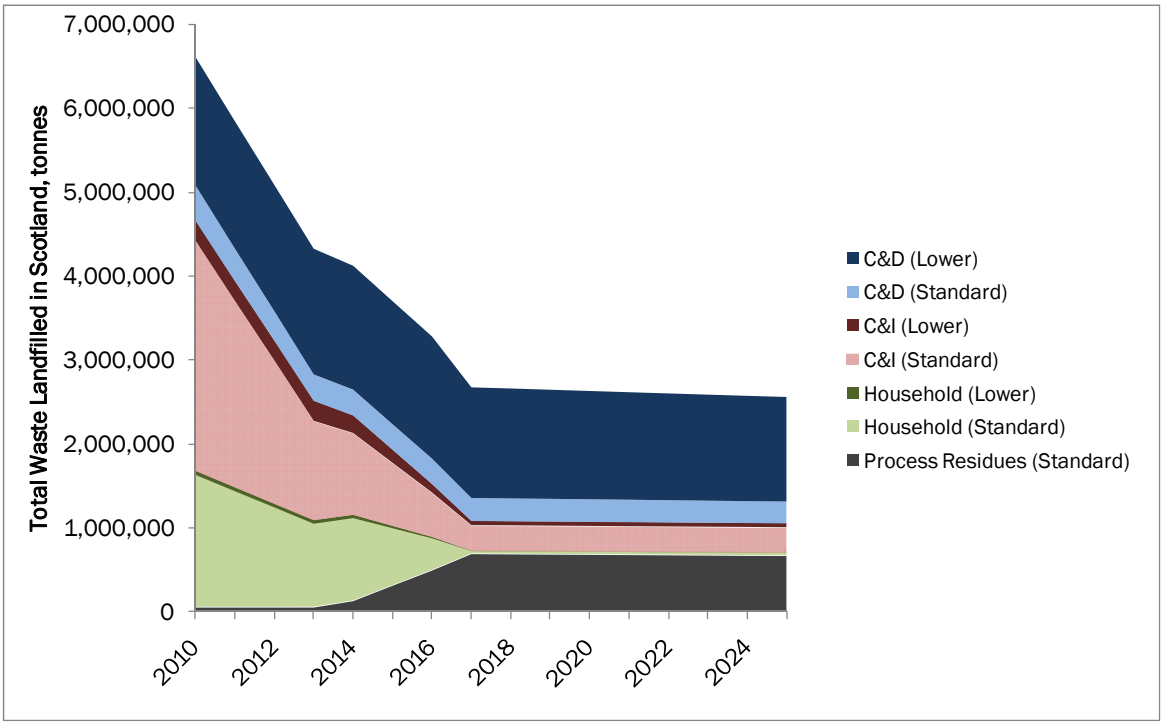
Source: Eunomia Landfill Tax Model

One can see that there is not a significant reduction in landfilling under the BaU baseline. The step change around 2013 – 2014 is a result of 320,000 tpa of

municipal residual waste treatment capacity all coming on-stream. The ongoing reduction in waste landfilled is a result of waste prevention effects in the industrial and C&D sectors (the growth rates for the household and commercial sectors were set at zero). The secondary process residues (rejects from MBT, un-recyclable wastes and combustion residues) are also included in the quantities landfilled, and taxed. One can see that as the new treatment infrastructure comes on-stream the quantity of residues landfilled increases.

The differences between the BaU and ZWP baselines are clear. There is minimal household waste still landfilled without treatment. The level of active commercial and industrial wastes landfilled also decreases significantly as the biodegradable waste landfill ban is implemented and significant quantities are thus treated by MBT, MHT and EfW. As a result the quantity of residues landfilled from these processes also increase with respect to BaU. The quantity of inert C&D waste (mainly soils and stones), presumably not currently recycled due to contamination and the like, does not decrease as dramatically as it is not biodegradable, and as such there are limited additional policy drivers affecting this waste stream in the ZWP.

Figure 7-12: ZWP Baseline Levels of Landfilling, tonnes



Source: Eunomia Landfill Tax Model

The tables with the data from the two charts above are presented below.

Table 7-2: BaU Baseline Levels of Landfilling, tonnes

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Process Residues (Standard)	51,464	51,731	52,276	53,112	123,717	123,580	123,443	123,308	123,173	123,040	122,907	122,775	122,644	122,514	122,385	122,257
Household (Standard)	1,579,163	1,503,404	1,427,648	1,351,895	840,156	840,156	840,156	840,156	840,156	840,156	840,156	840,156	840,156	840,156	840,156	840,156
Household (Lower)	48,731	47,079	45,424	43,766	27,084	27,084	27,084	27,084	27,084	27,084	27,084	27,084	27,084	27,084	27,084	27,084
C&I (Standard)	2,734,570	2,649,005	2,586,820	2,545,810	2,261,711	2,240,834	2,219,971	2,199,122	2,178,286	2,157,463	2,136,654	2,115,857	2,095,074	2,074,304	2,053,547	2,032,803
C&I (Lower)	242,904	242,854	245,179	249,921	225,297	223,720	222,154	220,599	219,055	217,521	215,999	214,487	212,985	211,494	210,014	208,544
C&D (Standard)	419,907	411,452	403,096	394,837	384,453	381,762	379,090	376,436	373,801	371,184	368,586	366,006	363,444	360,900	358,374	355,865
C&D (Lower)	1,527,053	1,516,332	1,505,686	1,495,115	1,476,093	1,465,760	1,455,500	1,445,312	1,435,194	1,425,148	1,415,172	1,405,266	1,395,429	1,385,661	1,375,961	1,366,330

Table 7-3: ZWP Baseline Levels of Landfilling, tonnes

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Process Residues (Standard)	51,464	51,731	52,276	53,112	128,865	311,492	493,590	689,492	686,656	683,826	681,005	678,190	675,383	672,582	669,789	667,003
Household (Standard)	1,579,163	1,385,812	1,192,556	999,460	989,023	687,914	386,711	39,536	39,584	39,635	39,688	39,744	39,803	39,865	39,931	40,000
Household (Lower)	48,731	46,883	44,941	42,839	41,300	28,608	16,011	1,627	1,578	1,528	1,475	1,419	1,360	1,298	1,232	1,162
C&I (Standard)	2,734,570	2,213,799	1,699,376	1,175,386	967,149	743,909	521,329	299,403	299,088	298,775	298,464	298,155	297,849	297,545	297,243	296,943
C&I (Lower)	242,904	240,561	240,124	241,434	211,881	157,560	103,990	51,162	50,804	50,448	50,095	49,745	49,396	49,051	48,707	48,366
C&D (Standard)	419,907	384,699	349,970	315,714	307,934	305,778	303,638	274,995	273,070	271,158	269,260	267,375	265,504	263,645	261,800	259,967
C&D (Lower)	1,527,053	1,516,177	1,505,373	1,494,639	1,475,267	1,464,940	1,454,685	1,317,460	1,308,238	1,299,080	1,289,986	1,280,956	1,271,990	1,263,086	1,254,244	1,245,465

7.1.4 Baseline Landfill Tax Revenues

The approach to estimating the quantity of taxable waste landfilled is as follows:

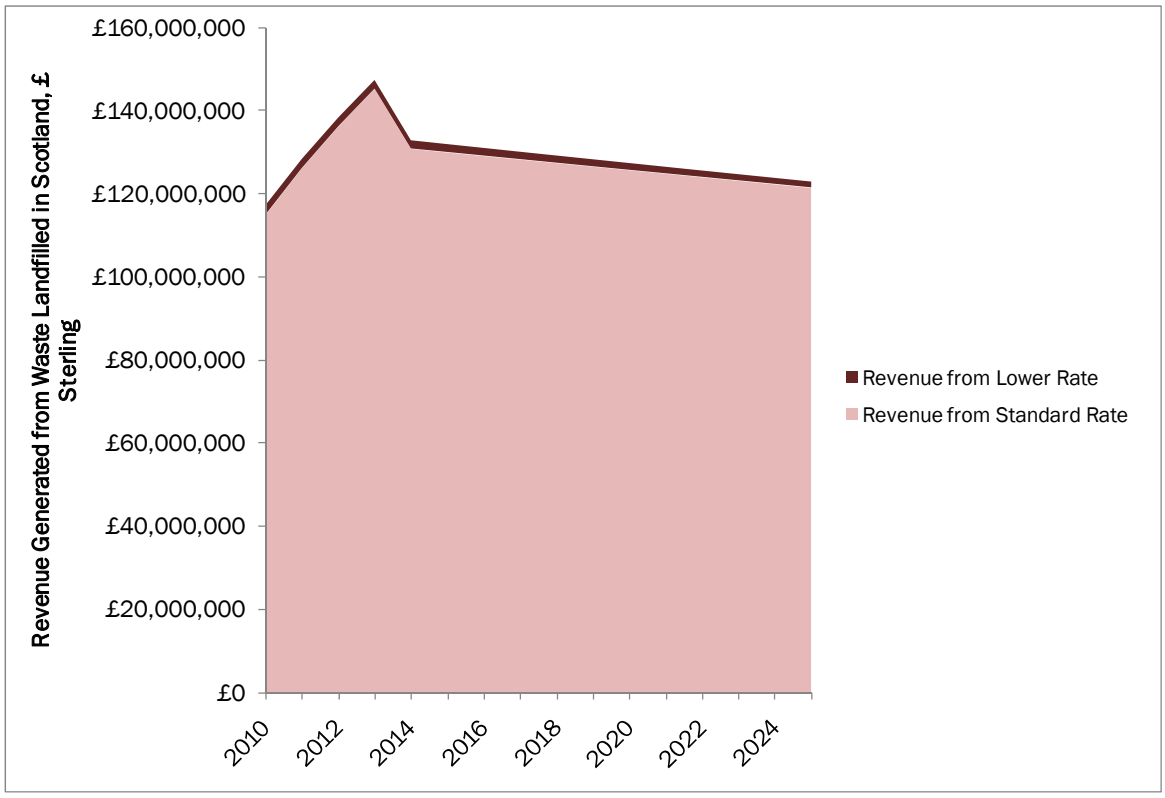
1) The proportion of UK municipal waste generation accounted for by Scotland is around 10%;
2) The same proportion of UK landfill tax revenues is taken to be equivalent to the tax take in Scotland only – this was approximately £100 million in 2009, which is aligned with the central estimate being used by Scottish Government and HMRC;[61]
3) Factors to represent a) waste landfilled with no tax receipts, b) active waste mixed in inert (and therefore not taxed at the standard rate) and c) waste exempt from tax for engineering purposes etc, were set for 2009 so that the model out-turns were equivalent to the estimated tax take for Scotland only.

It should be noted that the above assumptions may, in our view, underestimate the revenue-take accounted for by Scotland (there is no Scotland-specific figure for landfill tax revenues available from HMRC as the revenue receipts are based upon reporting a company level rather than by landfill site). The proportion of waste UK municipal waste *landfilled* in Scotland appears higher (15%) than the contribution to the total UK municipal waste arisings (10% - see point 1) above) , so basing estimates of tax take on contribution to (municipal) waste arisings will not necessarily give the best basis for estimating the likely tax take in Scotland.

The following charts show the model out-turns. One can clearly see that the significant proportion of revenue comes from active wastes taxed at the Standard rate.

[61] The HMRC Landfill Tax bulletin includes two sets of figures 1) Net Tax Declared on Trader Returns and 2) Total Receipts. The former was used as it reflects what should be paid, not what receipts operators have managed to submit at the time of publication.

Figure 7-13: Revenues Generated from Landfill Tax under BaU Baseline, £ 2010 Real Terms

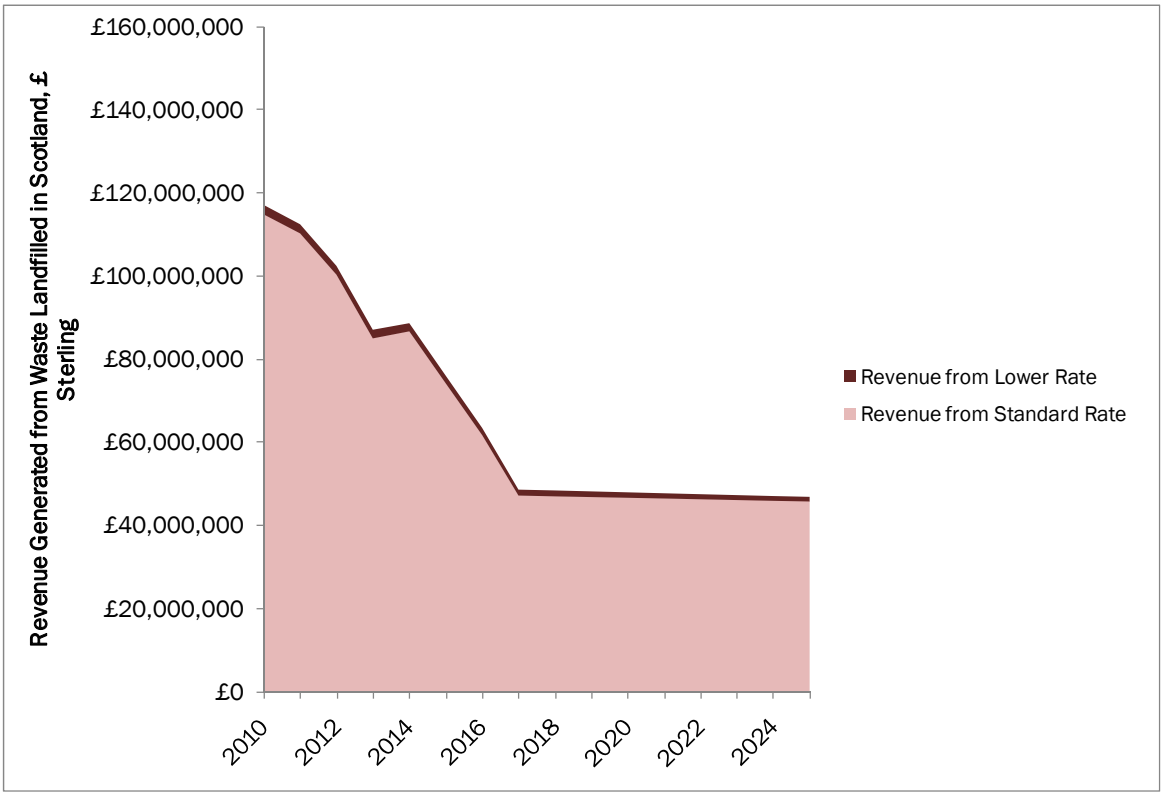


Source: Eunomia Landfill Tax Model

Under the ZWP baseline the level of revenue falls, as expected, as the Regulations drive waste away from landfilling to routes further up the waste hierarchy. The revenues fall to 2013 (when the requirements to sort are implemented) but increase again slightly to 2014. This is because there is very little additional landfill diversion from 2013 to 2014, but the tax has increased by £8 per tonne.

If one considers Figure 7-12 again, there is a relatively significant proportion of treated waste being landfilled from primary processes, such as MBT and MHT. This waste is stabilised, but currently taxed at the Standard rate. There are minimal levels (less than 5%) of untreated waste being landfilled by 2025. Thus the levels of revenue generated are perhaps higher than expected. In Section 4.1, above, we note that a lower rate of tax could be levied on stabilised wastes, thus reducing the costs of MBT processes but also the landfill tax receipts. This is discussed further in Section 8.2.

Figure 7-14: Revenues Generated from Landfill Tax under ZWP Baseline, £ 2010 Real Terms



Source: Eunomia Landfill Tax Model

The following tables show the tax revenue figures represented in Figure 7-13 and Figure 7-14 above.

Table 7-4: Revenues Generated from Landfill Tax under BaU and ZWP Baselines, £ millions 2010 Real Terms

	BaU Revenue from Standard Rate	BaU Revenue from Lower Rate	ZWP Revenue from Standard Rate	ZWP Revenue from Lower Rate
2010	£115	£2.3	£115	£2.3
2011	£126	£2.2	£110	£2.2
2012	£136	£2.1	£100	£2.1
2013	£145	£2.1	£85	£2.1
2014	£131	£2.0	£87	£2.0
2015	£130	£1.9	£74	£1.8
2016	£129	£1.8	£62	£1.7
2017	£128	£1.8	£47	£1.4
2018	£127	£1.7	£47	£1.4
2019	£127	£1.7	£47	£1.4
2020	£126	£1.6	£47	£1.3
2021	£125	£1.6	£47	£1.3
2022	£124	£1.5	£46	£1.2
2023	£123	£1.5	£46	£1.2
2024	£122	£1.4	£46	£1.2
2025	£121	£1.4	£46	£1.1

7.2 Scenario Results: Increase Standard Rate of Landfill Tax

In this section, the model out-turns that relate to the scenarios that increase the level of standard rate tax are described. The two scenarios modelled are:

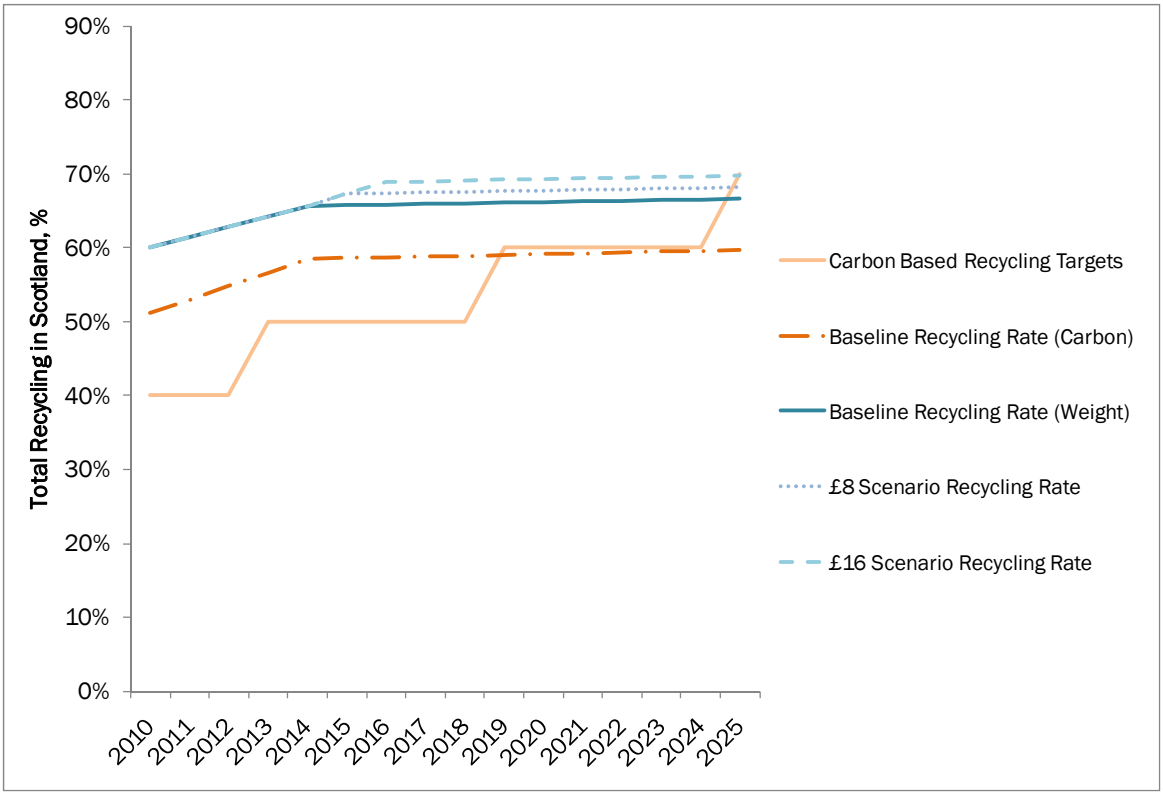
1) Increase Standard rate by £8 to £88 per tonne in 2015 (£8 Scenario); and
2) Increase Standard rate by £8 to £88 per tonne in 2015 and by £16 to £96 per tonne in 2016 (£16 Scenario).

Foremost the changes in waste management behaviour are shown, followed by the resulting quantities of waste landfilled, the revenues generated, the costs to Local Authorities and businesses, the potential for waste exports and finally the environmental impacts.

7.2.1 Changes in Non-Landfill Waste Management

Firstly, the change in recycling rate above both baselines is considered. Calculating the carbon based recycling rate is not straightforward as the methodology is not fully material specific, so uncertain assumptions with regards to the materials diverted would have to be made. With this in mind, the change in carbon based recycling rate has not been calculated for small changes in landfill tax.

Figure 7-15: Change in Weight Based Recycling Relative to BaU Baseline

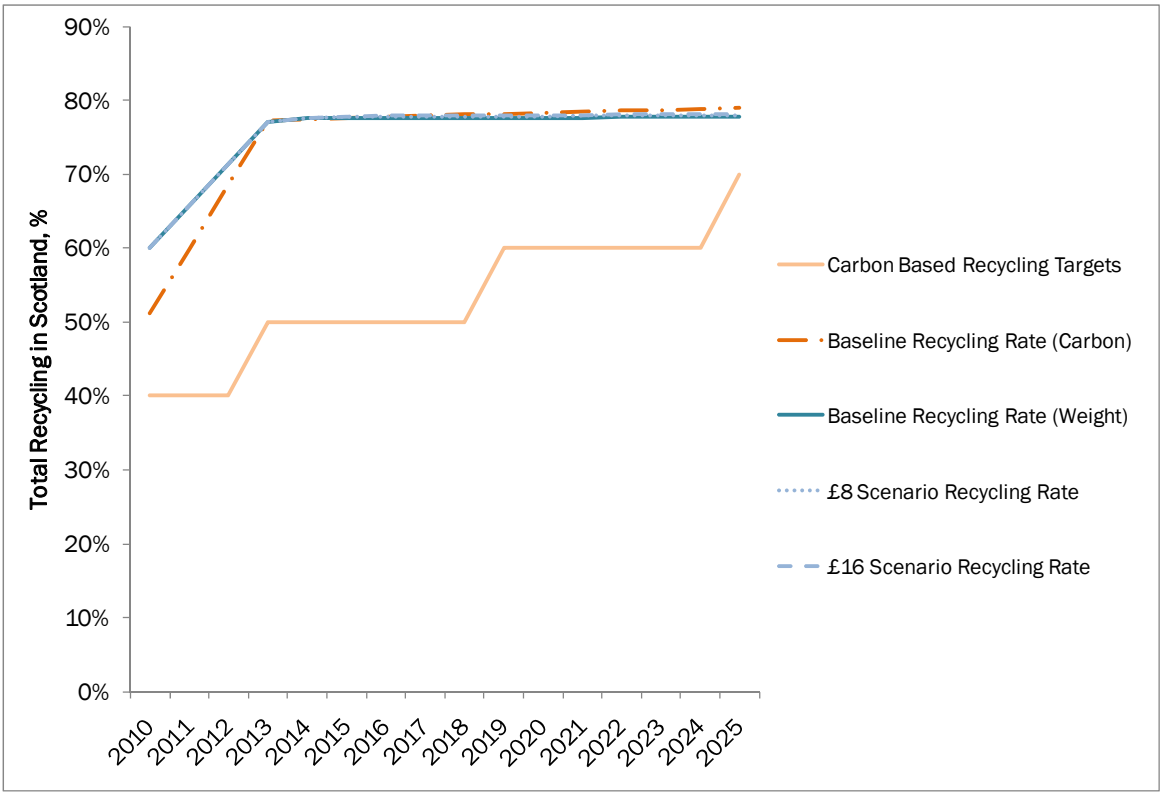


Source: Eunomia Landfill Tax Model

Note: The carbon based targets prior to 2025 would apply to household waste only.

Figure 7-15 shows that for Scotland as a whole the carbon based recycling target may not be met in 2025. The changes in weight based recycling (blue series) show the increases in recycling that result from changes in the tax. If one takes the change in weight based rate as a proxy for carbon based then the increases are unlikely to help Scotland achieve 2025. However, this does not reflect the situation by sector. The household recycling rates are still well below the target, mainly for the reasons discussed in Section 6.2.1.From Figure 7-16 one can see that the weight based and carbon based recycling rates are much more closely aligned. Little change can be seen in the recycling rates under the two scenarios, relative to the ZWP baseline. This is mainly because the recycling rates predicted by the economic modelling are less than the rates estimated to occur under requirements to sort and supporting policies like landfill bans. However, the carbon based recycling target for 2025, is likely to be met, in fact perhaps exceeded by 10%. This shows that, if the recycling targets are the key policy goal, any changes to the landfill tax will have no bearing on meeting the targets if the Regulations of the ZWP are enacted and fully policed.

Figure 7-16: Change in Weight Based Recycling Relative to ZWP Baseline



Source: Eunomia Landfill Tax Model

Note: The carbon based targets prior to 2025 would apply to household waste only.

The recycling rates presented in the figures above are detailed below in Table 7-5 and Table 7-6.

Table 7-5: Change in Weight Based Recycling Relative to BaU Baseline

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Carbon Based Recycling Targets	40%			50%							60%					70%
Baseline Recycling Rate (Carbon)	51%	53%	55%	57%	58%	59%	59%	59%	59%	59%	59%	59%	59%	59%	60%	60%
Baseline Recycling Rate (Weight)	60%	62%	63%	64%	66%	66%	66%	66%	66%	66%	66%	66%	66%	66%	67%	67%
£8 Scenario Recycling Rate	60%	62%	63%	64%	66%	67%	67%	68%	68%	68%	68%	68%	68%	68%	68%	68%
£16 Scenario Recycling Rate	60%	62%	63%	64%	66%	67%	69%	69%	69%	69%	69%	69%	69%	70%	70%	70%

Table 7-6: Change in Weight Based Recycling Relative to ZWP Baseline

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Carbon Based Recycling Targets	40%			50%							60%					70%
Baseline Recycling Rate (Carbon)	51%	60%	69%	77%	78%	78%	78%	78%	78%	78%	78%	78%	79%	79%	79%	79%
Baseline Recycling Rate (Weight)	60%	66%	71%	77%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%
£8 Scenario Recycling Rate	60%	66%	71%	77%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%
£16 Scenario Recycling Rate	60%	66%	71%	77%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%

The modelling suggests that the ZWP Regulations require investments in recycling which are in excess of those that would be expected with the tax at £96 per tonne, in other words recycling activities are implemented which are more expensive than the avoided cost of disposal with the tax at £96 per tonne. This implies that if the avoided cost of disposal were further increased additional recycling activities would be made 'cost effective', and therefore implemented, without the ZWP Regulations. If the model is re-run with the landfill tax increasing by £4 per tonne (nominal terms), per annum to £124 in 2025, and carbon based recycling rates estimated based upon the proportions calculated in the baselines, this gives an estimate of the level of landfill tax required to meet the ZWP carbon targets (without the implementation of the requirements to sort etc). This is not suggesting that the ZWP will not be implemented, simply to show the difference between the fiscal and regulatory policies (tax and requirements to sort respectively).

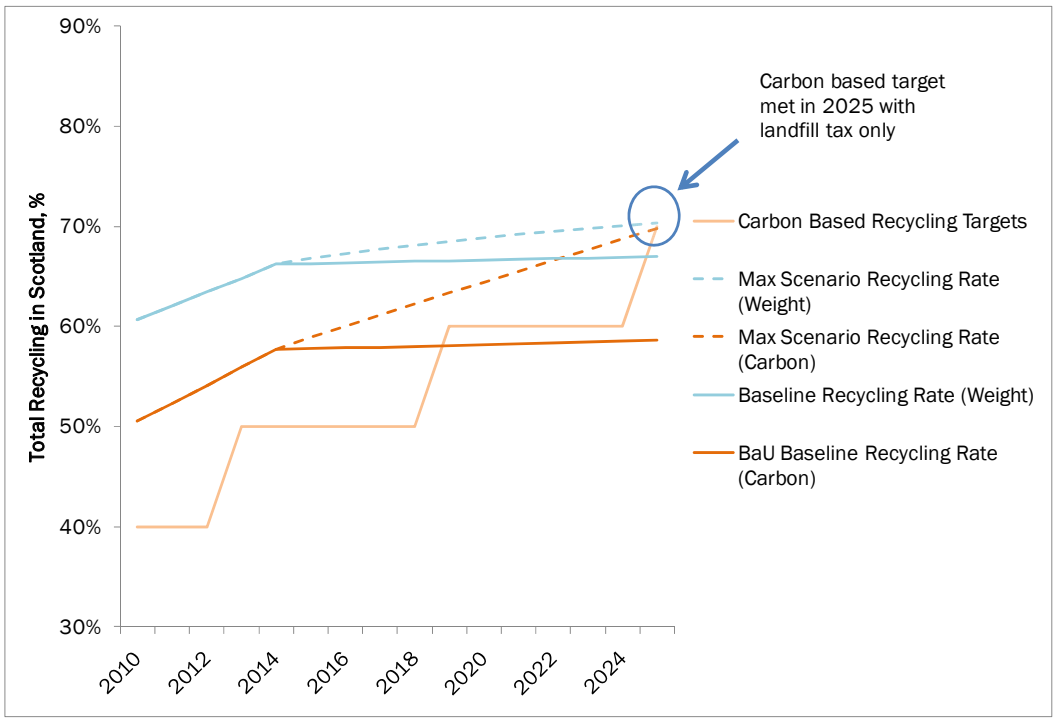
This suggests that, if a mechanism could be enforced to inhibit the migration of wastes out of Scotland, the tax-based policy required to meet the ZWP targets would include:

a) landfill tax increased to £124 per tonne in 2025 (in the manner described above); and

b) taxes on other residual waste treatments raised to ensure that the treatment costs were no less than those for landfill.

This approach would provide longer term certainty to the industry alongside the ZWP Regulations, whilst, importantly, it would also imply that those who failed to meet the targets were effectively encouraged to do so through the taxes being applied i.e. the tax is a financial 'stick' for those that evade enforcement.

Figure 7-17: Model Run with Standard Rate Tax Increasing to £124 per tonne in 2025



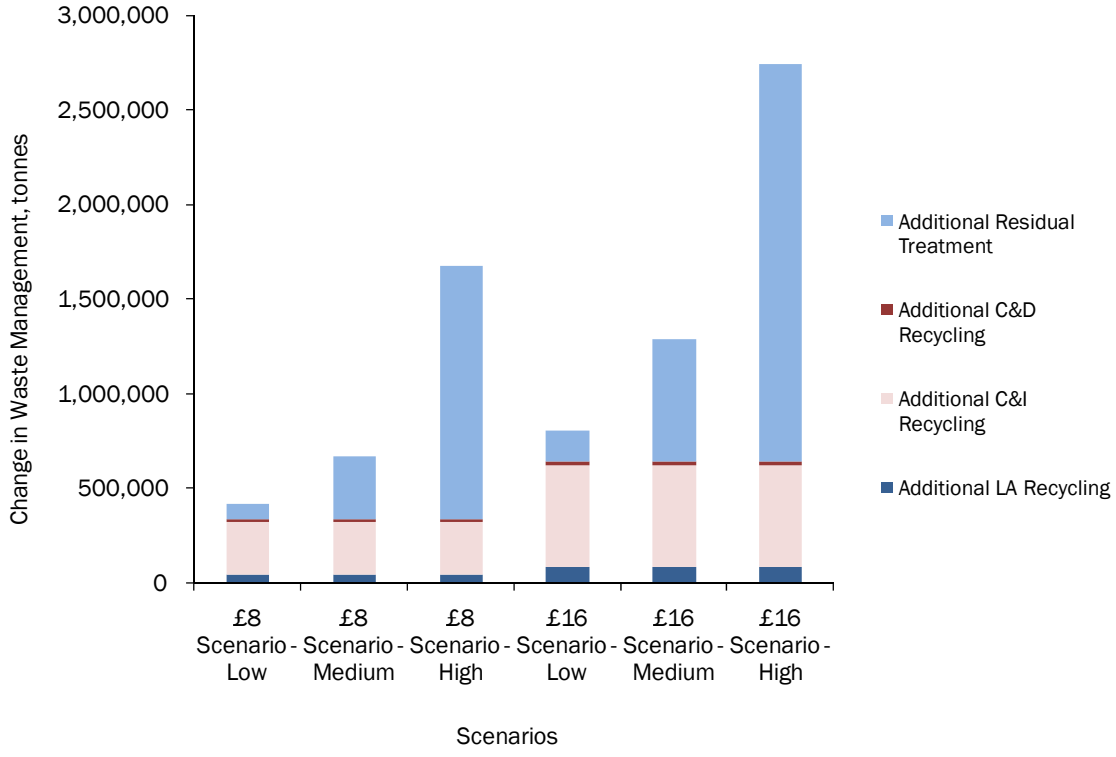
Source: Eunomia Landfill Tax Model

Figure 7-18 and Figure 7-19 show the absolute changes in recycling and residual waste treatment under the scenarios modelled. The £8 Scenario does not show much change in the results after 2015 as the tax rates stay constant in real terms, and the £16 Scenario only shows 2016 as the results for 2015 are the same as the £8 Scenario, and again they change little, on an annual basis, going forward to 2025.

Relative to the BaU baseline the most significant changes come from additional dry recycling and composting of food waste from the commercial sector. There is some additional recycling of active wastes from the C&D sector, such as wood, plastics and glass, that still may be found in mixed skips taxed at the Standard rate of tax. The proportion of non-inert to inert material in the sector is small, thus the changes are also not significant. Some additional recycling from the household sector comes from the increased performance of HWRCs. As discussed in Section 6.2.2 no change in the performance of kerbside systems, relative to marginal increases in tax, has been modelled. The three residual waste up-take scenarios (low, medium and high) are shown also. These reflect the uncertainty in the residual waste treatment market, and the extent to which non-landfill treatments become cost effective and available.

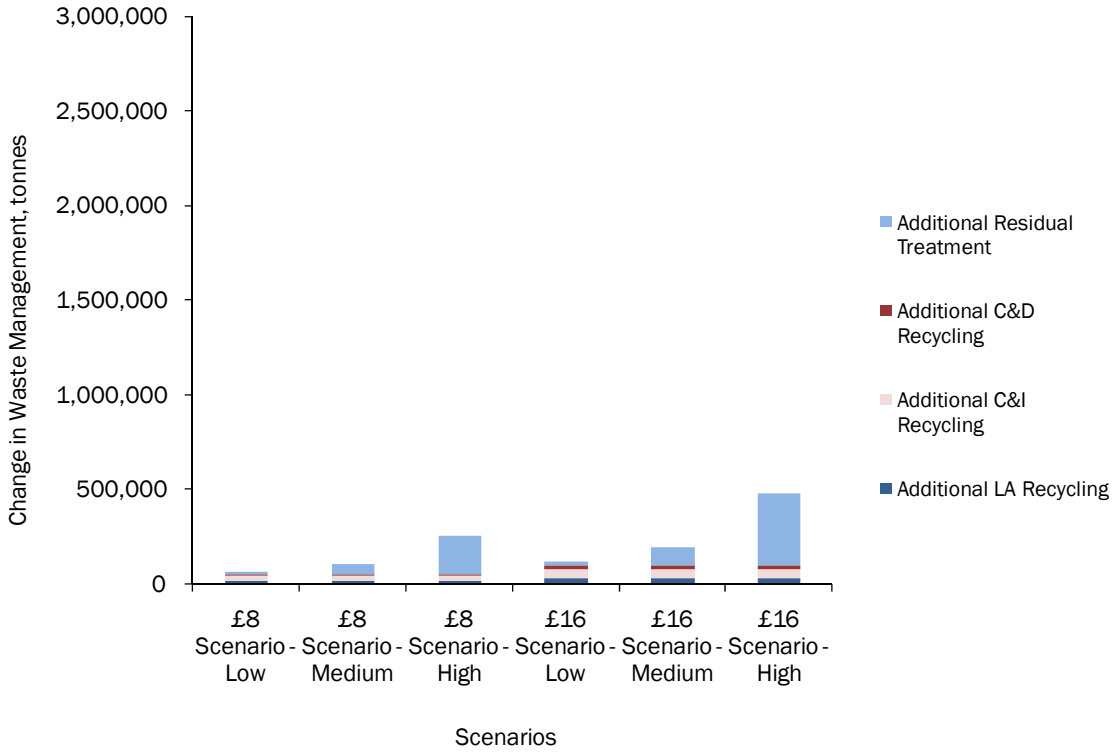
Figure 7-18 below shows that the quantities of waste recycled reduce significantly relative to the ZWP baseline as much of the cost effective recycling has already been achieved. However, the Regulations only target certain materials, so there is some scope for increased recycling from all sectors.

Figure 7-18: Changes in Recycling and Residual Treatment Markets (Relative to BaU Baseline), tonnes



Source: Eunomia Landfill Tax Model

Figure 7-19: Changes in Recycling and Residual Treatment Markets (Relative to ZWP Baseline), tonnes



Source: Eunomia Landfill Tax Model

The following tables indicate the changes in the waste management represented in Figure 7-18 and Figure 7-19 above.

Table 7-7: Changes in Recycling and Residual Treatment Markets (Relative to BaU Baseline), tonnes

	Additional LA Recycling	Additional C&I Recycling	Additional C&D Recycling	Additional Residual Treatment	Totals
£8 Scenario - Low	43,599	280,755	10,508	83,716	418,578
£8 Scenario - Medium	43,599	280,755	10,508	334,862	669,724
£8 Scenario - High	43,599	280,755	10,508	1,339,449	1,674,311
£16 Scenario - Low	84,717	538,271	19,419	160,602	803,009
£16 Scenario - Medium	84,717	538,271	19,419	642,407	1,284,814
£16 Scenario - High	84,717	538,271	19,419	2,098,245	2,740,653

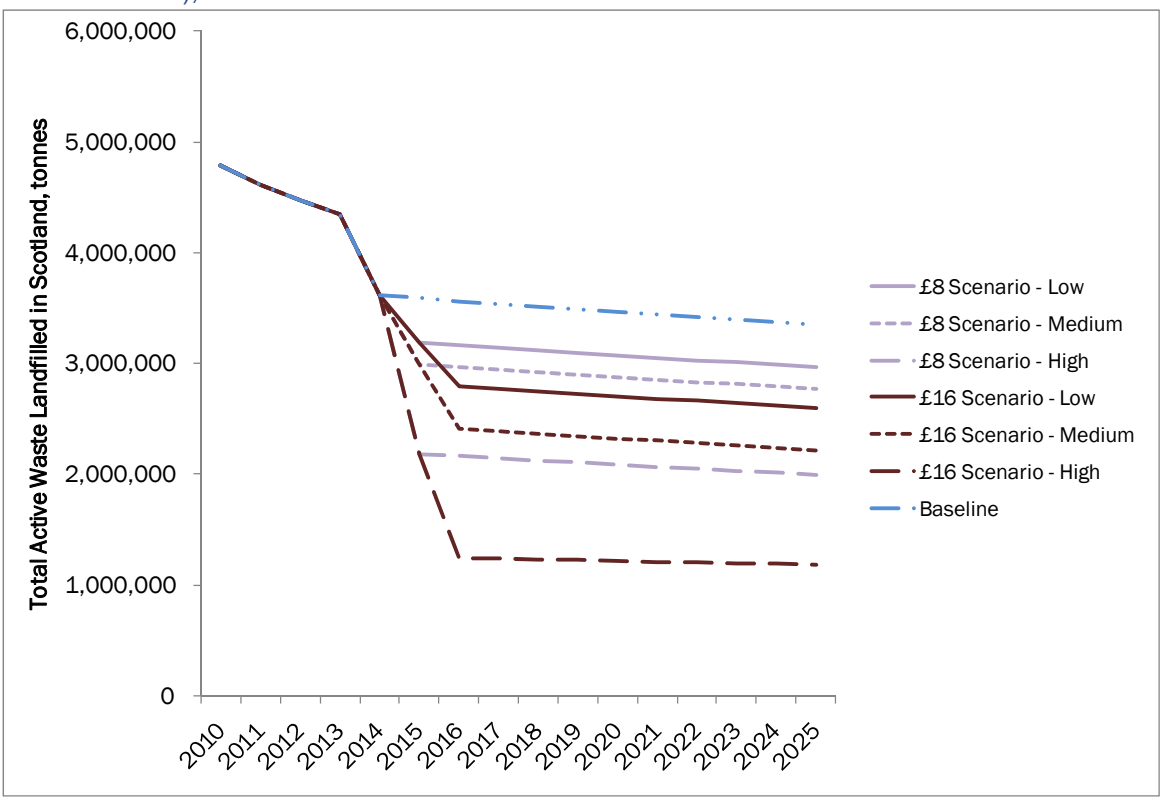
Table 7-8: Changes in Recycling and Residual Treatment Markets (Relative to ZWP Baseline), tonnes

	Additional LA Recycling	Additional C&I Recycling	Additional C&D Recycling	Additional Residual Treatment	Totals
£8 Scenario - Low	15,987	24,131	10,508	12,657	63,283
£8 Scenario - Medium	15,987	24,131	10,508	50,626	101,252
£8 Scenario - High	15,987	24,131	10,508	202,505	253,131
£16 Scenario - Low	31,064	44,730	19,419	23,803	119,016
£16 Scenario - Medium	31,064	44,730	19,419	95,213	190,425
£16 Scenario - High	31,064	44,730	19,419	380,851	476,063

7.2.2 Waste Landfilled

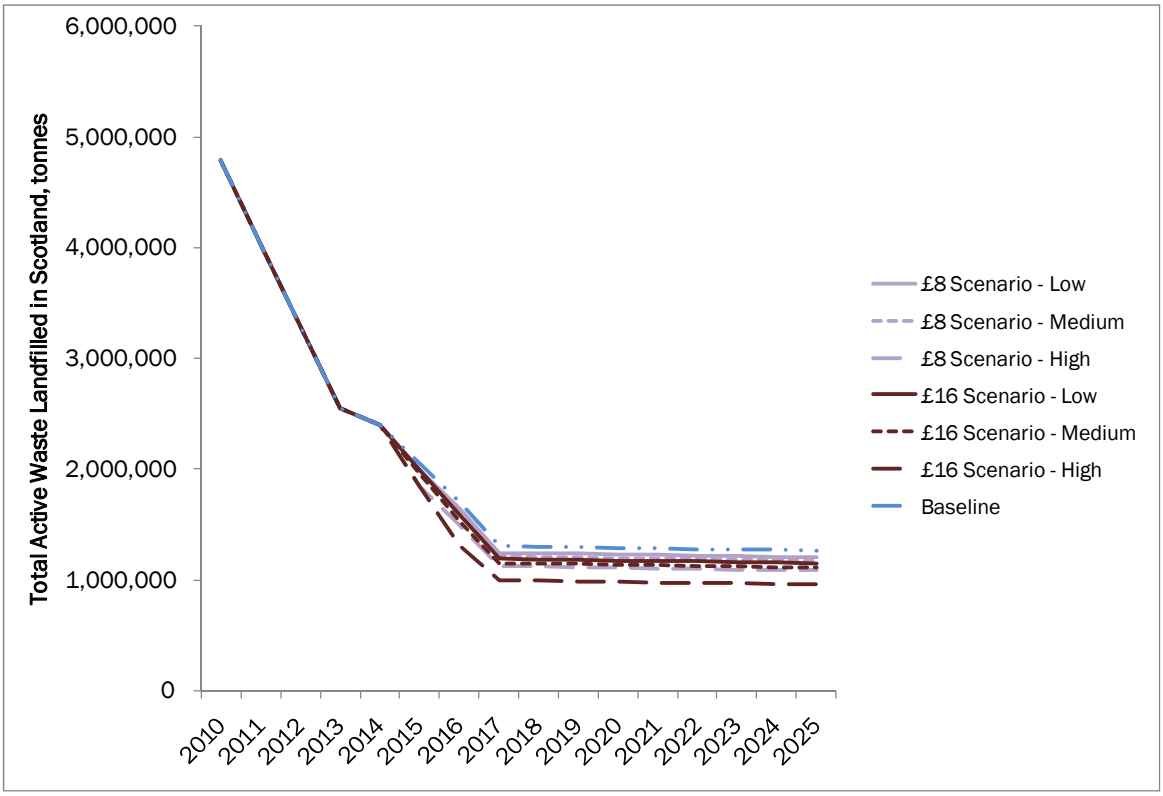
The following charts show the resulting landfilled quantities under the two baseline scenarios and the policy scenarios. Comparing the modelling relative to the BaU to the ZWP this shows that similar levels of landfill diversion to the ZWP baseline could be achieved by raising the tax to £16 per tonne. However, as Figure 7-20 shows, much of this diversion may result in residual waste treatment, not recycling.

Figure 7-20: Waste Landfilled Resulting from Increasing Standard Rate (Relative to BaU Baseline), tonnes



Source: Eunomia Landfill Tax Model

Figure 7-21: Waste Landfilled Resulting from Increasing Standard Rate (Relative to ZWP Baseline), tonnes



Source: Eunomia Landfill Tax Model

Figure 7-20 shows that there is already a significant decrease in waste landfilled as a result of the ZWP policies. Therefore, marginal landfill avoidance is much less than under BaU. Note, that process residues are also included. These have all been assumed to be landfilled at the Standard rate for simplicity, but it is recognised that some residues from thermal plants may be landfilled at the Lower rate.

The following tables indicate the quantities of waste landfilled under the scenarios represented in Figure 7-20 and Figure 7-21 above.

Table 7-9: Waste Landfilled Resulting from Increasing Standard Rate (Relative to BaU Baseline), M tonnes

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
£8 Scenario - Low	3.2	3.2	3.1	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0
£8 Scenario - Medium	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8
£8 Scenario - High	2.2	2.2	2.1	2.1	2.1	2.1	2.1	2.0	2.0	2.0	2.0
£16 Scenario - Low	3.2	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6
£16 Scenario - Medium	3.0	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.2	2.2
£16 Scenario - High	2.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Baseline	3.6	3.6	3.5	3.5	3.5	3.5	3.4	3.4	3.4	3.4	3.4

Table 7-10: Waste Landfilled Resulting from Increasing Standard Rate (Relative to ZWP Baseline), M tonnes

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
£8 Scenario - Low	2.0	1.6	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
£8 Scenario - Medium	2.0	1.6	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
£8 Scenario - High	1.8	1.5	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
£16 Scenario - Low	2.0	1.6	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1
£16 Scenario - Medium	2.0	1.5	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
£16 Scenario - High	1.8	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Baseline	2.0	1.7	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3

7.2.3 Revenue Generated

Table 7-11 and Table 7-12 show the changes in revenue generated from the policy scenarios. Relative to the BaU baseline the tax has a fairly significant effect on the waste treatment market, so the increased tax rates are not outweighed by the reduction in landfilled thus revenues fall. Relative to the ZWP baseline, landfill diversion is less pronounced, especially at low levels of residual uptake, so there are small increases in revenues under some scenarios. Despite the significant reduction in waste landfilled, and the 5% cap on landfilling of untreated wastes, process residues from residual waste treatment plants still continue to be landfilled. An average figure on 20% residues has been used in this study, but it is recognised that this could fall if all residues were thermally treated post-sorting and stabilisation.

Table 7-11: Total Tax Revenue under Standard Rate Tax Scenarios (Relative to BaU Baseline), £M 2010 real terms

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
£8 Scenario - Low	£124	£123	£122	£121	£120	£120	£119	£118	£117	£116	£115
£8 Scenario - Medium	£116	£115	£114	£113	£113	£112	£111	£110	£109	£108	£108
£8 Scenario - High	£85	£84	£83	£83	£82	£81	£80	£80	£79	£78	£77
£16 Scenario - Low	£124	£116	£115	£114	£113	£112	£111	£110	£109	£108	£107
£16 Scenario - Medium	£116	£100	£99	£98	£97	£96	£95	£94	£93	£93	£92
£16 Scenario - High	£85	£51	£51	£51	£51	£50	£50	£50	£49	£49	£49
Baseline	£130	£129	£128	£127	£127	£126	£125	£124	£123	£122	£121

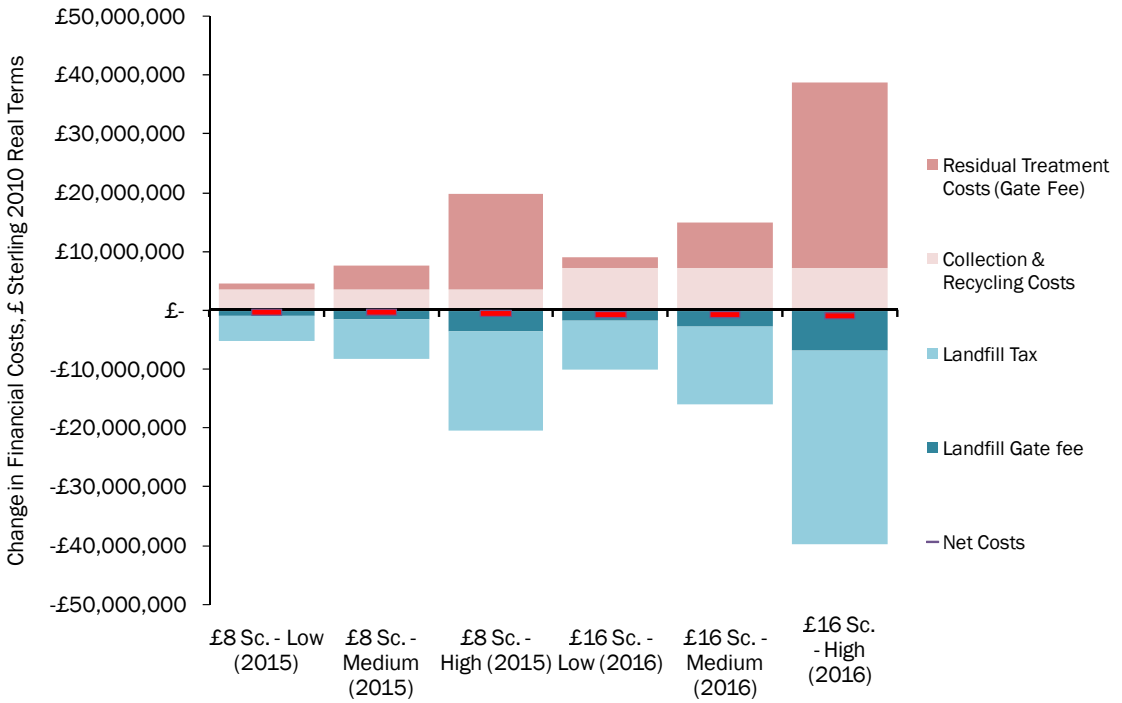
Table 7-12: Total Tax Revenue under Standard Rate Tax Scenarios (Relative to ZWP Baseline), £M 2010 real terms

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
£8 Scenario - Low	£77	£64	£48	£48	£48	£48	£48	£47	£47	£47	£47
£8 Scenario - Medium	£76	£63	£47	£47	£47	£47	£46	£46	£46	£46	£46
£8 Scenario - High	£71	£58	£44	£43	£43	£43	£43	£43	£43	£42	£42
£16 Scenario - Low	£77	£66	£49	£49	£49	£49	£48	£48	£48	£48	£48
£16 Scenario - Medium	£76	£63	£48	£47	£47	£47	£47	£47	£46	£46	£46
£16 Scenario - High	£71	£54	£41	£41	£41	£41	£40	£40	£40	£40	£40
Baseline	£74	£62	£47	£47	£47	£47	£47	£46	£46	£46	£46

7.2.4 Costs to Local Authorities

Figure 7-22 and Figure 7-23 show the costs to Scottish Local Authorities – positive figures indicate a financial costs and negative figures a saving. The main changes modelled are an increase in HWRC recycling and up-take of residual treatments, so these provide the only basis for the change in costs shown. One can see that at low levels of residual uptake the net costs may result in small savings as increased recycling at HWRCs is assumed to be less than the combined price of collecting and landfilling residual waste. The small savings occur because of market failures that limit the uptake of recycling even though the disposal costs are higher. In addition, under BaU, the cost of alternative treatment is broadly similar to landfill cost (in real terms). In fact the savings increase slightly under Scenario 1.B (increase to £16 per tonne) because the avoided cost of disposal increases above the cost of alternatives in real terms,

Figure 7-22: Change in Costs to Scottish Local Authorities Relative to BaU Baseline, £ 2010 Real Terms



Source: Eunomia Landfill Tax Model

Note, the collection costs stay constant between the three residual up-take scenarios because the same collection systems are required to transport mixed wastes to landfill or other residual treatments. The net costs are

Figure 7-23: Change in Costs to Scottish Local Authorities Relative to ZWP Baseline, £ 2010 Real Terms

Source: Eunomia Landfill Tax Model

Under the ZWP the average gate fee used for additional residual waste treatment processes is higher than landfill, thus more residual treatment equates to increasing costs. This can be seen in the increasing net costs from the low, to medium to high residual up-take scenarios. What seems clear from the financial analysis is that increases in the tax stimulate marginal changes in waste management that are at relatively similar costs, be it recycling or residual waste treatment. Thus the net costs to authorities from small increases in the landfill tax are small. The data corresponding to the figures above is presented in Table 7-13 and Table 7-14 (-ve figures represent a financial *saving*).

Table 7-13: Change in Costs to Scottish Local Authorities Relative to BaU Baseline, £ thousands 2010 Real Terms

	£8 Sc. - Low (2015)	£8 Sc. - Medium (2015)	£8 Sc. - High (2015)	£16 Sc. - Low (2016)	£16 Sc. - Medium (2016)	£16 Sc. - High (2016)
Landfill Gate fee	-£872	-£1,395	-£3,488	-£1,694	-£2,711	-£6,777
Landfill Tax	-£4,239	-£6,782	-£16,956	-£8,237	-£13,179	-£32,946
Collection & Recycling Costs	£3,706	£3,706	£3,706	£7,201	£7,201	£7,201
Residual Treatment Costs (Gate Fee)	£1,014	£4,055	£16,219	£1,970	£7,879	£31,515
Net Costs	-£391	-£417	-£519	-£760	-£810	-£1,008

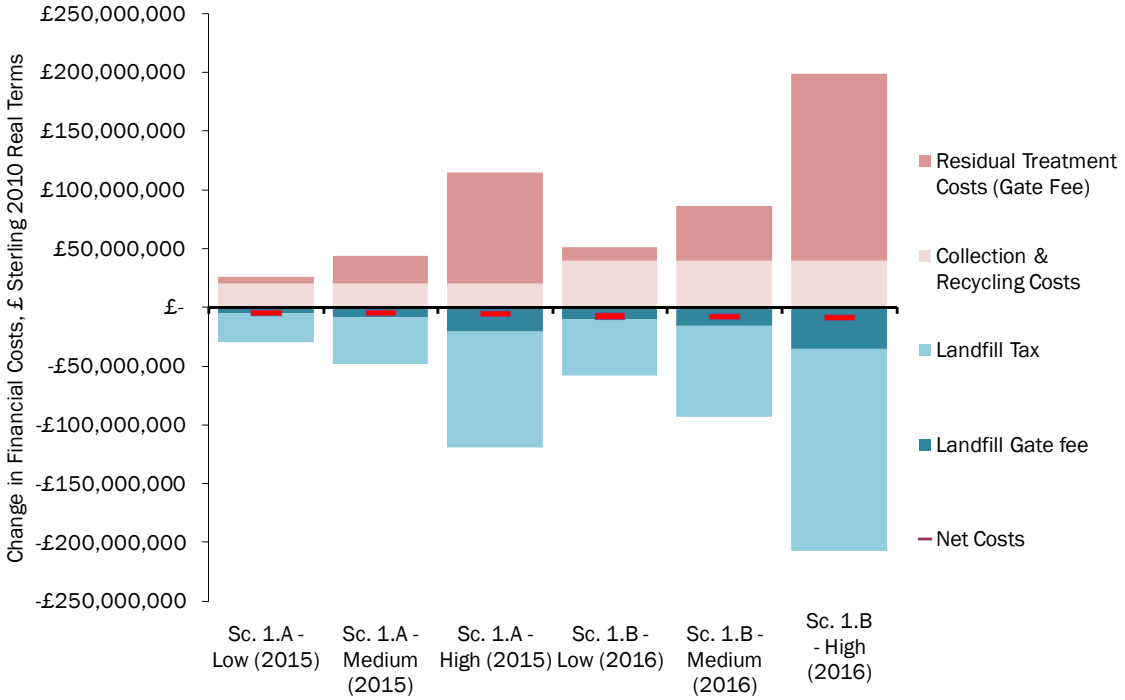
Table 7-14: Change in Costs to Scottish Local Authorities Relative to ZWP Baseline, £ thousands 2010 Real Terms

	£8 Sc. - Low (2015)	£8 Sc. - Medium (2015)	£8 Sc. - High (2015)	£16 Sc. - Low (2016)	£16 Sc. - Medium (2016)	£16 Sc. - High (2016)
Landfill Gate fee	-£320	-£512	-£1,279	-£621	-£994	-£2,485
Landfill Tax	-£1,554	-£2,487	-£6,217	-£3,020	-£4,832	-£12,081
Collection & Recycling Costs	£1,359	£1,359	£1,359	£2,640	£2,640	£2,640
Residual Treatment Costs (Gate Fee)	£436	£1,743	£6,970	£846	£3,386	£13,544
Net Costs	-£80	£103	£833	-£155	£200	£1,619

7.2.5 Costs to Businesses

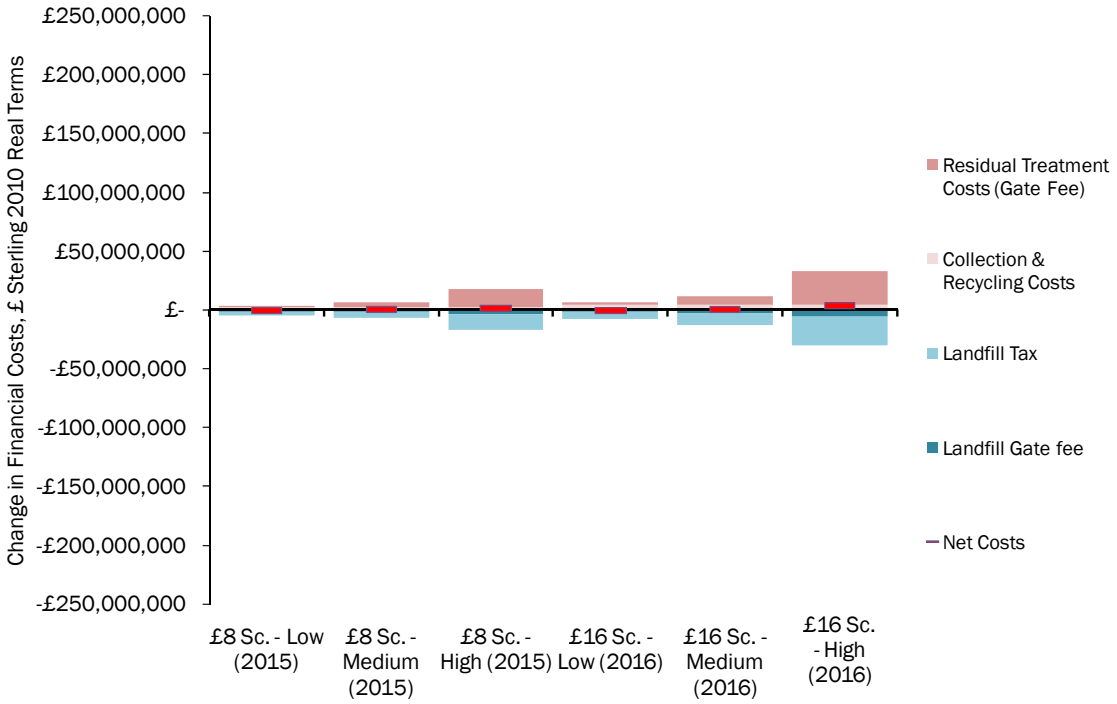
Figure 7-24 and Figure 7-25 show the change in costs to Scottish Businesses. Notwithstanding the uncertainties in the modelling, under BaU, the general position is that the increased costs of collection, recycling and residual waste treatment are offset by the savings resulting from reduced collection of refuse, landfill gate fee and the landfill tax. This is mostly due to the savings from recycling collections as the cost of residual treatments are only marginally lower than the price of landfilling – although there is a greater differential under the £16 per tonne increase scenario. Under the ZWP the costs of alternative residual treatments are higher due to the requirements of the Regulations. Therefore, as the proportion of residual treatments increase the savings fall and become a cost under the 'high' up-take scenario.

Figure 7-24: Change in Costs to Scottish Businesses Relative to BaU Baseline, £ 2010 Real Terms



Source: Eunomia Landfill Tax Model

Figure 7-25: Change in Costs to Scottish Businesses Relative to ZWP Baseline, £ 2010 Real Terms



Source: Eunomia Landfill Tax Model

The data corresponding to the figures above is presented in Table 7-15 and Table 7-16 (-ve figures represent a financial *saving*).

Table 7-15: Change in Costs to Scottish Local Authorities Relative to BaU Baseline, £ thousands 2010 Real Terms

	£8 Sc. - Low (2015)	£8 Sc. - Medium (2015)	£8 Sc. - High (2015)	£16 Sc. - Low (2016)	£16 Sc. - Medium (2016)	£16 Sc. - High (2016)
Landfill Gate fee	-£5,825	-£9,320	-£23,301	-£11,154	-£17,846	-£37,073
Landfill Tax	-£28,318	-£45,308	-£113,271	-£54,221	-£86,753	-£180,219
Collection & Recycling Costs	£21,917	£21,917	£21,917	£43,598	£43,598	£43,598
Residual Treatment Costs (Gate Fee)	£6,772	£27,087	£108,350	£12,966	£51,865	£163,622
Net Costs	-£5,454	-£5,624	-£6,305	-£8,811	-£9,136	-£10,073

Table 7-16: Change in Costs to Scottish Local Authorities Relative to ZWP Baseline, £ thousands 2010 Real Terms

	£8 Sc. - Low (2015)	£8 Sc. - Medium (2015)	£8 Sc. - High (2015)	£16 Sc. - Low (2016)	£16 Sc. - Medium (2016)	£16 Sc. - High (2016)
Landfill Gate fee	-£693	-£1,108	-£2,771	-£1,283	-£2,053	-£5,132
Landfill Tax	-£3,368	-£5,388	-£13,471	-£6,237	-£9,979	-£24,947
Collection & Recycling Costs	£2,821	£2,821	£2,821	£5,227	£5,227	£5,227
Residual Treatment Costs (Gate Fee)	£944	£3,776	£15,103	£1,748	£6,992	£27,969
Net Costs	-£296	£99	£1,681	-£545	£187	£3,116

7.2.6 Potential for Cross-Border Waste Movements

The modelling in Section 5.2 shows that there is a low potential for road-based cross-border impacts at landfill tax differentials of £8 or £16 per tonne, but the potential for rail-based transportation taking waste out of Scotland is not certain. Also exports to EU Member States may become feasible with an increase of £16 per tonne, giving a real-terms disposal cost of around £96 in the central belt of Scotland. If greater certainty is required, however, a border adjustment tax could be included in the landfill tax Statutory Instrument to inhibit any potential waste movements out of Scotland.

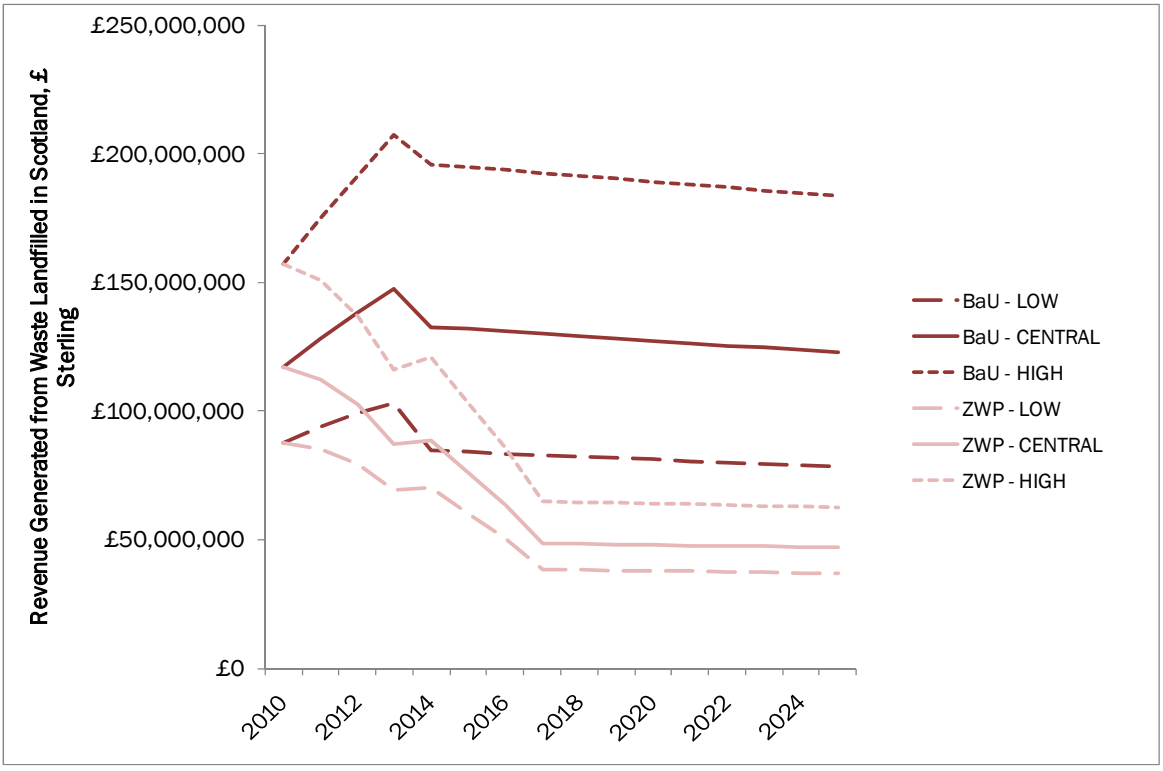
7.2.7 Sensitivity Analysis

Some issues relating to the quality of data available for this modelling work are discussed in Section 5.3. In consequence, some sensitivity analyses were undertaken around the central results provided hitherto in this section. High and low scenarios, relating to the calculated levels of landfilling, were modelled. The main parameters that were included in the sensitivity analysis were:

Parameter	LOW	HIGH
C&I Arisings	SEPA Landfill Site Returns dictating quantity landfilled and total waste generated figures are deflated.	Published data for C&I waste generation is taken from business waste survey and management proportions remain the same
Household waste projections (BaU baseline only – ZWP is fixed at 70% target)	Increase household recycling rate by +10%.	Decrease household recycling rate by -10%.
C&I Waste Projections (-0.5 Central Case Elasticity)	Decrease bounded rationality of cost curves thus resulting in more recycling and less landfill. Increase demand elasticities for recycling of other materials and treatment to -1.	Increase bounded rationality of cost curves thus resulting in less recycling and more landfill. Increase demand elasticities for recycling of other materials and treatment to -0.3. (for ZWP baseline this will only reduce recycling insofar as it remains above the carbon targets).

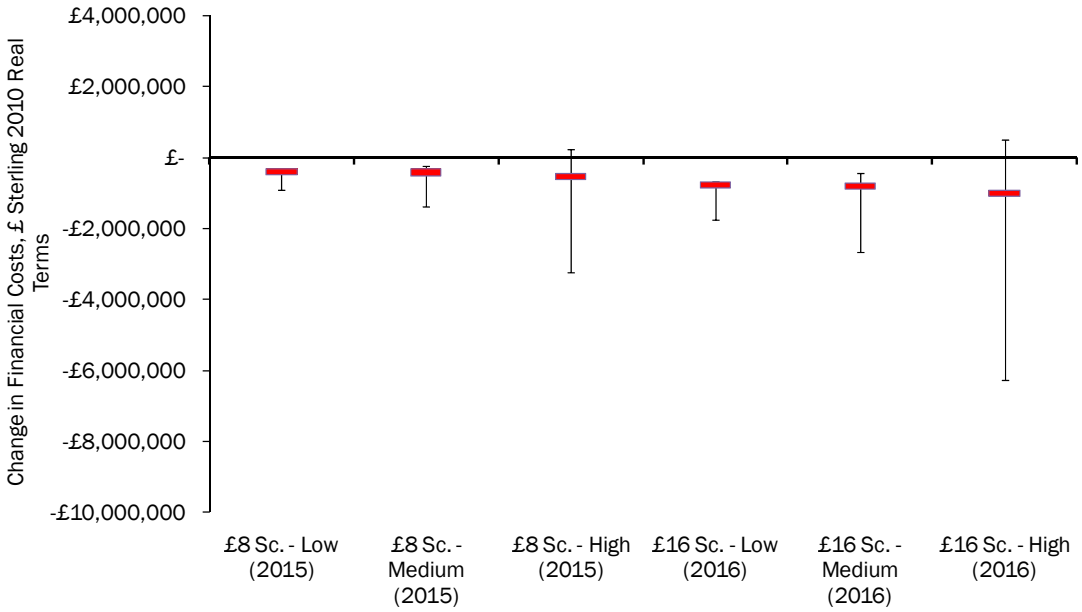
Parameter	LOW	HIGH
C&D Projections (-0.6 Central Case Elasticity)	Increase demand elasticities for recycling and treatment to -1.	Decrease demand elasticities for recycling and treatment to -0.3.
Taxable Proportion of Landfilled Waste (50% Central Case)	50%	65%
Treatment Cost Sensitivity (other C&I recycling costs, HWRC recycling costs, C&D recycling costs and residual treatment gate fees)	Increase costs by 10%	Reduce costs by 10%

Figure 7-26: Baseline Landfill Tax Revenue Generated under LOW, CENTRAL and HIGH Sensitivities (BaU and ZWP Baselines), £ 2010 Real Terms



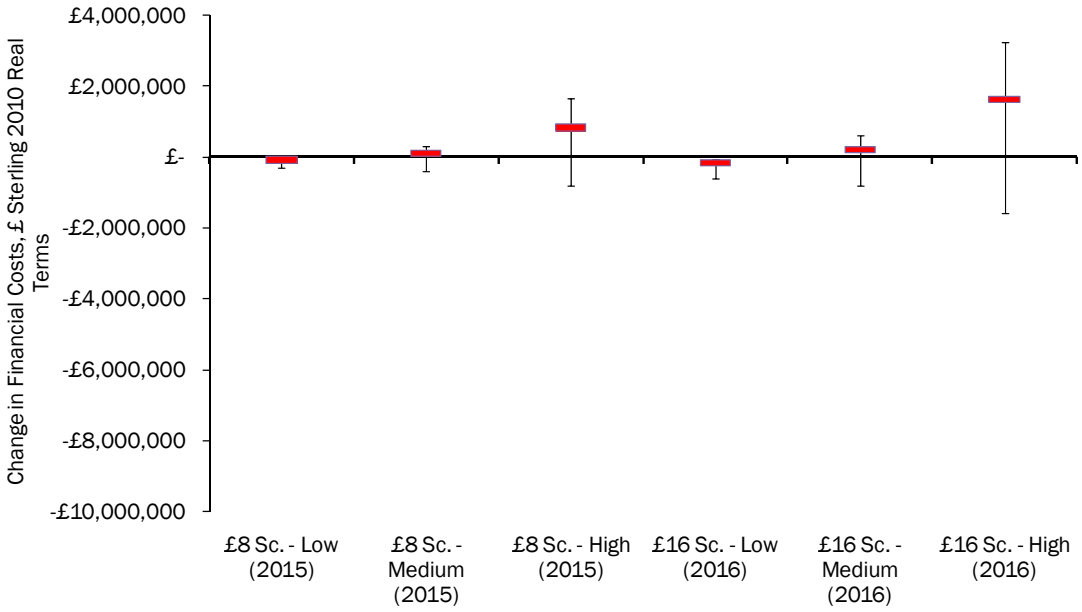
Source: Eunomia Landfill Tax Model

Figure 7-27: Net Costs to Local Authorities under £8 and £16 Increases in Standard Rate of Landfill Tax – Relative to BaU Baseline, £ 2010 Real Terms



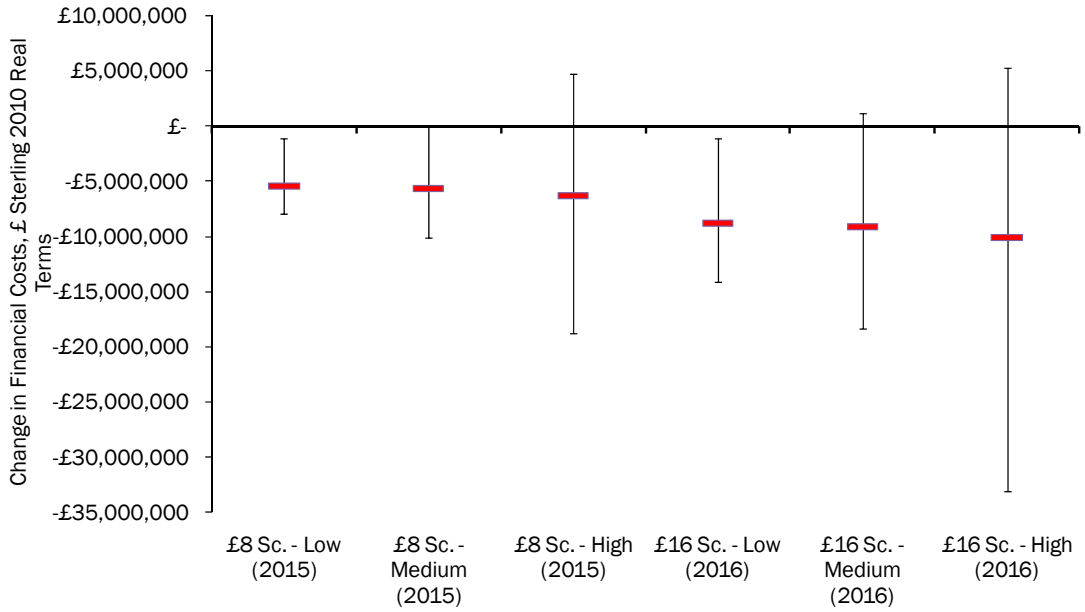
Note: Error Bars Indicate LOW and HIGH Sensitivities

Figure 7-28: Net Costs to Local Authorities under £8 and £16 Increases in Standard Rate of Landfill Tax – Relative to ZWP Baseline, £ 2010 Real Terms



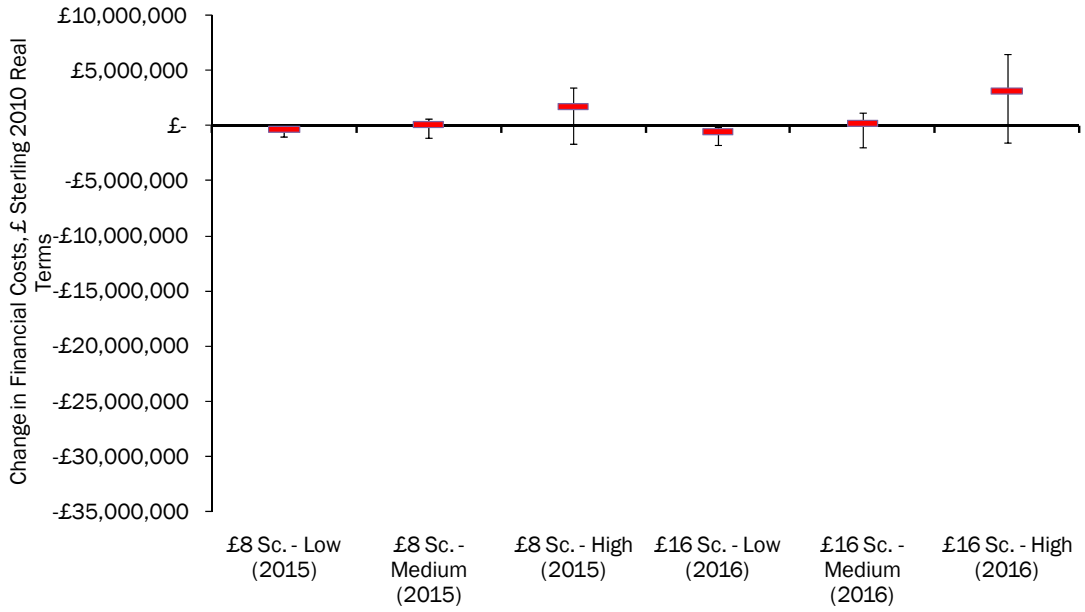
Note: Error Bars Indicate LOW and HIGH Sensitivities

Figure 7-29: Net Costs to Business under £8 and £16 Increases in Standard Rate of Landfill Tax – Relative to BaU Baseline, £ 2010 Real Terms



Note: Error Bars Indicate LOW and HIGH Sensitivities

Figure 7-30: Net Costs to Business under £8 and £16 Increases in Standard Rate of Landfill Tax – Relative to BaU Baseline, £ 2010 Real Terms



Note: Error Bars Indicate LOW and HIGH Sensitivities

The sensitivity analysis shows that there is a clear uncertainty in the quantity of waste landfilled and the revenue that will be generated for the Scottish Government. These uncertainties should be made clear when address the issues of a reduction in the block grant for Scotland when the powers to set the landfill tax are devolved.

The sensitivity analysis around the costs of increasing the standard rate of tax shows

that, again, there is some uncertainty in the results, but that, importantly, the mean values do not deviate from zero, or cost neutral, significantly. In addition, there is no instance where the financial costs switch to a significantly positive value. In the main this is due to the predicted state of the recycling market, where increasing costs of recycling are mostly, or fully, outweighed by the avoided costs of disposal.

8.0 Qualitative Assessment of Other Policy Options

In this Section of the report, the final policy options indicated in Section 4.0, and not fully modelled by the Scottish Landfill Tax Model, are discussed.

8.1 Policy Scenario: Increase Lower Rate of Tax

The HMRC landfill tax model, and other historic assessments of the effects of changes in the lower rate of landfill tax, use a simple demand elasticity approach to quantify the resultant diversion from landfill. However, these elasticities are not especially well known (to our knowledge, no one has made a serious attempt to estimate them through econometric analysis) and they might be rather sensitive to changes in tax levels since even small changes in tax levels imply rather large changes in the actual price of landfilling inert waste.

The market for processing inert waste, mainly from the construction and demolition sector, is now quite mature. The combined effect of the lower rate of landfill tax and the aggregates tax, as well as the Quality Protocol for secondary aggregates, have encouraged the recycling of material which is suitable for such use.

That having been said, as shown in Figure 7-11, it does appear as though a significant quantity is still being landfilled; the reason for this is not clear, either a lack of alternatives exist locally (transport costs are high), or the material is not of sufficient quality to be recycled into a product and not suitable for depositing in exempt sites, or the operators themselves are reducing pre-tax gate fees to 'bring in' material which they require for site engineering. The relevant demand elasticities (for landfill) are likely to be difficult to estimate: the possible responses to increases in tax range from operators dropping pre-tax gate fees to ensure they have sufficient site engineering material (presumably, they would do this up to the point where it becomes cheaper to acquire this material from alternative sources) through to waste carriers seeking to make increased use of material at sites exempt from licensing, through to waste generators making greater effort to segregate the material at source in such a way that more of it can be recycled (or otherwise beneficially used).

For example, waste deposited at sites exempt from tax is currently recorded by SEPA. However, the capacity of the sites and the potential for more to become available in the future is unknown. If the lower rate of tax increased operators may to seek out the closest exempt sites, if the nature of the waste permitted it. However, as the nature of the landfilled waste and the costs of alternatives are not well understood it is difficult to assess the resultant market behaviour. The whole picture is complicated further by the fact that, as well as sites exempt from permitting, an unknown quantity of material, there are materials which are landfilled but which are exempt from the tax. Evidently, this material is not affected by the increase in tax, but the mapping of 'what this material is' to 'how it is taxed' is far from perfect (and to our knowledge, has never been attempted).

It should be noted that we expect the increased Standard rate of tax under the

Baselines to also drive further separation of inert materials from mixed loads into recycling and recovery, thereby affecting the recycling and recovery market and making the quantification of marginal changes more complex. Thus a full quantitative assessment of the policy scenario is extremely difficult, especially as regards the environmental effects of the changes, since even if the reduction in the quantity of material landfilled was being accurately assessed, the new fate of that material would be rather difficult to predict.

What would be the effect if the Lower rate of tax was increased by £1 to £3.50 or £2.50 to £5? To add some context to the potential scale of inert waste diverted from landfill a simple analysis using demand elasticities has been carried out. The HMRC model supplied to Eunomia indicated a demand elasticity for Inert wastes of -0.6. As discussed above, it is likely that this is quite a high figure given the relative maturity of the market, and the fact that a range of cost-effective alternative management routes are already competitive with landfilling. The reality may well be that the key to understanding the effect of the tax is a much more localised understanding of (amongst other things):

1. how much further it makes sense to move materials as a consequence of the tax; and
2. the local availability – and this is subject to change – of suitable sites exempt from waste management licensing.

Thus the analysis includes elasticities of -0.6, -0.3 and -0.1 to show a range of results.

Table 8-1 shows that the potential for waste diversion from landfill could be between circa 50,000 to 270,000 tonnes per annum for an increase of the tax to £3.50 per tonne, and circa 100,000 to 470,000 tonnes per annum for an increase of the tax to £5.00 per tonne (no specific year has been modelled so the costs are effectively modelled in nominal terms, and thus represent maximum shifts of waste). These are large quantities, but a maximum of only 4% of all waste generated in Scotland. The propensity for waste to be exported to England for disposal is also uncertain, but the higher costs per tonne mile of transporting dense materials limit the distance to which waste will move economically per £ differential in price.

Table 8-1: Estimated Waste Landfilled at Lower Rate in Scotland, tonnes

	£1 Increase	£2.50 Increase
Baseline (2010)	1,458,485	1,458,485
-0.6	266,625	467,305
-0.3	140,035	256,145
-0.1	48,258	90,933

Source: Eunomia Landfill Tax Model

The change in revenues are also briefly considered. Table 8-2 shows the tonnage landfilled multiplied by the tax rates the material is landfilled at (note that the pre-tax

gate fee has been modelled as £0 per tonne). At higher elasticities the increased level of tax is offset by the reduction in landfilling so the additional revenue take is much smaller. Cost to business or Local Authorities associated with the landfilling itself is limited. If the price response is at the lower end of our estimate, then if the lower rate tax is increased to £5, revenues may double.

Table 8-2: Estimated Tax Revenue / Cost of Landfilling at Lower Rate in Scotland, £ millions 2010 Real Terms

	£1 Increase	£2.50 Increase
Baseline (2010)	£3.6	£3.6
-0.6	£4.2	£5.0
-0.3	£4.6	£6.0
-0.1	£4.9	£6.8

Source: Eunomia Landfill Tax Model

Note that the costs to businesses of this are not fully captured by the revenues for obvious reasons. The material alternative fates to which material is being sent still need to be paid for. This additional cost depends upon the fates to which the materials are sent.

As mentioned above, understanding the final destination of the diverted waste is not easy. In fact the current data on waste fates from the C&D data is limited. Most data sources are limited to high level categorisation of reuse, recycling or treatment. This is typified in Table 8-3 and Table 8-4 below. Thus estimating the fate, and resultant costs and benefits from any future policy scenarios is extremely difficult – the data is not good, and the waste-related data from site returns and the like cannot be squared with the data from HMRC. This simple fact applies to the UK as a whole, but the difficulties are exaggerated at the Scotland level simply because there are no figures from HMRC about the tax take related to sites in Scotland only (companies report on a UK basis, irrespective of how many landfills are based in England, Scotland, Wales, Northern Ireland etc.).

As such, considerable uncertainty remains regarding this proposal, in particular:

1. The quantitative effects on waste landfilled;
2. The change in revenues which a tax might lead to; and
3. The environmental consequences of any reduction in waste landfilled.

As regards the last of these, it is not even clear that changes would be unequivocally positive. If operators are required, as a result of the tax, to resort to use of primary materials, there may be some disbenefits associated with the approach, especially if the material which otherwise would have been landfilled is moved into sham recovery routes.

Table 8-3: Fate of Scottish C&D Waste Arisings in 2009, tonnes

EWC STAT code[1]	EWC description	Treated on site		Land treatment	
		Non-Haz.	Haz.	Non-Haz.	Haz.
12.11.0	Concrete, bricks and gypsum	434,762	0	289,511	0
12.11.1		0	19		
12.12.0	Waste hydrocarbonised road-surfacing material	15,364	0	59,123	0
12.12.1		0	2,118		
12.13.0	Mixed construction wastes	721,369	0	720	0
12.13.1		0	1,883		
Total		1,171,495	4,020	349,354	0
		1,175,515		*349,354*	

Note: 1. European Waste Catalogue for Statistics (ECW STAT) code; 2. Non-hazardous waste; 3. Hazardous waste.

Source: SEPA 2011

Table 8-4: Management options for C&D waste in the UK

Fate	% used
Aggregate used on site	17
Aggregate removed off site	24
Aggregate crushed on site for use on site	36
Aggregate crushed on site for offsite sale	14
Total landfill	6
Total hazardous	3

Source: CRW (2009) Overview of Demolition Waste in the UK, a report by the Construction Resources & Waste Platform, www.crwplatform.co.uk/conwaste/crwp-publications/

8.1.1 Summary

Increase Level of Lower Rate Tax

PROs	*CONs*
Increased costs of disposal would allow for other recycling options to become cost effective and provide the economic stimulus for operators to reduce the quantities of inert waste landfilled (mainly from the C&D sector and combustion residues from the Industrial sector).	The magnitude and destination of the waste diverted from landfill is not certain. There is a possibility that wastes would simply be diverted to exempt sites where the value of the recovery activity might be limited.
The modelling suggests that increasing the level of tax would stimulate landfill diversion.	Although the costs of transport are higher for dense materials, there is still the possibility that wastes would migrate across the border to England for disposal, unless constraining mechanisms were put in place. However, there would appear to be a very low likelihood of this happening.
It is possible that the recycling and recovery of inert wastes would increase.	Landfill operators, some of whom are already struggling to find relevant engineering materials, may find the tax exacerbates shortages.
	Some landfill operators in need of engineering materials may simply absorb the tax in preference to paying for alternative materials. The tax might not always be 'passed through' to waste producers, therefore, with the tax incident largely on the operators in these cases.

8.2 Policy Scenario: Lower Rate of Landfill Tax for Stabilised Wastes

Most residual waste treatment processes generate some form of residue. For incinerators, this is in the form of ash and air pollution control residues. For some configurations of mechanical biological treatment (MBT), the rationale for the process is largely predicated upon rendering the landfilling of the residue (relatively) problem-free. The concept emerged in Germany out of discussions regarding how to make landfill less problematic.

Because residues from MBT are considered as taxable at the standard rate, the fact that a relatively large quantity of material from MBT may be destined for landfill makes the effect of the tax especially strong on the costs of the overall treatment concept. Elsewhere, we have sought to demonstrate the rationale for a lower rate of tax for waste which has been stabilised such that its fermentability falls below a specified threshold (typically, of the order 10mg O_2 / g d.m.).[62]

Without a lower rate for stabilised wastes, the costs of Scotland meeting the requirement to pre-treat waste under the ZWP Baseline are increased. This is subject, however, to the way in which the Regulation regarding landfilling of waste (no more than 5% overall) is implemented. On the other hand, for reasons discussed in Section 5.1, if a lower rate for stabilised biowaste means that residual waste treatment through MBT becomes rather less costly than landfill, so this might reduce the level of recycling achieved under the BaU Baseline.

Another effect of a lower rate for stabilised biowaste is that there is a weaker rationale for choosing processes which are generally slower to implement and for which the non-tax element of the costs borne by WDAs is higher. As it is this 'non-tax element' which determines the magnitude of new funds required by the public sector in the round, in the current situation, the funding gap for waste management services would be lower than would be the case under the current system (central government would still receive revenue from the landfilling of the residue even where the material was being pre-treated).

The Eunomia paper from 2008 put forward the case for 'biostabilised' wastes from MBT facilities receiving the same level of taxation as incinerator bottom ash and soils, which can be shown to have similar externalities when sent to landfill. The evidence base shows that a differential rate of Landfill Tax for 'biostabilised' wastes would:

- Reduce contract prices for all forms of MBT, as sending 'biostabilised' wastes to landfill represents the 'backstop' option for managing market failure;
- Allow MBT facilities to be implemented to meet Scotland's future objectives at

[62] Eunomia (2008) *'Biostabilisation' of Waste: Making the Case for a Differential Rate of Landfill Tax*, January 2008, http://www.eunomia.co.uk/shopimages/Eunomia%20Landfill%20Tax%20Paper%20Final.pdf

least cost;

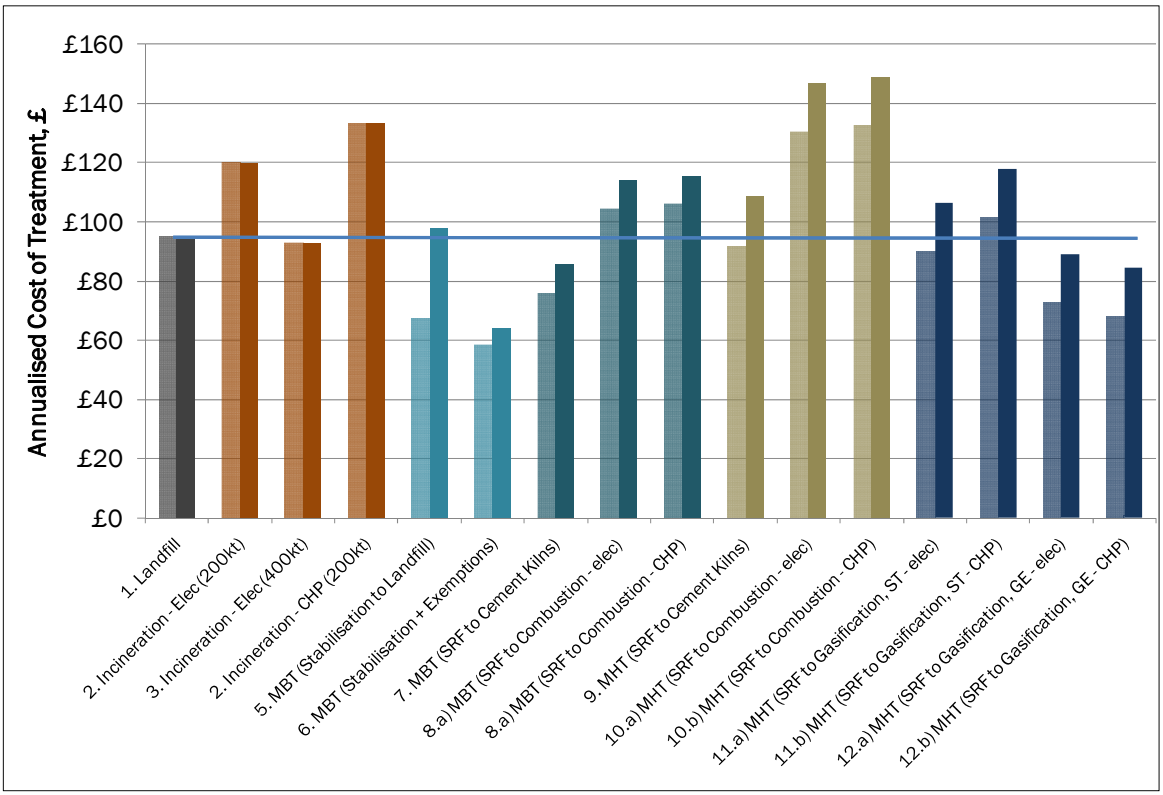
- Promote technologies that can be fully integrated wider waste management strategies, which include both separate collection and treatment of kitchen wastes and incineration;
- Lower the overall environmental impacts of landfill, and waste management more generally, in the UK, particularly with regard to climate change.

The modelling clearly demonstrated that there is a significant difference between the externalities of landfilling untreated wastes compared to those from landfilling 'biostabilised' wastes, and that a differential rate of tax is, therefore, justified. It should be acknowledged, however, that modelling of this kind is subject to a range of assumptions and will thus always be somewhat controversial. However, more recent work for the Irish Government suggests that the externalities associated with landfilling stabilised waste are, on average, around £25 per tonne.

The ZWP includes the desire to implement landfill bans on biodegradable waste in such a manner that would require waste to be pre-treated, by processes such as MBT, before landfilling by around 2017. This would drive the market to develop MBT plants, but still at a higher cost than the externalities suggest is reasonable. Therefore, given the requirements to pre-treat waste before landfilling and the economic constraints on Local Authorities and businesses, the level of tax levied on stabilised wastes should be reduced from the standard rate to around £25 per tonne.

It is difficult to model, quantitatively, the changes in the waste market following from the introduction of this policy, as a result of the uncertainties in the outcomes of the residual waste treatment market. So some cost data and the key issues are discussed only. If this policy option was implemented, the possible change in gate fees is shown in Figure 8-1. The modelling suggests a decrease of average gate fees from £105 to £96 per tonne, and a major reduction in the cost of MBT where residual waste is consigned to landfill.

Figure 8-1: Potential Changes in Gate Fees as a Result of a £25 Landfill Tax on Stabilised Wastes, £ 2010 Real Terms



Note: The left column of each treatment shows the gate fee with the lower rate of tax. The right column includes residues taxed at £80 per tonne.

Source: Eunomia Residual Treatment Financial Cost Model

In terms of the economic description of how the waste market operates (see Section 5.1), this reduction in gate fees lowers the residual waste treatment cost curve, potentially below the current 'back-stop' cost of disposal (landfill), so becoming the primary benchmark figure for the avoided cost of disposal. If this cost falls significantly it may inhibit the separate collection of waste for reuse, recycling, composting and digestion. Therefore, the timing of this policy is important. However, with the ZWP regulations in place there are significant drivers to recycle, thus the lowering of the tax for stabilised wastes is less likely to stimulate excessive growth in treatment capacity. Moreover, if non-thermal processes are favoured, it will reduce the overall costs to Local Authorities and businesses which comply with the Regulations.

What seems clear regarding this policy is that if it were implemented against the backdrop of the ZWP, then since the Regulations themselves exert a fairly strong effect on recycling, then the potential for a lower rate of tax for stabilised waste to reduce the rate recycling is not as significant as under BaU. Under BaU, therefore, a pragmatic approach to the setting of the tax rate would be warranted so that – if the intention was to allow the tax to drive recycling forward - the cost of MBT was not bellow (or not significantly below) the cost of landfilling. A ceiling rate of £50-£60 per tonne would be warranted on this basis.

8.2.1 Summary

Lower Rate for Stabilised Wastes

PROs	*CONs*
The research suggests that stabilised wastes produce less methane emissions when landfilled, and thus cause less global environmental damage. The monetised environmental damages are estimated to be around £15 per tonne, less than the £61 to £76 range estimated for untreated residual waste. As the UK landfill tax was based upon the principle of internalising environmental externalities, it is appropriate to set the level of the landfill tax at around this lower level.	The research around landfill emissions is caveated by a number of assumptions and modelling parameters. Thus the extent of the reduction in environmental damages resulting from stabilisation of waste is not certain.
The reduction in disposal costs for processes which stabilise wastes will translate to lower gate fees for businesses and Local Authorities. This would be helpful in the current economic climate.	By reducing the gate fees for residual waste treatment processes, the cost of stabilising waste before landfilling might become the 'back-stop' price in the residual waste market. This would reduce the financial drivers for more recycling and waste prevention. It should be noted, however, that this issue is more of a concern under BaU than under ZWP, since under ZWP, specific drivers seek to deliver additional recycling at levels in excess of what the tax alone seems likely to deliver.
This policy aligns with the aim to ban biodegradable waste under the Zero Waste Plan (ZWP).	If the costs of residual waste treatment fall in Scotland, compared with England, this may stimulate 'waste tourism' to Scotland. For reasons discussed in Section 9.6.4, however, the differentials would likely need to become significant for this to occur.
	Potentially introduces a new rate into an established tax structure.

8.3 Policy Scenario: Introduce Incineration Tax

The research in this study including an analysis of international literature has suggested that there is a justifiable case of a tax on incineration on environmental grounds. Appendix A.1.0 indicates that the externalities range from around £10 per tonne to £50 per tonne. The key point to note is that, as with the climate change impacts, damage costs for air pollution are much lower in the earlier studies, even allowing for cost increases as a result of inflation - this reflects the increased awareness over time of the nature of pollution impacts of upon human health. Therefore the current understanding tends towards a higher figure for the externalities. £30 per tonne is a reasonable average figure from the literature.

In this section the different types of tax mechanism are described and how they could be implemented and enforced. However, for the modelling purposes a representative tax level, derived from the literature review, is simply applied to the tonnage of waste treated. It is not the intention of this study to fully define how such a mechanism may work, but simply to show the general principles and effects of such a tax. The actual mechanism would need to be further defined and agreed by the Scottish Government, however, it should be noted that this option would require legislative change at a UK level, is outwith the scope of assessing a Scottish landfill tax and therefore is not currently being considered.

The definition of incineration for the purposes of this analysis includes all thermal treatment processes for residual waste treatment (including gasification and pyrolysis). The different processes that should be covered by the tax, therefore, are:

- Incineration (moving grate and fluidised bed); and
- Gasification and pyrolysis.

There is no reason why, in principle, such a tax should not be extended to other residual waste treatments in line with their externalities (and the lower rate for stabilised biowaste is one such example).

The two main mechanisms that have been used to tax energy from waste plants are as follows:

1) Weight based – where the tax is applied to the weight of the material entering the EfW plant; and
2) Emissions based – where the tax is applied to the measurements of different pollutants expelled into the atmosphere from the plant.

The benefits of a weight based tax mechanism are that the measurement and administration of the tax is simpler and cheaper. In principle, although tax returns would be expected to be submitted by the operator to HMRC (or an alternative agency), site returns should be capable of providing the basis for a check on the quantities being incinerated. If some pre-sorting of metals, or other materials, is undertaken pre-combustion, this quantity should be subtracted from the figure used to assess waste for the tax. The final quantity of waste entering the thermal plant is thus recorded and returns sent to HMRC (or the body used to collect the tax if this is not HMRC) on a quarterly basis.

This type of mechanism is most applicable if the Government simply wants to affect

the relative costs of different waste management processes and steer the market in one direction or another.

Weight-based mechanisms, such as the one just described, provide no incentive for the operator of the facility to reduce the levels of emissions below legal thresholds stipulated by the EU Waste Incineration Directive (and it is these emissions, particularly of NO_x, which lead to the generation of a significant proportion of the externalities). With an additional emissions based tax, the operator can make the decision as to whether it is worthwhile to invest in more expensive pollution abatement control technologies, and thus lower the amount of tax that is required to be paid, or pay the higher levels of tax. This mechanism would improve the performance of plant above and beyond the primary effects mentioned above.

The reduction of pollutant emissions within exhaust gases produced by combustion systems can be achieved by:

- Avoiding the formation of such substances in the first instance – defined as *primary* measures for pollution reduction; and
- The removal of the pollutants from the exhaust gas after they have been formed - described as *secondary* measures. [63]

Primary measures include technological activities for reducing emissions resulting from incomplete combustion (dust; PM_{10}; CO; NMVOC; PAH; PCDD/F; heavy metal; SO_2; NOx). Primary measures include:

- Modification of fuel granulation by means of compaction processes e.g. pelletisation, and supervision of the distribution of the fuel;
- Use of a catalyst or combustion modifier, or catalytic converter;
- Homogenisation and stabilisation of the moisture content of the fuel; and
- Combustion process control optimisation.

Secondary measures are used to reduce particulate matter emissions. This will also reduce the other emissions linked to particulate matter – heavy metals, PAHs, PCDD/F. Secondary measures to reduce particulates include:

- Multiple cyclone separators (these were considered standard for Swedish boilers in 2003) which can have thermal efficiencies of 94-99%;[64] and
- Electrostatic precipitators (99.5% efficiency & above) or fabric filters (99.9% efficiency), although the former are not usually financially viable for small facilities.[65]

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[63] Kubica K, Paradiz B and Dilara P (2007) *Small combustion installations: techniques, emissions and measures for emission reductio*n, report for the EC JRC / IES

[64] Pagels J, Strand M, Rissler J, Szpila A, Gudmundsson A, Boghard M, Lillieblad L, Sanati M and Swietlicki E (2003) Characteristics of aerosol particles formed during grate combustion of moist forest residue, *Aerosol Science*, 34 p1034-1059

[65] Kubica K, Paradiz B and Dilara P (2007) *Small combustion installations: techniques, emissions and*

Secondary measures for control of PCDD/F, NOx and SO_2 also exist, namely:

- Selective Non-Catalytic Reduction (SNCR) systems which inject ammonia into the boiler;
- SCR systems, such as have been described with respect to NOx emissions resulting from the combustion of biogas or syngas. Whilst this system has a greater efficiency of NOx destruction in comparison to the SNCR approach, more process energy must be used.

Under this mechanism sensors are placed in the flue gas that is released to the atmosphere. Continuous measurements are made or checked every half hour, for example, and the data stored on computer in the operations room. For the pollutants covered by the WID, incinerators, or other thermal plants, are required to show they are meeting the requirements of the Directive so much of the relevant monitoring equipment and associated data will already be in place.

In a pollutant-based tax, the tax would be based upon the quantity of the emissions released, and each particular pollutant would have its own associated tax rate (i.e. a tax per unit of emission of the specified pollutant). This type of approach is expected to allow operators to determine the optimal level of pollution control for them given the unit tax rates applied to the pollutants (economically rational operators would be expected to abate emissions of the pollutants up to the point where marginal costs of further abatement were equal to the tax rates applied to them).

At this stage of research the detail of how the tax should be administered has not been suggested. In the modelling work, therefore, a single unit based level of tax has been applied to the input tonnage of EfW facilities. This is expected to reflect the overall level of tax the operator pays over the year. The research suggests that the level of Incineration tax should be around £30 per tonne residual waste treated for all residual thermal processes (see Appendix A.1.0). This tax should be set in 2011 real terms and increased year on year by inflation.

In considering this policy scenario, this level of tax has been applied to the gate fee of the EfW plants, and the resulting change in tax revenue and cost of treatment is shown. Some assessment of how the change in gate fee will affect the residual waste treatment market is also made. However, for reasons explained in Section 5.1, it is very difficult to assess the likely effect on the supply of different residual waste treatment, or disposal, options.

There are a number of incinerators already operating in Scotland. Several Authorities have procured facilities or are in the process of doing so. Older facilities tend to have lower gate fees than newer plants, or those currently being built, or in the procurement process.[66] For some older facilities, a £30 per tonne tax, in real terms, may imply a significant additional cost. However, the nature of contracts governing the supply of waste to such facilities is likely to be such that there would be little response to these changing prices where existing facilities are concerned. Most

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*measures for emission reductio*n, report for the EC JRC / IES

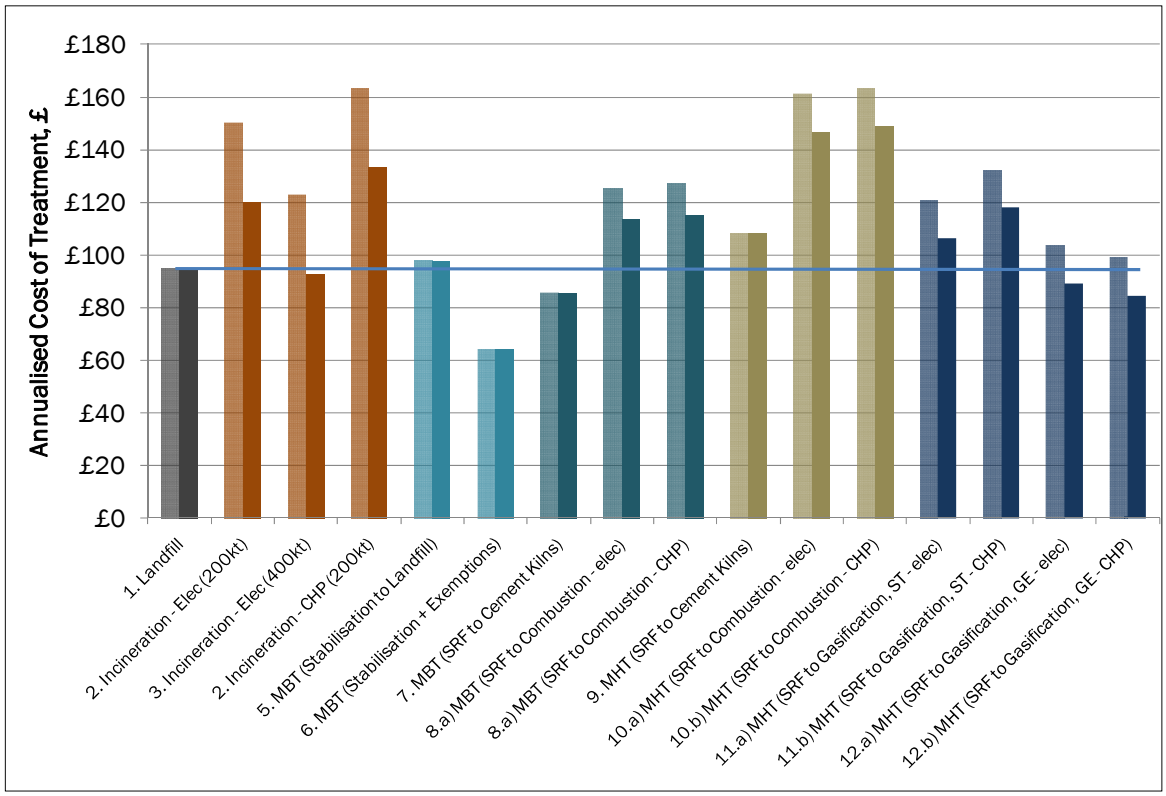
[66] Eunomia (2011) WRAP Gate Fees Survey 4, Report still to be published.

contracts will include ‘change of law’ conditions, which set out how the effects of changes in law will be felt within a given contract. It would be expected that contracts with well-specified clauses in would either allow for contractors to increase their unitary payments under such changes (i.e. they pass the tax on to the other contracting party) or they effectively require the contracting party to pay all such taxes (which amounts to much the same thing).

Again, this option is difficult to model quantitatively, as a result of the uncertainties in the outcomes of the residual waste treatment market. So the relative changes in gate fees are first presented to contextualise the discussion. Figure 8-2 shows the possible increases in gate fees as a result of a £30 incineration tax. In essence, this raises the residual waste treatment cost curve. In this instance, the modelling suggests an increase of average gate fees from £105 to £120 per tonne. At current price levels, all incineration options effectively become ‘too expensive’, and it would be expected that procurements ongoing at the time of any announcement would be affected significantly by this.

The actual level of tax will influence the relative costs of different waste treatment costs and shape the treatment market. If the tax shifts the cost of thermal options so that they are much less competitive with landfilling, then the likelihood would be that under BaU the Baseline, even less waste is treated than might have been envisaged. The effect relative to the ZWP baseline would, potentially, be to increase the costs of the pre-treatment requirement. Indeed, the measure could introduce additional costs for industry and local authorities without any significant change in outcomes. If the incinerator tax was to be introduced, then in principle, the likelihood of additional environmentally beneficial changes being introduced would be enhanced if the landfill tax was raised at the same time. This would increases the marginal benefits of avoided disposal / treatment of residual waste and strengthen incentives for higher-in-hierarchy applications.

Figure 8-2: Potential Changes in Gate Fees as a Result of a £30 Incineration Tax, £ 2010 Real Terms



Note: The left column of each treatment shows the gate fee with the Incineration tax. The right column includes residues taxed at £80 per tonne.

Source: Eunomia Residual Treatment Financial Cost Model

It should be noted that as with the lower tax on stabilised waste, the timing of announcement of this tax is critical. Unless the aim is purely to raise revenue, then the aim ought to be to influence decision making, not to tax retrospectively once decisions have been made. As such, early announcement of the intent would be necessary to avoid the industry being disillusioned by the apparently ad hoc nature of decisions regarding tax policy.

8.3.1 Summary

Extend the Landfill Tax to Incineration

PROs	*CONs*
Under BaU, the policy ensures that waste does not simply switch from landfill to other residual waste treatments.	There is currently no legal basis for this tax in Scotland and it lies outwith the scope of the devolved landfill tax policy.
The evidence suggests that there are environmental externalities associated with incineration which are not currently internalised in any policy mechanism, only WID emission limits which seek to constrain the risks of airborne pollutants exist.	Indecisive action on this policy could result in further uncertainty, and future costs, for Scottish businesses.
The policy can be designed to promote abatement of emissions which contribute to health damages.	The tax could be undermined if facilities with available capacity exist in the rest of the UK, or in other EU Member States.
	May increase costs of residual waste management to local authorities and businesses (depending upon counterfactual).

8.4 Policy Scenario: Revenue Used to Refund Recycling Activities

In this policy option revenue generated from the landfill tax would be refunded to pay for investment in the development of recycling activities. At this time, the mechanism for instigating and managing these funds outside of public sector control has not been considered. In fact there are more significant obstacles to ensuring the fair distribution of funds across multiple companies and business sectors. Therefore, this mechanism only relates to the waste that comes under the management of local authorities.

The exact mechanism for incentivising recycling activities for LAs is yet to be determined. The Scottish Government believed that further detailed research into a range of policy options would be required, and Local Authorities would have to be consulted with and the mechanism agreed. Therefore, a range of potential options will be discussed but without any single option being modelled in detail. Moreover, the degree to which refunding would be considered as 'ring-fencing' under the existing Concordat has also not been assessed. It would be at the discretion of the Scottish Government to consider if these plans were to be taken further.

8.4.1 The Catalonia Example

One option could be similar in nature to that used in the Catalonia region of Spain. A possible model would involve refunding a part of (or all of) the tax paid by local authorities on landfilling of local authority managed waste. The Catalonian landfill tax mechanism is described in detail in Appendix A.8.0. In short, the landfill tax in Catalonia is levied on all municipal waste being sent to public or private landfills in Catalonia. The tax is paid by the local authorities that operate, or contract out the operation of the municipal waste management service and the municipal waste producers. The tax is paid when the waste holder delivers the waste to the landfill operator or incinerator plant. At present the landfill tax rate is set at €10 (£8.75) per tonne of waste sent to landfill for municipalities that operate separate biowaste collection services, and €20 (£17.50) per tonne for those that fail to do so (at present only two municipalities pay these higher levies).

The funds generated from the landfill tax are transferred into an environmental fund (Fons de Gestió de Residus) which is used to finance waste diversion activities (e.g. separate waste collections, recycling, composting). This fund is managed by the Waste Agency of Catalonia (Agència de Residus de Catalunya) who receive the taxes from the local municipalities and industries producing waste which is similar to municipal solid waste

The funds are then redistributed to Municipalities, 50% being used to improve the separation and treatment of organic wastes, and the remainder being used for infrastructure for separate collection, recovery and pre-treatment, and educational

activities.[67] The municipalities fund much of the infrastructure required for the collection of organic, and other wastes, from businesses also: thus the tax is levied on household and similar wastes from commercial and industrial sectors. In the scenario considered in this report, the tax would only be levied on household waste and therefore the refunded revenue would only be used by Local Authorities to fund the separate collection of biowastes from households.

8.4.2 Options for Scotland

8.4.2.1 Catalonia-based System

The first option that the Scottish Government could consider is based on the Catalonia tax system, and effectively directly refunds tax revenue to all Local Authorities that chose to implement a separate food waste collection service. It is noted that this is an example of how the mechanism could be structured, and that funding other services could be prioritised after consultation with Local Authorities. Under this system only the separate collection of food waste would be funded, in line with the proposed ZWP Regulations. Much previous research has shown that a more efficient service configuration is achieved when householders are charged for the garden waste service rather than being given the service free of charge.[68]

The fund would be managed by whatever is the most competent authority set up to manage the receipts from the devolved tax mechanisms (this detail is not as important at this stage of development as the workings of the policy). As in the Catalonian example, weightings could be used to differentiate the level of refund between urban, mixed and rural areas, reflecting the different densities of the logistics. An important part of the mechanism would be to reduce the refund where higher levels of contamination were observed. This would incentivise Authorities to implement robust collection services which, following organic treatment, would result in higher quality compost outputs. A novel addition might be to incorporate some link to the carbon metric in the refunding mechanism.

Of course, depending on the level of revenue generated, other recycling activities could also be refunded. This could also be the case where local conditions would result in a very high cost of food collection waste services. The types of activity that could be included are:

- Separate collection of dry recyclables;

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[67] EC (2008) *Organisation of Awareness-raising Events Concerning the Application and Enforcement of Community Legislation on Shipments of Waste and on Landfills, Report Extract: Spain*, a report by BiRPO for the European Commission, November 2008, www.bipro.de/waste-events/doc/events08/Report%20Extract%20Landfill%20ES.pdf.

[68] See Eunomia (2007) *Managing Biowastes from Households in the UK: Applying Life-cycle Thinking in the Framework of Cost-benefit Analysis*, Banbury, Oxon: WRAP; Eunomia (2007) *Dealing with Food Waste in the UK*, Report for WRAP, March 2007, http://www.wrap.org.uk/downloads/Dealing_with_Food_Waste_-_Final_-_2_March_07.2c685030.3603.pdf.

- Collection of recyclables at household waste recycling centres;
- Pre-treatment of residual waste before landfilling to remove recyclables and reduce biodegradability; and
- Pre-treatment of residual waste before energy from waste processes to remove recyclables.

The amount of refunding available to the LAs would of course depend on how much tax revenue was available from the landfilling of household wastes. It would also depend upon the up-take of services: the faster the up-take, the less available for each LA. As landfill tax revenues diminished, the funding for the continued operation of the services would also be more limited unless (for example) other residual waste treatments were also subject to a tax which was to refunded in a similar way.

To give a representative view of the amount of revenue available for refunding, the total, and per household, tax revenue generated from landfilling household waste under the BaU and ZWP baselines is shown in Table 8-5 below.

Table 8-5: Refunding Available under Baseline Mass-flows

	2015	2020	2025
Total Revenue, £ millions 2010 Real Terms			
Business as Usual	£61	£61	£61
Zero Waste Plan	£50	£3	£3
Per Household, £ 2010 Real Terms			
Business as Usual	£25.88	£25.88	£25.88
Zero Waste Plan	£21.19	£1.22	£1.23

Source: Eunomia

Table 8-6 shows that the per household, separate food waste collections costs are somewhere between around £7 and £15 depending on, amongst other factors, whether the LA is rural, urban or mixed in categorisation and what type of vehicle is used.

Table 8-6: Modelled Per Household Collection Costs for Separate Food Waste Collection in Scotland, £ 2010 Real Terms

Authority Type	Combined with dry recycling on stillage vehicle	Separate food waste vehicle (when recycling commingled)
Urban	£7.78	£8.46
Mixed	£9.46	£11.02
Rural	£11.05	£14.07

Source: Eunomia collection modelling – see Appendix A.7.0 for a summary of the model

Table 8-5 and Table 8-6 shows that as long as the ZWP Regulations are enacted and enforced there would be limited scope for full financing of separate food waste collections in the long term. Rather, in this context, the revenue refunding would become a form of 'transition funding'. In addition, the potential £2 million of ongoing receipts from the household sector is also small fraction of the estimated £150 million that will be required to fund household waste collection services in Scotland every year (figure estimated during a recent cost benefit analysis of the Scottish Zero Waste Plan).[69] However, in early years after the devolution of the tax, before landfill tax receipts fall and all LAs procure services, there is a healthy fund that could be used to catalyse the initiation of separate food waste collections, as well as fund other activities.

Alongside the development of any incentive schemes which focused on the collection of food waste, for example, some consideration would have to be given to the varying investment cycles Local Authorities are in. Some may have just procured collection services, and for these authorities changing the nature of the service, or contract, may be more challenging than for those at the start of the process, thus penalising those who have already recently embarked upon the introduction of new services.

8.4.2.2 Incentive-based Schemes

Given the size of the pot available, however, some competition could be included in the mechanism to either incentivise the introduction of services by refunding revenue based on performance. Refunding options could be based upon performance relative to a specified target, such as:

a) The amount by which an authority exceeds (betters) performance against a specific target for residual waste; or

b) The amount by which an authority exceeds (betters) performance against a

[69] Eunomia (2011) *Economic Assessment of the Zero Waste Plan for Scotland*, Final Report for WRAP. April 2011

target set in relation to the carbon metric currently under consideration.

In principle, the mechanism would include refunding of all the revenue identified for the purpose to the authorities in proportion to their performance against the target. To elucidate the mechanism two examples are provided that relate to the performance targets described in a) and b) above.

Firstly, a target on the performance of an authority's ability to limit the quantity of residual waste could be set. If a target of this nature is required it provides incentives for waste prevention as well as reuse and recycling, rather than just focusing on a recycling rate. Moreover, it does not necessarily unfairly disadvantage those authorities with demographics considered to inhibit high levels of recycling, such as those with high levels of high-rise properties (where the waste generation figures tend to be lower). The current levels of performance for Scottish Authorities, in terms of residual waste arisings per inhabitant, are given in Table 8-7.

This data is easily calculated from WasteDataFlow returns and the number of households in each authority. Average waste generation for all Scottish households is around 1,240 kgs / hhld / yr. If a residual waste target of 300 kgs / hhld / yr was set, for example, authorities would receive a percentage of the total revenue generated from landfill tax receipts depending on how far they were from this target. If, for example, the reciprocal of the distance from the target to the current performance was taken, and normalised, a percentage of the total landfill tax receipts for household waste could be refunded to each authority. The principle being that the lower the residual waste per household the greater the level of refund, providing an incentive to invest in interventions that reduce residual waste before other authorities.

This type of approach could also be used with respect to the carbon metric recycling target. Each local authority's carbon metric based performance would be assessed and distance from the nearest target (in terms of the year) used to apportion the refunds in a similar manner to that discussed above.

One of the key arguments against this type of approach is that it could favour those authorities that are already performing to a higher level, thereby further penalising those authorities that struggle to gain access to funding for high quality services needed to return high capture rates. Therefore, an alternative approach would be to create a more level 'playing field' and refund tax revenues based upon *change in* performance year-on-year. For each year the change in residual waste per household could be easily calculated; the greater the change the greater the refund. This does, to some degree, further benefit those already at lower levels of performance as, in general, larger increases in recycling can be made for lower cost at lower levels; the higher the recycling rate the lower the marginal increase in recycling for a given cost. This mechanism would also continue to provide ongoing incentives to recycle, as opposed to where higher proportions of refunding are simply paid to lower performing authorities, resulting in an increasing benefit for staying in the *status quo* position.

Table 8-7: Residual Household Waste per Household, kgs / annum / year

Authority	Residual Waste Per Household	Authority	Residual Waste Per Household
Aberdeen	952	Highland	775
Aberdeenshire	991	Inverclyde	696
Angus	814	Midlothian	845
Argyll and Bute	794	Moray	782
Clackmannanshire	805	North Ayrshire	751
Dumfries and Galloway	851	North Lanarkshire	818
Dundee	690	Orkney Islands	671
East Ayrshire	716	Perth and Kinross	803
East Dunbartonshire	1,130	Renfrewshire	775
East Lothian	967	Scottish Borders	627
East Renfrewshire	825	Shetland Islands	927
Edinburgh	691	South Ayrshire	691
Eilean Siar	1,392	South Lanarkshire	899
Falkirk	770	Stirling	683
Fife	767	West Dunbartonshire	774
Glasgow	809	West Lothian	648

Source: Waste Data Digest and ONS

8.4.2.3 Comment

The second set of options based upon performance from a target could, in principle, require less effort to develop and administrate, as any mechanism which required fixed annual rates for refunding to specific activities would require work to ascertain:

1) The level of each rate; and

2) The order of preference for the funds.

The levels of refund available to each LA under the second set of options would, to a more significant extent, be self-regulating with the framework of the policy.

An alternative would be to refund revenue at fixed rates for specified activities and to establish a preference order for these. However, this would require much more work to agree these activities and the relevant rates.

No quantitative modelling has been undertaken on this policy. A further study would be required to develop a plausible set of policy options, consult with Local Authorities and model the costs and benefits.

8.4.3 Summary

Revenue Used to Incentivise Recycling Activities

PROs	*CONs*
The revenue raised from the tax goes directly back to the waste management industry to help pay for the costs of developing the required infrastructure.	There is some uncertainty about the outcomes likely to be obtained.
There a number of potentially different mechanisms which could be considered, some of which act to incentivise performance. Some of these are performance levellers (e.g. targeting residual waste per household instead of a recycling rate).	Some argue that where mechanisms reward the best performers, this tends to leave the laggards behind and entrench their position.

8.5 Policy Scenario: Combustion Residues Classified at Standard Rate

Combustion processes, especially incineration of municipal waste, have received widespread attention because of the environmental and health impacts associated with these activities. When raw materials (e.g. coal, biomass) and wastes (e.g. municipal solid waste, clinical, commercial and industrial waste) are burned potentially harmful substances in these materials can be volatilised or remain bound to the ash by-products. The fate of potentially toxic contaminants contained in incinerated primary materials can take three forms:

1) remain as part of the ash;
2) partition off into the volatile phase and be removed by scrubbers/precipitators; or
3) escape into the atmosphere.

The two chief concerns associated with incineration are thus a) the emission of contaminants to the atmosphere, and b) the production of potentially hazardous ash/filter materials. To ascertain whether a change in the rate for some combustion residues is justified, a literature review of the impacts associated with residues from combustion processes was carried out, and focused on the following areas:

- The hazardous nature of IBA from municipal incinerators
- The composition of ash (IBA) from municipal waste incinerators
- The chemical composition of Municipal Waste
- Partitioning factors
- The hazardous nature of furnace bottom ash and pulverised fuel ash from power stations and other industrial processes
- The loss of Valuable Precious Metals with Disposal of PFA, FBA and IBA

An analysis of the scale of ash production in Scotland was also undertaken. This discussion is presented in Appendix A.9.0. The conclusions of this research are summarised in the following points:

1) The European Waste Catalogue classifies IBA as a 'mirror' entry, i.e. it is either hazardous or non-hazardous. Other ashes, such as power station ash, are simply classified as non-hazardous. The most significant factor that leads to ash being classified as hazardous is the ecotoxicity potential, which can be ascertained through testing. A clear indicator of the characteristics of IBA can be taken from a key incinerator operator in the UK. Veolia has been reported as saying that they estimated that about 40% of their ash would *fail* these tests in the UK if they were to be applied properly.[70]
2) Evidence reported in the literature suggests that IBA is indeed ecotoxic. The following comments come from referenced sources in the Appendix:
    i) *'A range of potentially harmful inorganic compounds have been shown to leach easily from these materials [ashes]'*;
    ii) *'concerns over ecotoxicity have been raised in a number of biological leaching and ring experiments'*;
    iii) *'these tests clearly indicated that the bottom ash was ecotoxic'*;
    iv) *'clear ecotoxicological hazard potential for some of the MWI ashes'*;
    v) *'high concentrations of non-hazardous components (Ca, K) influenced the toxicity of almost all ash eluates, whereas hazardous components (e.g. Zn, Pb) only influenced the toxicity of the eluates ranked as most hazardous'*;
3) Some of the most problematic elements that result in ecotoxicity are zinc, calcium and lead. The metals themselves are not as problematic but the high temperatures and presence of oxygen in the combustion process will lead to more dangerous oxides and chlorides forming and remaining in the ash. Indeed, The Commission Directive 2004/73/EC of 29 April 2004 reclassified zinc oxide and zinc chloride as R50/53 – 'very toxic to aquatic organisms, may cause long term

[70] ENDS (2009) *Confusion Over status of Incinerator Bottom Ash*, Environmental Data Services (ENDS), Vol.410, pp.23-24.

effects in the aquatic environment'.[71]

4) The reason why these elements remain in the ash is twofold. Firstly the elements are widely present in municipal waste. In fact, zinc in particular, is present in relatively high concentrations. Thus it is evident that significant quantities of these metals maybe inputted into incinerators as part of the residual waste stream. Secondly, from the review of transfer factors (proportions of elements that end up in fly ash, flue gas, bottom ash etc) presented in the Appendix, it is evident that the majority of metals, other than mercury, end up remaining behind as part of the bottom ash or fly ash (reflecting, for some metals, the improvement in flue gas cleaning). These partitioning coefficients have clear implications for the chemical composition of ash materials which are being derived from the incineration of municipal solid waste.
5) There is a large body of evidence which suggests that IBA may be hazardous, and should be considered carefully due to the uncertainties of its environmental impact. Some key comments from the literature are as follows:
    i) *'it is [also] clear that ashes commonly contain persistent hazardous organic compounds'*;
    ii) *'all of the materials [ashes] tested could 'not be considered as inert'*;
    iii) *'The Environment Agency has admitted it does not "have 100% confidence"' in its classification of incinerator bottom ash (IBA) as non-hazardous waste'*;
6) Due to the fact that there appears to be a fine line between whether IBA is hazardous or not. It seems surprising then that the recent HMRC consultation rejected a proposal to increase the level of tax on a wide range of combustion residues, including IBA. It is believed that the best way to proceed is to assume that incinerator bottom ash is hazardous until it has been shown to be otherwise and that the rate of landfill tax reflects this. However, if there are uncertainties about the 'hazardous' nature of IBA, it is even more clear that the material is not inert, and again supports the argument that bottom ash from municipal incinerators should not be subject to the lower rate of tax.
7) With respect to furnace bottom ash, there are comparable levels of metals and other inorganic pollutants in the ash material, but no significant evidence was found with regards to the ecotoxicity of the material. Thus without further testing regimes it is not conclusive whether the material is hazardous, but the very presence of some heavy metals, suggests that it is probably not inert. There is more evidence with regards to the presence of potentially ecotoxic pollutants in pulverised fuel (or fly) ash, especially when co-firing occurs, however, further

[71] European Commission (2004). "Commission Directive 2004/73/EC of 29 April 2004 adapting to technical progress for the twenty-ninth time Council Directive 67/548/EEC on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances (Text with EEA relevance) " Official Journal of the European Communities, **L 152**(30.4.2004): 1–311.

research would be required in this area being suggesting a change to the classification of these materials as falling under the lower or standard rates.

8) The secondary benefits to increasing the costs of disposal of bottom ashes, especially IBA, include providing the economic stimulus for investment in recovery, as opposed to disposal, of the material. This is increasingly important as the composition of mixed waste streams includes many precious and rare earth metals, and as we have demonstrated, a significant proportion of these metals will transfer to the bottom ash. In fact, bottom ash contains high concentrations of, among other elements, copper, lead and zinc. Operators of ash reprocessing plants indicate to us that the costs of these processes are likely to be around £80 to £120 per tonne. If the ash was classified as active, and taxed the standard rate, many of these processes would be cost comparable, and many rare elements could be sustainably recovered. In addition, some simple analysis shows that the maximum value of the metals within the material could be somewhere between around £140 and £340 per tonne for IBA, and for fly ash, £230 to £400 per tonne. For furnace bottom ash the estimated range is between £8 and £340 per tonne. This in itself is evidence that recovery over disposal should be promoted.

Given the outcome of the recent HMT and HMRC consultation on landfill tax it must be noted that if Scotland were to apply the standard rate of tax to incinerator bottom ash from municipal waste incineration a significant price differential would exist between Scotland and England. This could cause significant migration of ash residues across the border. Thus a similar mechanism to the border adjustment tax for all active wastes (discussed at Section 6.3.6) should be considered. However, the current quantity of mixed municipal waste, or similar in nature, sent to incineration facilities is low, thus the quantity of ash currently produced is minimal compared to the total combustion residues in Scotland. The higher rate of tax, therefore, would only exert a significant impact on those facilities that become operational in the future. Given the small number of facilities that would be likely to exist to treat the mixed 'municipal-type' waste stream, it does not seem unreasonable for SEPA to be able to understand where the IBA is being sent to, ensuring that it does not leave the country for cheaper disposal options. The following tables show the quantities of waste sent for incineration and co-incineration in Scotland, and some estimated of the ash arising at the plants.

Table 8-8: Waste Arisings Sent for Incineration and Co-incineration in Scotland (2004 to 2008), tonnes

	2004	2005	2006	2007	2008
Municipal	93,142	102,333	85,279	97,928	88,145
Commercial & Industrial[1]	228,790	177,598	188,314	156,225	247,968
Total	*321,932*	*279,931*	*273,593*	*254,153*	*336,113*

Note: 1. These figures do not include any waste collected as part of municipal waste collections.

Source: SEPA (2010) Waste Data Digest 10: Key Facts and Trends, Scottish Environmental Protection Agency final report,www.sepa.org.uk/waste/waste_data/waste_data_digest.aspx

Table 9: Breakdown of Waste Inputs for Incineration and Co-incineration and Estimated Ash Arisings (2008), tonnes

Waste type	Incineration and co-incineration with energy recovery	Incineration and co-incineration for disposal	Range and average ash content[1] (%)	Estimated ash arisings[2]
Animal remains/litter	0	121,810	7 – 64 (35.5)	43,243
Chemical wastes	11,056	16	-	-
Healthcare wastes	0	1,016	44 – 55 (48)[3]	488
Household and similar	0	77,537	27 (27)	20,935
Oil sludges	0	749	-	-
Paper and card	0	123	1 – 22 (11.5)	14
Refuse derived fuel	0	13,017	9 – 25 (17)	2,213
Sewage sludge	48,652	0	31 – 32 (31.5)[4]	15,325
Shredded tyres	16,310	0	(17)[5]	2,773
Sorting residues	0	2,000	-	-
Wood	43,256	0	1 – 10 (5.5)	2,379
Other	0	572[6]	-	-
Total	*119,274*	*216,839*[7]		*87,369*[8]

Notes: 1. Data from ECN Phyllis Database – ash values vary according to contents of waste inputs and thus vary from study to study, range in values given with average of the two in parenthesis; 2. Product of the average ash percentage and mass of waste incinerated; 3.Range from four samples analysed by Gidarakos et al[72]; 4. Untreated sewage sludge; 5. Value reported by Juma et al[73]; 6. Includes textiles and mixed packaging; 7. 88,145 tonnes of the total inputs came from municipal sources; 8. Approximate total ignoring the likely small additions which would be made by the incineration of chemical wastes, oil sludges and 'other' materials.

Source: Incineration data obtained SEPA (2010) Waste Data Digest 10: Online Excel Tables, 15th April 2010, data accessed on 7th January 2011, www.sepa.org.uk/waste/waste_data/waste_data_digest.aspx

Currently the arisings of ash from municipal waste incinerators is around 87,000 tonnes per annum. Some of this ash is recycled, and some is hazardous fly ash and the like. Under the zero waste plan, regulations would be enacted to require the pre-treatment of waste entering thermal plants. Mass flow modelling suggests that the input tonnage to these plants could be in the order of 2 million tonnes by 2020. Some level of pre-treatment is required reducing the quantity of waste input into the thermal part of the process between around 600 ktpa and 1,800 ktpa, depending on the process. If ash production is also around 20% of the input tonnage, then potentially 120 ktpa to 360 ktpa of ash from mixed municipal like waste could be generated. These are not insignificant quantities. So, not only is there potential for extracting valuable resources, and increasing the landfill tax take, the environmental impacts

[72] Gidarakos, E., Petrantonaki, M., Anastasiadou, K. and Schramm, K-W. (2009) Characterization and hazard evaluation of bottom ash produced from incinerated hospital waste, *Journal of Hazardous Materials*, Vol.172, No.2-3, pp.935-942.

[73] Juma, M., Korenova, Z., Jelemensky, L. and Bafrnec (2007) Experimental Study of Pyrolysis and Combustion of Scrap Tire, *Polymers for Advanced Technologies*, Vol.18, No.2, pp.144-148.

resulting from this waste stream would be minimised if the material was classed as 'active' waste.

In terms of the implications of taxing IBA at the standard rate the following is noted:

1) The effect of increasing the cost of IBA disposal by around £80 per tonne, would primarily increase the cost of incineration itself. This would increase the avoided costs of disposal, especially if the standard rate of landfill tax was also increased, so that there would be a greater economic incentive to recycle. However, as the analysis in this report shows, this would be unlikely to have a significant effect on the household waste stream as significant levels of recycling would occur with the landfill tax at £80 per tonne. In addition, the policy would have a more pronounced effect under BaU. Under the ZWP there are other mechanisms for increasing recycling, so the effect may simply be to increase the cost of disposal. However, the ZWP does not cover all wastes so there would be some stimulus to the recycling market.
2) In either case (BaU or ZWP) what is clear is that the costs of disposing of IBA would increase significantly. This would provide an economic incentive for investing in technologies to recovery materials from the ash, and reduce its hazardousness. This could increase the supply of recycled inert material for construction purposes (once the hazardous elements had been removed or stabilised) and allow for cost effective extraction of precious and rare earth metals locked up in the ash.

8.5.1 Summary

Combustion Residues Classified at Standard Rate

PROs	*CONs*
A growing body of scientific evidence supports the notion that ashes from municipal waste incinerators have the potential to cause environmental damage.	There is limited evidence to suggest that furnace bottom ash from coal fired power stations or foundries is toxic and would cause significant environmental damage if untreated.
Increased costs of disposal for ashes would stimulate the market for the recovery of precious and rare earth metals, supporting the idea of sustainable production and consumption.	May increase costs of residual waste management to local authorities and businesses (depending upon counterfactual).
Increased costs of disposal for incinerator ash would increase the gate fees for the process and have the same effect as an incinerator tax i.e. ensure the costs are sufficient not to constrain the reuse, recycling and recovery markets. This could be relatively important under BaU	

in increasing the incentive to recycle and prevent waste.	

8.6 Other Policy Interventions and Issues

Other areas of policy the Scottish Government could consider where highlighted during the stakeholder interviews. These are:

- Better Regulation of Exempt Sites;
  - During the interviews a number of stakeholders suggested that there is some illegal activity occurring with respect to exempt landfill sites. Material which, due to its composition, would not be allowable in inert landfills under the waste acceptance criteria, is still being landfilled at exempt sites. This potentially causes environmental harm, and the Government miss out on a revenue raising opportunity.
  - Revenue from landfill taxation could be used to fund the increased burden on regulators.
  - This would be preferential vis-à-vis licensing and taxing exempt sites as the latter would jeopardise some genuine recovery options.
- More checks of operators from HMRC.
- Cross-checking of tax return and site return data from EA / SEPA.

8.7 Unintended Consequences

In England, Local Authorities (LAs) bear the costs of clearing up waste that is fly-tipped on public land.[74] Some claim to have experienced increases in fly-tipping, however, it is also mentioned that this could be due to a greater awareness of the problem post-tax, and that there was a poor baseline, because LAs previously defined fly-tipping in different ways. At significant levels of tax there are clearly greater drivers to fly-tip than the baseline. However, the extent to which there will be increased fly-tipping above the £80 per tonne tax is uncertain.

Eunomia's household waste prevention report states that there was some concern that waste which was previously in the commercial and industrial stream entered the household stream through being taken to civic amenity sites. The effect is that municipal waste almost certainly increased as a result of the tax. This resulted in the tightening up of procedures at HWRCs to stop the switch of C&I wastes into the municipal stream. For example, the drivers of any vans now entering HWRCs in England have to produce a proof of address, copy of hire certificate, and demonstrate to the site operators what is in the vehicle on entrance.

[74] Eunomia et al (2007) *Household Waste Prevention Policy Side Research Programme*, Final Report for Defra

9.0 Summary Findings of the Study

This study has approached the issue of understanding landfill taxes for a variety of angles. The initial review of evidence included a number of different approaches, including a literature review, stakeholder interviews, investigation of the approaches taken in other countries to *ex ante* or *ex post* evaluation of such taxes and exploration of modelling approaches already used in the UK. The work then progressed to develop policy options for further investigation, and based the analysis of these on a combination of quantitative modelling and qualitative assessment.

The key findings of the study are presented below.

9.1 Review of Literature and Other Country Experience

The following points summarise the findings from the literature review:

- Many countries within the European Union have utilised landfill taxes since around the mid-1980s;
- The rationale of most landfill taxes was to stimulate waste minimisation and reuse/recycling. This is realised by increasing the cost of landfilling, and thus making alternative management methods more cost competitive, and waste prevention more financially rewarding. In addition some countries specifically seek to raise revenue, or internalise the externalities of landfilling;
- The revenue can be used for a number of purposes, including being directed to the national budget, funding environmental projects and supporting waste management activities;
- Most landfill taxes covers all waste streams, rates are often split between active and inert wastes, and in many cases, the rates have increased significantly over time;
- Most countries exempt some materials from the tax when they are landfilled;
- With the UK landfill tax at £80 per tonne, however, it will be one of the highest rates in Europe. Only the Netherlands has a comparable level of tax (which is used to support a policy banning many waste streams from landfill);
- Spain, Belgium and Italy each have regional variations in landfill tax policy;
- In Belgium and Italy, there are mechanisms in place to effectively apply a form of border tax adjustment between regions when waste is moved from one region to be landfilled in another. The details of these mechanisms have, however, been difficult to obtain;
- Many countries with higher landfill taxes include supporting policies to help drive whatever behaviour is required by the national waste management plans. These include policies directed at increasing recycling, and measures to ensure residual waste does not simply switch from landfill to incineration. In some countries, however, where recycling policies have not been so strong, landfill taxes have, alongside landfill bans, had the effect of shifting residual

waste from landfill to other treatment routes (typically, incineration);

- In terms of the link between landfill taxes and landfill bans, some countries have noted the need to have higher taxes to dissuade companies from having repeated recourse to exemptions from a ban (which may be necessary in some contexts). In Austria, where a ban on landfilling biodegradable wastes was implemented, this was incentivised through offering a lower rate of tax for wastes that had been pre-treated such that their tendency to generate methane when landfilled was significantly reduced;
- There is a complete dearth of ex ante analyses of landfill taxes in other countries as far as we could discern. Most countries appear to have taken a much more pragmatic approach to the design of their landfill tax, and we could find no country where there was some officially sanctioned model of the workings of a landfill tax (which does not mean to say that this does not exist); and
- Finally, there is a tendency, which appears to be gathering pace, for countries to establish taxes on other waste treatments too, notably incineration. Several countries – Denmark, Austria, Belgium, Sweden and Catalunya among them – have 'waste taxes' which cover incineration as well as landfill, albeit that the tax rates for incineration are generally much lower than for landfill.

9.2 Stakeholder Perspectives

A range of stakeholders within Scotland were consulted regarding their experiences with the tax, how it was currently working, and for their views on whether or not the tax should be changed (and if so, how). Some observations drawn from these consultations are offered below:

- It was generally felt that the administration and regulation of the existing tax mechanism was good;
- The current and proposed structure and levels of the tax were considered 'about right' and it was generally accepted that the tax was a key driver in changing waste management behaviour. Indeed, there was a view that 'landfill' was certainly not the best industry to be in today;
- There were mixed opinions in regards to whether the level of the tax should remain at £80 or be increased further;
- There was some concern expressed regarding the possible fracturing of waste policy within the UK and of the possibility of 'unlevelling the playing field' for industry. Some commentators considered that a UK wide system was considered to be easier and cheaper to administer. It was also believed that any change to the tax mechanism should be simple;
- Differences in the level of tax are likely to cause waste to move across borders as in the current economic climate industry is very closely watching 'the bottom line'. The magnitude of the flow is uncertain but the distance waste travels is directly related to the difference in price.
- The current level of waste movements across the Scottish border was considered to be low, though exact figures were not generally known; and

- The current level of landfill gate fees was also reported to be low in the southern and central areas of Scotland, closest to the border with England. This was offered as one of the explanations for the (presumed) low level of export of waste for landfill outside of Scotland.

9.3 Review of Modelling

Several models were reviewed with a view to seeking pointers as to how a Scotland-specific model could be developed. There was, however, no model which really captures the full dynamics of the waste sector, and hence, which really considers all the variables affecting the landfilling of waste. The following comments highlight some key points:

- No econometric exercise of any significance has been conducted, as far as we can see, on the tax to elicit specific response parameters associated with it. This is not especially surprising given a) the poor quality of the historic data, and b) the fact that the tax affects a range of waste producers who effectively face different 'menus' of alternatives to landfill;
- Notwithstanding this fact, many of the models (e.g. HM Treasury) understandably, perhaps, rely on the use of elasticity based functions to drive the change in behaviour. Such models rarely incorporate cross-price effects, basing predictions instead upon constant price elasticity of demand functions. These are unlikely to be reliable over non-marginal price changes;
- The LAWRRD model used in England to consider household waste management takes an approach based upon marginal costs of 'managing waste' in different ways. The drawback of such approaches is that they are heavily reliant upon extremely accurate data. No such approach has been developed for other waste streams, and to do so would rely upon characterising different waste producers according to which alternative options are available to them and at what price. This would be a substantial task, and would have to address the fact that the relevant cost data is not obviously available in the public domain; and
- The REEIO – Regional Economy Environment Input Output model incorporates a number of parameters and equations that describe the functionality of the model, but no price response functions or parameters could be identified in the model descriptions. The model also appears to be described as assessing changes in arisings and keeps the pattern of waste management (i.e. the proportion being sent to landfill, being recycled, etc.) constant. Therefore, as this study is primarily concerned with responses to landfill prices, it appears to have little to offer. It must be stated, however, that we were not privy to the model itself so could not be certain whether this was the case in the actual model.

There is, therefore, no 'easy choice;' when considering how to develop a model of 'waste management' which gives a clear indication of how much might be landfilled in future. One key problem – which own-price elasticity models conveniently sidestep – is that even if all one is interested in is 'the quantity of waste landfilled', it is difficult to ignore the fact that the price of the most important (and in the ideal world, all

other) waste management alternatives needs to be factored in, in some way, to the model.

On balance it was felt that given that much of the remaining landfilled waste appears to be of a nature similar to residual household and commercial waste, it might be possible to gain a handle on the costs of the key alternative management options. Hence, the more complex approach of constructing cost curves for key recycling alternatives, as opposed to using own- and cross-price elasticities (which could only be guessed at), was chosen for this piece of research. In reality, the model also includes some elements which are modelled using an elasticity approach, typically where we have insufficient evidence to develop the relevant marginal cost curves for the alternatives.

9.4 Development of Policy Scenarios

Through considering the international review, and taking into account the views of stakeholders, and then through setting out the pros and cons of various possible policy options, we arrived at a final set of options that were taken forward to the modelling stage. Some options were conducive to quantitative modelling techniques, similar to those discussed in the review stage of the study. However, some are not far enough advanced in conceptualisation, or rely upon data that has not yet developed to a sufficient degree. Therefore, these policy options have been appraised through both quantitative analysis and qualitative discussion. This is reflected in how the final options are presented in the following list:

Options for Quantitative Modelling;

- Increase Level of Standard Rate Tax;

Options for Qualitative Appraisal:

- Increase Level of Lower Rate Tax;
- Lower Rate for Stabilised Wastes;
- Introduce Incineration Tax;
- Revenue Used to Incentivise Recycling Activities;
- Combustion Residues Classified at Standard Rate;
- Export / Border Adjustment / Equalisation Tax to discourage cross-border waste movements;

9.5 Scottish Landfill Tax Model - Baseline Development

Included in the study was the requirement to develop a mass flow model of Scottish waste and to understand the possible effects of adjusting the already announced levels of the tax against two baselines:

3) A Business as Usual (BaU) Baseline; and

4) A Zero Waste Plan (ZWP) Baseline.

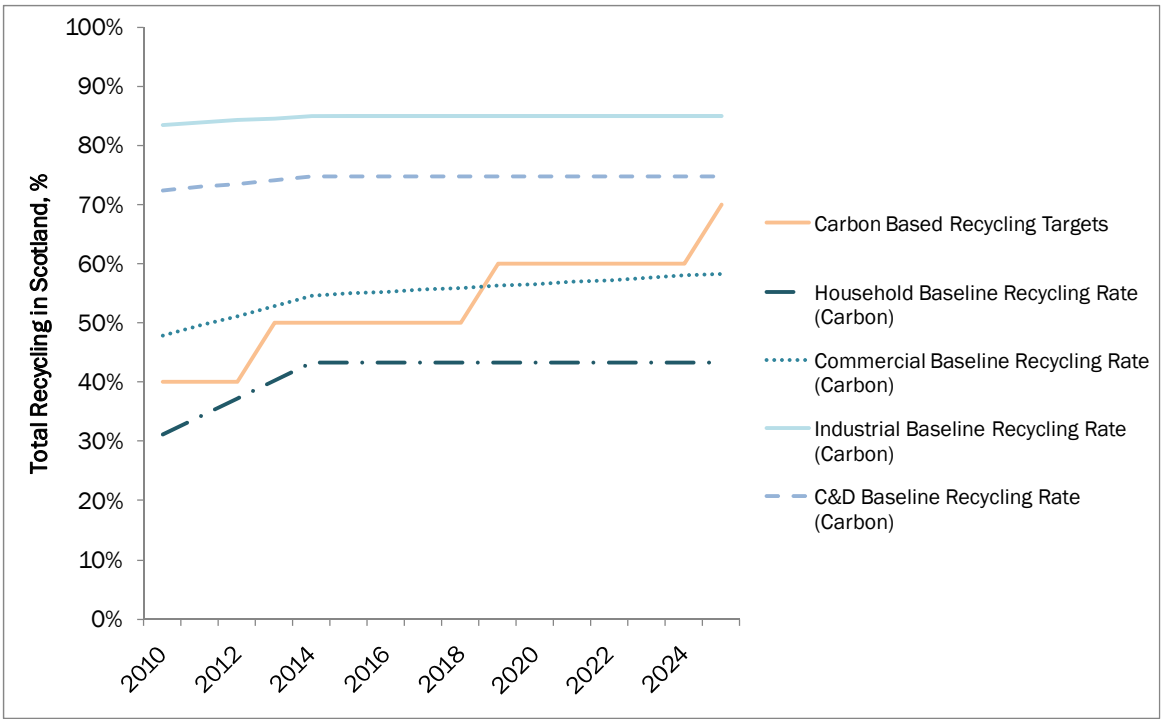
The organisation of the relevant data proved to be a challenge. Moreover, there was some concern raised about the quality of the data used to underpin the macro

modelling undertaken in this study, and therefore some of the quantitative results. However, the Scottish Government is aware of the issues and is setting out to resolve data issues in future, to the extent possible, through powers gained under the Climate Change (Scotland) Act 2009.

The following points, relating to the modelling of waste management projections under the two approaches, are worthy of note (see also Figure 9-1 and Figure 9-2):

- For household waste none of the interim carbon targets are met under the BaU baseline. Under the ZWP Baseline, the 70% recycling target for 2025 proves to be difficult to meet;
- The extent of the change between the two Baselines is not significant for industrial waste. Indeed much of the 'high carbon weighting' material is being captured well already, and 'low carbon weighting' material, such as wastes from thermal processes (i.e. ash) is still being landfilled. For the commercial sector, carbon based recycling rates are already higher than is the case for household waste, but the 2025 target is still missed under BaU. Under the ZWP Regulations, effort can shift more heavily to 'high carbon weighting' materials so the rates increase significantly, and the targets are met;
- For the C&D sector, the carbon based target is met even in the BaU Scenario. The extent of the change between the Baselines is not as great as that for household waste. Carbon based rates are more easily exceeded, reflecting the higher proportion of 'low weighting' materials in the waste stream;
- The Waste Framework Directive and Landfill Directive targets are being met under both baselines; and
- In essence, the comparison between the baselines shows that there is still a significant additional change that can be made to waste management in Scotland over and above the influence of the existing landfill tax escalator.

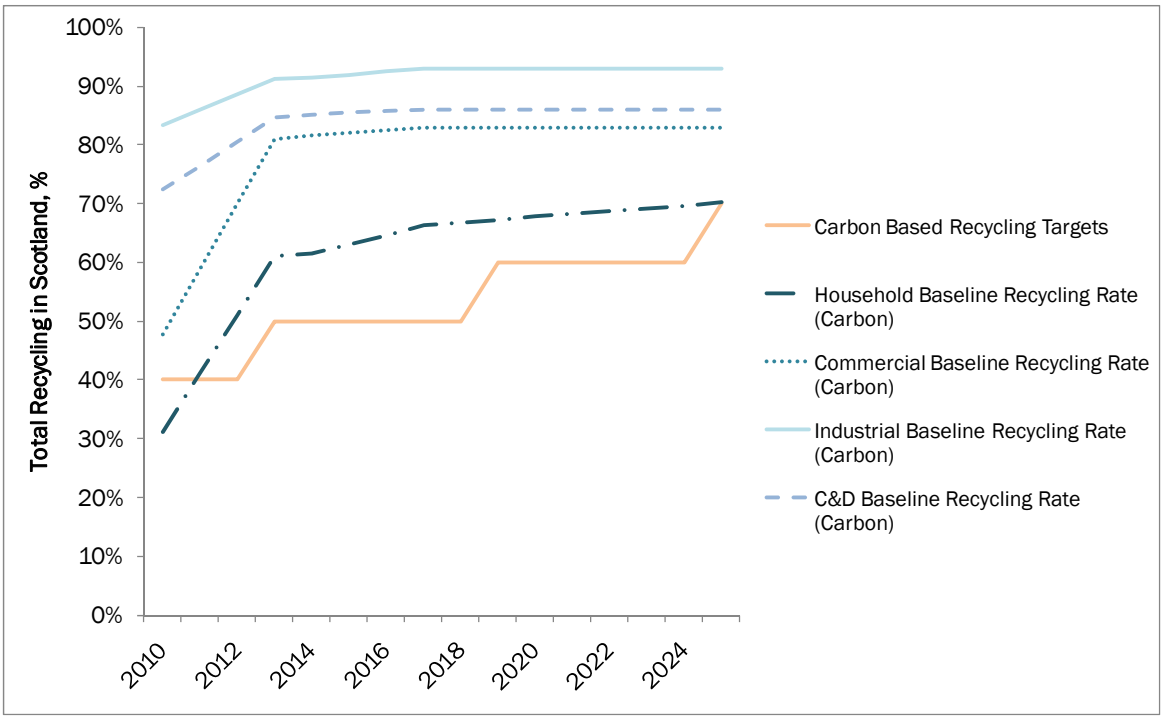
Figure 9-1: Carbon Based Recycling Rates for All Sectors v Time (BaU Baseline)



Source: Eunomia Landfill Tax Model

Note: The carbon based targets prior to 2025 apply to household waste only.

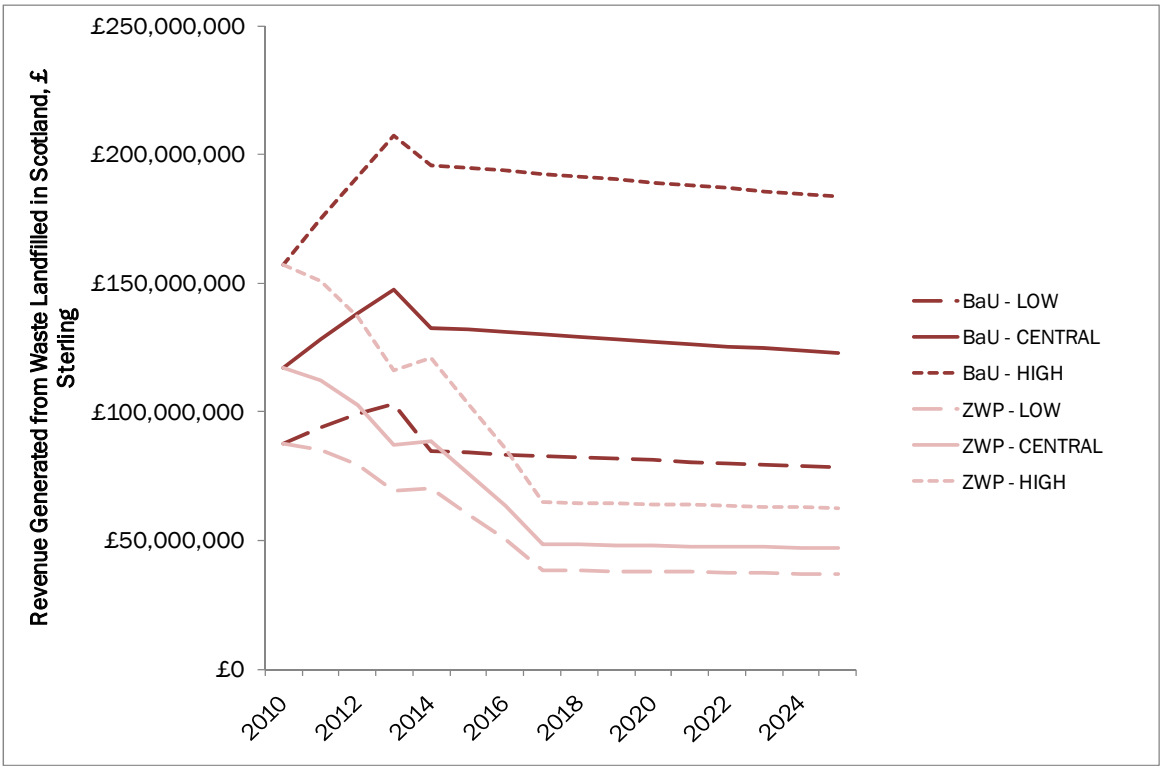
Figure 9-2: Carbon Based Recycling Rates for All Sectors v Time (ZWP Baseline)



Source: Eunomia Landfill Tax Model

Note: The carbon based targets prior to 2025 apply to household waste only.

Figure 9-3: Baseline Landfill Tax Revenue Generated under LOW, CENTRAL and HIGH Sensitivities (BaU and ZWP Baselines), £ 2010 Real Terms



Source: Eunomia Landfill Tax Model

Following from the recycling and treatment of waste the quantity of waste landfilled can be derived, and the landfill tax revenue estimated. HMRC do not hold disaggregated tax receipts for Scotland so this figure cannot be benchmarked at the current time. Some sensitivity analysis was undertaken, where a number of key baseline parameters were flexed (see Section 7.2.7). The results are shown in Figure 9-3. One can see that under BaU the uncertainties in the project tax take are much higher than under the ZWP, mainly because the quantities landfilled are estimated to be lower.

9.6 Scottish Landfill Tax Model - Quantitative Results

The aim of the quantitative modelling was to develop a model to enable the effects of a change in standard rate tax to be modelled. The scenarios chosen were:

3) Increase Standard rate by £8 to £88 per tonne in 2015 (£8 Scenario); and
4) Increase Standard rate by £8 to £88 per tonne in 2015 and by £16 to £96 per tonne in 2016 (£16 Scenario).

To provide some context to the results of the study we first summarise the discussion around the uncertainty in the residual waste treatment market.

9.6.1 Uncertainty in the Residual Waste Market

In the central approach to the modelling, we have assumed that those who are seeking to offer residual waste treatment capacity at costs competitive with landfill (once the tax reaches £80 per tonne in nominal terms) on a merchant basis are already likely to be engaged in the planning process. Due to the extended periods of time these facilities can take to become fully operational (over 7 years in some cases), then given also the period already elapsed between the announcement of the tax rising to £80 per tonne and the time of writing,[75] we have taken the view that, in terms of household and commercial waste, the only increase in treatment capacity which is motivated by the level of the £80 per tonne tax is what is already known about by virtue of its being in the planning process. For household waste, this amounts to an additional capacity of around 320,000 tpa, or 16% of Scotland's household waste.[76]

Other than these facilities, therefore, we have assumed that landfill tax is the benchmark figure for 'avoided disposal' which drives increases in recycling under BaU. The significance of this assumption was explored in the Main Report (Section 5.1). Evidently, if other residual waste treatments 'undercut' landfill, then in sectors where there is a strong price focus, it will be the price of these treatments, and not that of landfill, which drives the behavioural response. This affects not just the modelling of any change in tax which might be considered, but it also affects how the BaU (and to a lesser degree, the ZWP) baseline mass flows are developed (it would, of course, affect the *costs* of both Scenarios).

There is, therefore, some uncertainty in the modelling which relates to the price of residual waste management alternatives to landfill. In consequence, a scenario based approach was chosen in modelling the effects of the tax on the up-take of residual treatments. Three levels, low, medium and high, were set to provide a realistic range. These scenarios are evident in the quantitative findings below.

9.6.2 Quantitative Results

In this section the key quantitative results of the modelling work are summarised. The total waste landfilled, revenue generated and costs to Local Authorities (LAs) and businesses under BaU and the ZWP are shown.

Note that the tax revenue figures for Scotland may be understated for reasons outlined in Section 6.1.2.4. More accurate estimates could be derived if, for example, over the coming years, HMRC or Scottish Government requested tax returns from operators to report by site rather than in the aggregate by reporting company.

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[75] This is May 2011.

[76] Scottish Futures Trust (2011) *Untitled* http://www.scottishfuturestrust.org.uk/docs/262/File%206%20-%20Copy%20of%20Project%20Data%20-%2014%20Dec%202010.pdf

Table 9-1: Waste Landfilled Resulting from Increasing Standard Rate, M tonnes

	BaU			ZWP		
	2015	2020	2025	2015	2020	2025
£8 Scenario - Low	3.2	3.1	3.0	2.0	1.2	1.2
£8 Scenario - Medium	3.0	2.9	2.8	2.0	1.2	1.2
£8 Scenario - High	2.2	2.1	2.0	1.8	1.1	1.1
£16 Scenario - Low	3.2	2.7	2.6	2.0	1.2	1.1
£16 Scenario - Medium	3.0	2.3	2.2	2.0	1.1	1.1
£16 Scenario - High	2.2	1.2	1.2	1.8	1.0	1.0
Baseline	3.6	3.5	3.4	2.0	1.3	1.3

Source: Eunomia Landfill Tax Model

Table 9-2: Total Tax Revenue under Standard Rate Tax Scenarios (Relative to BaU Baseline), £ millions 2010 Real Terms

	BaU			ZWP		
	2015	2020	2025	2015	2020	2025
£8 Scenario - Low	£124	£120	£115	£77	£48	£47
£8 Scenario - Medium	£116	£112	£108	£76	£47	£46
£8 Scenario - High	£85	£81	£77	£71	£43	£42
£16 Scenario - Low	£124	£112	£107	£77	£49	£48
£16 Scenario - Medium	£116	£96	£92	£76	£47	£46
£16 Scenario - High	£85	£50	£49	£71	£41	£40
Baseline	£130	£126	£121	£74	£47	£46

Source: Eunomia Landfill Tax Model

Table 9-3: Net Change in Costs to Scottish Local Authorities and Businesses Relative to BaU and ZWP Baselines, £ thousands 2010 Real Terms

	LA - BaU	LA - ZWP	Business - BaU	Business - ZWP
£8 Sc. - Low (2015)	-£391	-£80	-£5,454	-£296
£8 Sc. - Medium (2015)	-£417	£103	-£5,624	£99
£8 Sc. - High (2015)	-£519	£833	-£6,305	£1,681
£16 Sc. - Low (2016)	-£760	-£155	-£8,811	-£545
£16 Sc. - Medium (2016)	-£810	£200	-£9,136	£187
£16 Sc. - High (2016)	-£1,008	£1,619	-£10,073	£3,116

Source: Eunomia Landfill Tax Model

9.6.3 Sensitivity Analysis

To account for uncertainties such as that discussed above, and also, to take into account the effect of varying some key behavioural response parameters, sensitivity analysis was conducted with a view to generating high and low estimates of the magnitude of change around our central scenario.

The sensitivity analysis shows that there is a clear uncertainty in the quantity of waste landfilled and the revenue that will be generated for the Scottish Government. These uncertainties should be made clear when address the issues of a reduction in the block grant for Scotland when the powers to set the landfill tax are devolved.

The sensitivity analysis around the costs of increasing the standard rate of tax shows that, again, there is some uncertainty in the results, but that, importantly, the mean values do not deviate from zero, or cost neutral, significantly. In addition, there is no instance where the financial costs switch to a significantly positive value. In the main this is due to the predicted state of the recycling market, where increasing costs of recycling are mostly, or fully, outweighed by the avoided costs of disposal.

9.6.4 Cross-border Movements

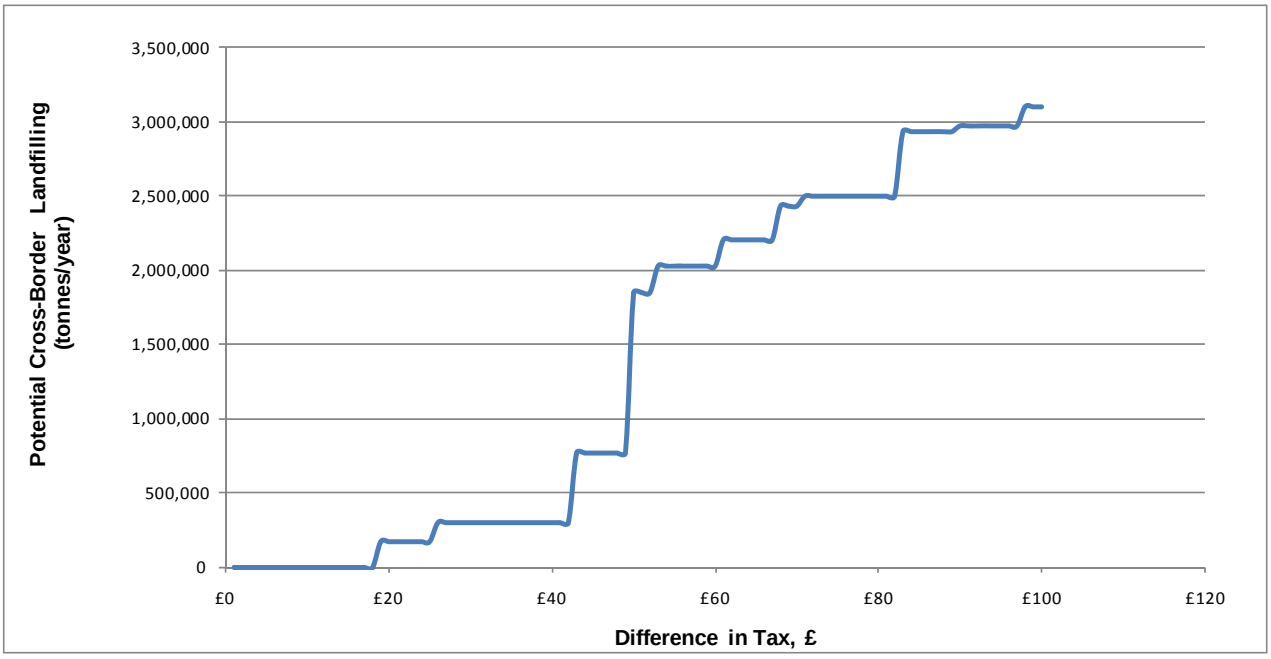
Higher landfill taxes in Scotland could lead to additional movements of waste across the border to England. During the data gathering stage of the project, however, it was determined that very little waste currently crosses the border with England, or other countries. Some hazardous waste is transported to find appropriate treatment facilities, but non-hazardous waste, such as residual waste, is nearly all treated or disposed of in Scotland. Therefore, it was assumed that current movements of residual waste to English landfills are zero in the Baselines.

We modelled the amount of landfill void space in England which would 'become available' as one moves an increasing distance from the border, and translated this into a typical haulage cost. There are of course some uncertainties with this kind of

modelling (the accuracy of the waste data, the potential for landfills to expand beyond their permitted capacities, local and national contractual arrangements, the relative pricing and availability of alternatives, the capacity of rail transport and the propensity to export waste to other EU Member States for recovery, amongst others).

Notwithstanding these points, there does not appear to be a significant amount of waste that would cross the border at low levels of increase in the tax. The plot of the potential size of the movement against the required cost differential is shown in Figure 9-4. At tax differentials of up to £15 to £20 there is not likely to be any significant additional migration of wastes to English landfills. Once the differentials increase above this level waste exports may find cheaper alternative routes by being transported by road to landfills in England, and at above £40 per tonne the movements could become very significant. For rail transport the situation is more finely balanced. At differentials of maybe even £5, some waste transport to England could be cost effective.

Figure 9-4: The Potential Cross-Border movement of Scottish Business Waste Destined for Landfill, tonnes per year



Source: Eunomia

One important caveat needs to be added at this point. There may be non-landfill residual waste treatments which become competitive at prices below the level of landfill plus tax, once the tax reaches £80 per tonne. If this happens, then of course, the price differential between Scotland's landfills and England's treatment facilities may be wider than has been predicted here, and waste may well flow not to English landfills, but to English incinerators and other non-landfill treatments. The effect of low cost recovery facilities in other EU countries would have a similar influence.

If the landfill tax was to be increased more significantly, or greater certainty was required, one option could be to introduce some fiscal mechanism to provide a financial penalty for transporting waste out of Scotland for disposal. This is discussed within the next section of the qualitative assessment of the policy options.

9.7 Qualitative Assessments of Policy Options

This Section summarises the findings of the research undertaken for each policy option examined, including those assessed through a more qualitative approach. These were:

- Increase Level of Lower Rate Tax;
- Lower Rate for Stabilised Wastes;
- Introduce Incineration Tax;
- Revenue Used to Incentivise Recycling Activities;
- Combustion Residues Classified at Standard Rate;
- Export / Border Adjustment / Equalisation Tax to discourage cross-border waste movements;

It should be noted that several of the policies examined might, if they were introduced, benefit from some form of mechanism to ensure cross-border movements did not undermine the measure. Although the final policy in the above list is presented as a standalone policy, it is, in fact, a measure which complements other policies.

The key findings, in terms of the pros and cons of introducing the policy in Scotland, are summarised below.

Increase Level of Lower Rate Tax

PROs	*CONs*
Increased costs of disposal would allow for other recycling options to become cost effective and provide the economic stimulus for operators to reduce the quantities of inert waste landfilled (mainly from the C&D sector and combustion residues from the Industrial sector).	The magnitude and destination of the waste diverted from landfill is not certain. There is a possibility that wastes would simply be diverted to exempt sites where the value of the recovery activity might be limited.
The modelling suggests that increasing the level of tax would stimulate landfill diversion.	Although the costs of transport are higher for dense materials, there is still the possibility that wastes would migrate across the border to England for disposal, unless constraining mechanisms were put in place. However, there would appear to be a very low likelihood of this happening.
It is possible that the recycling and recovery of inert wastes would increase.	Landfill operators, some of whom are already struggling to find relevant engineering materials, may find the tax exacerbates shortages.
	Some landfill operators in need of engineering materials may simply absorb the tax in preference to paying for alternative materials. The tax might not always be 'passed through' to waste producers, therefore, with the tax incident largely on the operators in these cases.

Lower Rate for Stabilised Wastes

PROs	*CONs*
The research suggests that stabilised wastes produce less methane emissions when landfilled, and thus cause less global environmental damage. The monetised environmental damages are estimated to be around £15 per tonne, less than the £61 to £76 range estimated for untreated residual waste. As the UK landfill tax was based upon the principle of internalising environmental externalities, it is appropriate to set the level of the landfill tax at around this lower level.	The research around landfill emissions is caveated by a number of assumptions and modelling parameters. Thus the extent of the reduction in environmental damages resulting from stabilisation of waste is not certain.
The reduction in disposal costs for processes which stabilise wastes will translate to lower gate fees for businesses and Local Authorities. This would be helpful in the current economic climate.	By reducing the gate fees for residual waste treatment processes, the cost of stabilising waste before landfilling might become the 'back-stop' price in the residual waste market. This would reduce the financial drivers for more recycling and waste prevention. It should be noted, however, that this issue is more of a concern under BaU than under ZWP, since under ZWP, specific drivers seek to deliver additional recycling at levels in excess of what the tax alone seems likely to deliver.
This policy aligns with the aim to ban biodegradable waste under the Zero Waste Plan (ZWP).	If the costs of residual waste treatment fall in Scotland, compared with England, this may stimulate 'waste tourism' to Scotland. For reasons discussed in Section 9.6.4, however, the differentials would likely need to become significant for this to occur.
	Potentially introduces a new rate into an established tax structure.

Extend the Landfill Tax to Incineration

PROs	*CONs*
Under BaU, the policy ensures that waste does not simply switch from landfill to other residual waste treatments.	There is currently no legal basis for this tax in Scotland and it lies outwith the scope of the devolved landfill tax policy.
The evidence suggests that there are environmental externalities associated with incineration which are not currently internalised in any policy mechanism, only WID emission limits which seek to constrain the risks of airborne pollutants exist.	Indecisive action on this policy could result in further uncertainty, and future costs, for Scottish businesses.
The policy can be designed to promote abatement of emissions which contribute to health damages.	The tax could be undermined if facilities with available capacity exist in the rest of the UK, or in other EU Member States.
	May increase costs of residual waste management to local authorities and businesses (depending upon counterfactual).

Revenue Used to Incentivise Recycling Activities

PROs	*CONs*
The revenue raised from the tax goes directly back to the waste management industry to help pay for the costs of developing the required infrastructure.	There is some uncertainty about the outcomes likely to be obtained.
There a number of potentially different mechanisms which could be considered, some of which act to incentivise performance. Some of these are performance levellers (e.g. targeting residual waste per household instead of a recycling rate).	Some argue that where mechanisms reward the best performers, this tends to leave the laggards behind and entrench their position.

Combustion Residues Classified at Standard Rate

PROs	*CONs*
A growing body of scientific evidence supports the notion that ashes from municipal waste incinerators have the potential to cause environmental damage.	No compelling evidence to suggest that furnace bottom ash from coal fired power stations or foundries is toxic and would cause environmental damage if untreated.
Increased costs of disposal for ashes would stimulate the market for the recovery of precious and rare earth metals, supporting the idea of sustainable production and consumption.	May increase costs of residual waste management to local authorities and businesses (depending upon counterfactual).
Increased costs of disposal for incinerator ash would increase the gate fees for the process and have the same effect as an incinerator tax i.e. ensure the costs are sufficient not to constrain the reuse, recycling and recovery markets. This could be relatively important under BaU in increasing the incentive to recycle and prevent waste.	

Export / Border Adjustment / Equalisation Tax to discourage cross-border waste movements

PROs	*CONs*
Supports a Scotland-specific policy implementation of landfill tax.	Questions regarding legal competence arise under some of the possible options.
Initial analysis suggests that the issue might not be a major one anyway unless the tax rates in Scotland and the rest of the UK diverge significantly.	Might impose additional administrative burdens on waste carriers.
Once the tax increases beyond a certain level, the cost of local alternatives to landfill may present themselves before it becomes economic to export to the rest of UK.	May be difficult to enforce.

There are already procedures which have to be followed for trans-frontier shipments, so border tax adjustments related to export for recovery to other EU member states may be easy to track.	

9.8 Policy Changes and the Issue of Certainty

The act of reviewing, or considering, changes in, a particular policy raises expectations that the policy concerned could be the subject of change. The effect of this is to create a degree of uncertainty, the scope of which may depend upon how the nature of any such review is communicated, and the credibility of that communication.

Within an uncertain policy environment, decisions regarding 'what to do' are affected pending further clarity about the policy procurement. In particular, if decisions regarding investments in waste prevention, waste collection or waste treatment are under consideration, the uncertainty may lead to delay in the making of these decisions until the uncertainty is removed (or diminished).

Scotland is in a relatively fortunate position from this respect in that:

c) The general direction of policy – the move to higher recycling / composting / digestion rates, and reduced landfilling - is becoming increasingly clear; and

d) Some of the decisions regarding the commitment of large sums of capital have yet to be made.

In this context, the sooner the policy environment in which these treatments must operate is known with a tolerable degree of uncertainty (it cannot be expected that nothing ever changes, after all), then the earlier investors, waste companies, local authorities and other decision makers can come to a view as to what is the best strategy for them going forward.

Whatever changes are made to the landfill tax upon introduction in 2015 the levels going forward must be decisive and clear. Indeed, in anticipation of taking control over the lever of landfill tax, it would seem prudent for the Scottish Government to make clear its intentions well in advance of those intentions being translated into real changes in the tax. This is especially true for changes in the tax which would affect the relative costs and competitiveness of different treatment options, such as the increased tax on landfill, taxes on incineration, the tax on incinerator bottom ash, and the reduced tax for stabilised biowaste. The decision regarding these should be made clear at an early stage, and the commitment to tax rates in future years should extend as far forward in time as is politically, and practically, possible. The ideal solution would be to set the progression of tax rates deemed necessary to achieve the longer term objectives as soon as possible and commit to these once responsibility for the tax is transferred to the Scottish Government.