Meeting Scotland's Zero Waste Targets

Assessing the Costs Associated with New Waste Management Infrastructure

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Contents

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Executive Summary

Purpose of the Report

1. One of the Scottish Government's strategic outcomes is that of creating a greener Scotland. As part of the drive towards this, Scotland faces the challenge of achieving ambitious targets for waste management. The Scottish Government recently reviewed the 2003 National Waste Plan for Scotland and subsequently produced "Scotland's Zero Waste Plan" and associated "Strategic Environmental Assessment" for consultation[1]. Following the consultation, the government aims to introduce a new waste strategy for Scotland in 2010. This study will inform the new national waste strategy by answering two key questions:

- What new additional infrastructure will be required to meet Scotland's Zero Waste targets for municipal waste?
- What are the costs associated with achieving these targets?

Municipal Waste Targets

2. Scotland's waste management targets for Municipal Solid Waste (MSW) fall into two main categories. The statutory waste management targets laid down in EU legislation and the more ambitious national targets set out by the Scottish Government.

EU Targets

3. Scotland must ensure that it meets its share of the statutory UK Landfill Directive targets (required under EC Landfill Directive 1999/31[2]) and the EU's Waste Framework Directive (2008/98/EC). In effect this means that collectively local authorities in Scotland must meet the following targets:

- by 2010 no more than 1.32 million tonnes of biodegradable municipal waste (BMW) can go to landfill;
- by 2013 no more than 880,000 tonnes of BMW;
- by 2020 no more than 620,000 tonnes of BMW; and
- 50% reuse/recycling of household waste and similar by 2020.

Scottish Government Targets

4. In addition to the targets set out above, the Scottish Government has set a number of national waste targets as part of its policy of establishing Scotland as a "Zero Waste" nation. These targets focus on halting the growth of total MSW arising by 2010; increasing the levels of

[1] Scotland's Zero Waste Plan: Consultation, August 2009
[2] Official Journal L 182, 16/07/1999 P. 0001-0019, Landfill Directive

recycling and composting; setting a cap on Energy from Waste (EfW) and reducing the amount of BMW going to landfill. The targets are summarised as follows:

- stop the growth of municipal waste by 2010;
- recycling/composting rates of at least 40% of municipal waste by 2010, rising to 50% by 2013, 60% by 2020 and 70% by 2025;
- by 2025 no more than 5% municipal waste to landfill (assumes all municipal, not just BMW); and
- 25% cap on the amount of waste used to produce energy.

Current Municipal Waste Management

5. Historically, Scotland's municipal waste programme has been dominated by landfill with 92% of municipal waste going to landfill in 2001/2002[3]. Since then, significant progress has been made in reducing landfill, with corresponding growth in recycling and composting. By 2008/2009, Scotland had reduced its municipal waste going to landfill to 63%[4] and is on course to meet its 2010 obligations.

6. Although progress to date has been encouraging, the advances made so far will most likely prove to be the easiest steps on the road to a Zero Waste society as the more straightforward gains are achieved first. Consequently, future municipal waste management will prove more challenging and require further changes in our approach to waste management.

7. To achieve Scotland's municipal waste targets, costs will inevitably have to increase to help develop practices in waste management; invest in new technology; replace existing infrastructure; maintain or reduce waste arisings; embed recycling and composting practices through communication; and transform public values and behaviour towards waste generation and management.

Municipal Waste Future Scenarios

8. To ascertain what infrastructure is required to meet future waste obligations and how much it will cost, Scotland's future municipal waste streams were forecast. This study considered six scenarios that were modelled and these are summarised in Table 1.

Table 1 Waste Forecast Scenarios

Scenario Number	Description
Scenario 1a. **Do Nothing (With Landfill Fines)**	Continue at 2008/2009 levels of municipal waste processing and at present cost levels. No change in waste streams. The appropriate landfill fines are imposed.
Scenario 1b. **Do Nothing (No Landfill Fines)**	Continue at 2008/2009 levels of municipal waste processing and at present cost levels. No change in waste streams. No landfill fines are imposed.

3 SEPA, Waste Data Digest 3, 2002
4 SEPA, Landfill Allowance Scheme Data April 2008 – March 2009, 2009

Scenario Number	Description
Scenario 2. **EU WFD Only**	Meet all EU statutory obligations (only) such as the Waste Framework Directive and the Landfill Directive (e.g. landfill targets for 2010, 2013 and 2020; and 50% recycling/composting by 2020), but not the Scottish Government targets.
Scenario 3. **EU WFD & SG Targets (50/20)**	Meet all EU statutory obligations and all Scottish Government targets. This scenario assumes a 50/20 split between source segregation and residual waste treatment to meet the 70% recycling and composting target.
Scenario 4. **EU WFD & SG targets (60/10)**	Meet all EU statutory obligations and all Scottish Government targets as per scenario 3 except this scenario assumes a 60/10 split between source segregation and residual waste treatment to meet the 70% recycling and composting target.
Scenario 5. **EU WFD & SG Targets (65/5)**	Meet all EU statutory obligations and all Scottish Government targets as per scenario 3 except this scenario assumes a 65/5 split between source segregation and residual waste treatment to meet the 70% recycling and composting target.
Scenario 6. **EfW cap by 2018**	Meet all EU statutory obligations and all Scottish Government targets as in scenario 3 except that EfW reaches its 25% cap earlier in 2018.

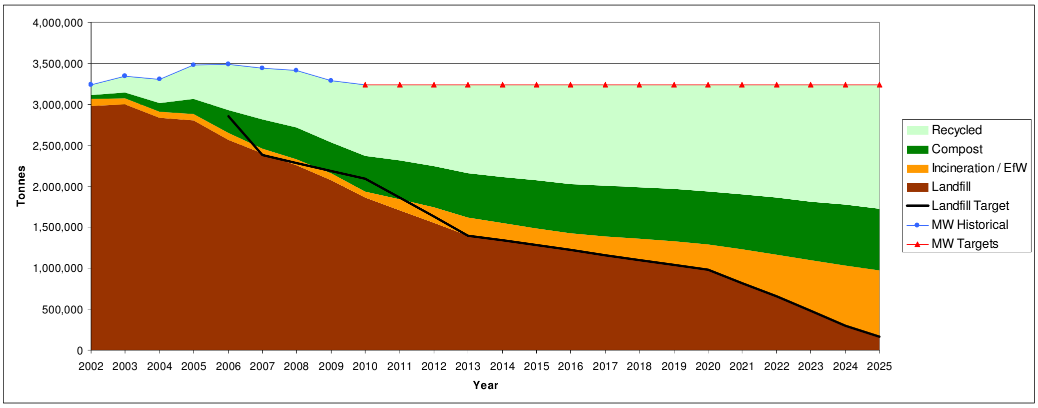
Source: SQW Energy [n.b. any increases in landfill tax after 2013 (as announced in the March 2010 budget) will impact on the costs presented, particularly 1a and 1b where more waste is landfilled]

9. Scenario 1a and 1b presents the 'Do Nothing' option as a datum to illustrate the implications of continuing in a 'business as usual' manner with no change in procedure or to the costs of dealing with municipal waste. Scenario 1a includes any landfill fines imposed for missing targets, while Scenario 1b does not take into account landfill fines. Scenario 2 highlights the minimum required to comply with EU statutory obligations only and avoid any penalties. Scenario 3, 4 and 5 demonstrate what is needed to meet all EU statutory obligations and achieve the targets set down by the Scottish Government with varying degrees of source segregation. Scenario 6 also meets EU and Scottish Government targets, but shows the effect of bringing EfW online sooner.

Municipal Waste Targets and Forecasts

10. Figure 1 illustrates the municipal waste arising forecast to 2025 that would meet the requirements set out by the EU and Scottish Government.

Figure 1 Municipal Solid Waste Arising (Meet all EU and Scottish Government Targets)



Source: SQW Energy

11. To meet all targets and obligations, each waste stream forecast to 2025 is effectively determined by the waste management targets set down by the EU and the Scottish Government. The EU landfill targets are the primary goal as they are legally binding and limit the absolute quantity of BMW sent to landfill. In conjunction with the EU Landfill Directive, the targets for recycling and composting must be achieved and these are expressed as a percentage of the total municipal waste arising. The goal of no growth beyond 2010 of the total municipal waste arising puts an upper limit on future forecasts. As a result, if EU landfill targets are not met, then it becomes more difficult to achieve the Scottish Government recycling and composting targets and vice versa.

12. This leaves the EfW waste stream. The maximum that can go to EfW is the waste that remains once the other targets are satisfied. In Scenario 3, EfW does not reach its cap until 2025. In effect, if the national targets are to be met exactly (no more, no less), the sizes of Scotland's municipal waste streams to 2025 are pre-defined by the targets.

Waste Management Infrastructure

13. From Figure 1 it can be seen that further change is required in the way municipal waste in Scotland is managed if national municipal waste targets are to be achieved. Existing infrastructure capacity will be insufficient to meet these targets.

14. For each of the scenarios, the type, capacity and timing of waste infrastructure required to meet future waste targets was calculated by:

- Identifying the existing waste infrastructure in each of the Waste Strategy Areas (WSA) - see Annex C for WSA definitions;
- Estimating the shortfall between existing capacity and future annual requirements; and
- Calculating the additional infrastructure required to meet the forecasted demand in each year for each of the WSAs.

These estimates were then aggregated to give the national picture with the size and timing of new infrastructure units scheduled to 2025.

15. At a national level, the additional infrastructure required to meet all EU and National municipal waste management targets to 2025 (Scenario 3 with 50% source segregation), excluding existing infrastructure that is replaced, is shown in Table 2.

Table 2 Additional waste infrastructure required in Scotland to meet all targets (Scenario 3)

Waste infrastructure required	No. of units	Operational capacity (tonnes per unit)*	Total Capacity (tonnes)*
aerobic (1,000t)	0	1,000	0
aerobic (10,000t)	2	10,000	20,000
aerobic (25,000t)	2	25,000	50,000
aerobic (50,000t)	3	50,000	150,000

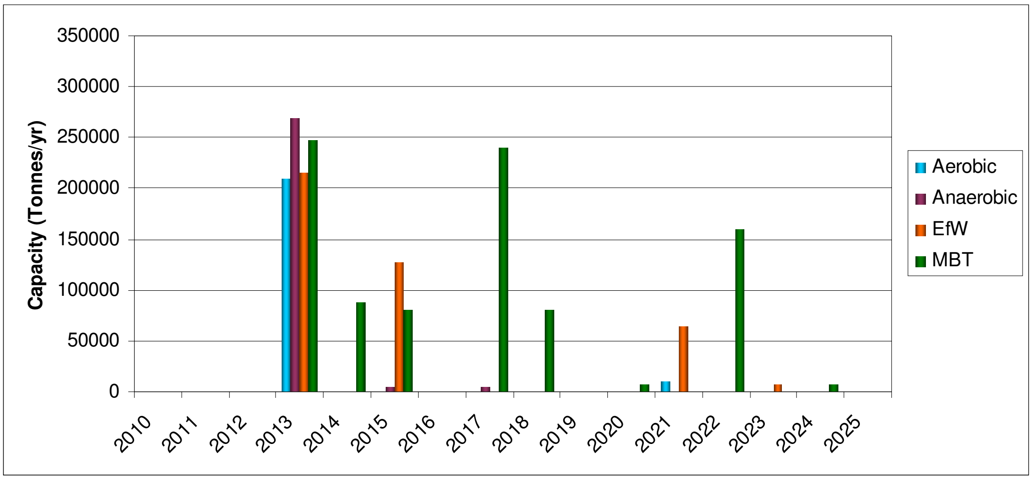
Waste infrastructure required	No. of units	Operational capacity (tonnes per unit)*	Total Capacity (tonnes)*
anaerobic (1,000t)	4	1,000	4,000
anaerobic (5,000t)	5	5,000	25,000
anaerobic (30,000t)	5	30,000	150,000
anaerobic (50,000t)	2	50,000	100,000
EfW (8,000t)	4	8,000	32,000
EfW (64,000t)	6	64,000	384,000
EfW (200,000t)	0	200,000	0
MBT (8,000t)	4	8,000	32,000
MBT (40,000t)	4	40,000	160,000
MBT (80,000t)	9	80,000	720,000

* For modelling purposes EfW and MBT plants are assumed to operate at 80% of total stated capacity to reflect downtime for maintenance and repairs.

Source: SQW Energy

16. Figure 2 illustrates the capacity of additional infrastructure required and the year by which it must be operational to meet all EU and Scottish Government waste management targets set out in Scenario 3.

Figure 2 Infrastructure Capacity Requirement to meet EU & Scottish Government Targets (Scenario 3) with 50% source segregation.



Source: SQW Energy

17. It can be seen that there is a significant requirement for additional infrastructure to be operational by the year 2013. Assuming a minimum two to three year lead time for most infrastructure projects, steps must be taken now if the 2013 targets are to be met.

18. Although all four technologies analysed require similar capacities to be operational by 2013, both EfW and MBT will require additional capacity to be commissioned between 2013 and 2025.

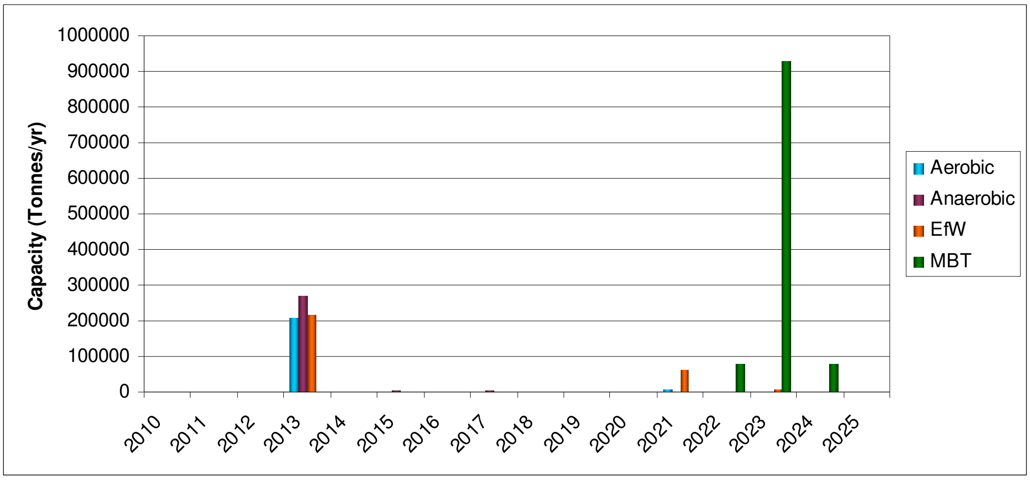
19. There is a growing requirement for MBT infrastructure, chiefly composed of medium and large units, as source segregation approaches its maximum capture rates (for Figure 2 (Scenario 3) -assumed to be 50% of Total Waste Arising) and as demand for EfW feedstock comes on stream.

20. Once the appropriate capacity of Aerobic and Anaerobic infrastructure is commissioned by 2013, there is little requirement for additional composting infrastructure.

21. Of the six scenarios examined, Scenario 5 was the most cost efficient scenario, primarily due to the increased levels of source segregation. Of the three 'meet all targets' scenarios (scenario 3 to 5), the Net Present Cost (NPC) reduces as more source segregation is done. This is due to a combination of reduced infrastructure required to process residual waste and less processing costs as sorting and processing costs are shifted towards the point of waste collection.

22. Scenario 5 has source segregation levels of 65%. Figure 3 shows the capacity of additional infrastructure required and the year by which it must be operational to meet all EU and Scottish Government waste management targets set out in Scenario 5.

Figure 3 Infrastructure Capacity Requirement to meet EU & Scottish Government Targets (Scenario 5) with 65% source segregation.



Source: SQW Energy

23. By increasing the level of source segregation (as in Scenarios 4 and 5), the requirement for infrastructure, particularly MBT, is delayed significantly. If the lead time to get new infrastructure installed by 2013 is insufficient (for example due to planning constraints), then increasing the level of source segregation offers an alternative solution.

24. In effect, by continuing to improve the capture rates of current collection infrastructure and increasing source segregation, processing costs are shifted towards the waste producer rather than centralised MBT units.

Cost Benefit Analysis

25. The annual net cost of collecting and processing all the municipal waste in Scotland according to the most recent publicly available data (2007/2008) is £404 million[5]. For this study, Scotland's future waste management requirements were modelled to assess the financial impacts above and beyond existing spending levels under the six scenarios through to 2025.

26. Detailed costs and benefits of implementing the six waste management scenarios were evaluated in line with the HM Treasury Green Book[6]. This included the capital cost of new infrastructure; the cost of collecting; processing; landfill fines and the benefits arising from processed waste (e.g. recyclate revenue, generated electricity, etc). The cost benefit analysis did not account for non-market benefits (externalities). The headline results of the Cost Benefit Analysis (CBA) are shown in Table 3.

27. Table 3 shows, for each of the scenarios, a breakdown of the Net Present Value (NPV) for each of the main elements associated with implementing municipal waste management in Scotland to 2025. The Net Present Cost to 2025, if current levels of spend (£404M) are continued, is £5,069 million. The final column shows the Net Present Cost, over and above current spending levels, of implementing each of the scenarios.

Table 3 – Cost Benefit Analysis (2010 to 2025) - all figures are Net Present Value

Scenario	Collection (£ million)	Processing (£ million)	Landfill Fines (£ million)	Infrastr. Investment (£ million)	Benefits (£ million)	Total Net Present Cost (£ million)	Cost in excess of current NPV spend levels [£5,069] (£ million)
1a. Do Nothing (with Landfill Fines)	£2,480	£4,115	£1,288	£91	£559	£7,415	£2,346
1b. Do Nothing (without Landfill Fines)	£2,480	£4,115	0	£91	£559	£6,127	£1,058
2. EU Only	*£3,347*	£3,431	0	£434	£697	£6,514	£1,445
3. EU & SG Targets (50/20)	*£3,763*	£3,006	0	£449	£682	£6,536	£1,467
4. EU & SG Targets (60/10)	*£3,724*	£2,888	0	£342	£682	£6,271	£1,203
5. EU & SG Targets (65/5)	*£3,695*	£2,799	0	£303	£682	£6,114	£1,046
6. EfW Cap by 2018	*£3,811*	£2,981	0	£646	£741	£6,697	£1,628

Source: SQW Energy

28. The Collection and Processing costs of each scenario are shown for the period to 2025. Landfill Fines are shown separately to demonstrate the level of penalty enforced. The capital investment in new infrastructure required to achieve each of the scenarios is then given. The

[5] http://www.scotland.gov.uk/Topics/Statistics/Browse/Local-Government-Finance/PubScottishLGFStats
[6] HM Treasury, The Green Book, 2009 http://www.hm-treasury.gov.uk/d/green_book_complete.pdf

total market benefits of each scenario are then set out. (n.b. this does not include any non-market costs/benefits (externalities)).

29. The Net Present Cost figure represents the amount over and above the current level of spending (NPV=£5,069M) that would be required through to 2025 to implement each of the scenarios. To meet all EU and Scottish Government waste management targets, Scenario 5 (with 65% source segregation) gave the most cost effective solution and required the following from 2010 to 2025:

- NPV Infrastructure Investment = **£303 million**
- Net Present Cost in excess of present spend levels = **£1,046 million**

30. Where source segregation levels are lower but all EU and Scottish Government targets are still achieved (as shown in Scenarios 3 and 4) the costs were significantly higher. In effect, by continuing to improve the capture rates of current collection infrastructure and increasing source segregation, costs can be shifted towards the waste producer rather than centralised MBT units.

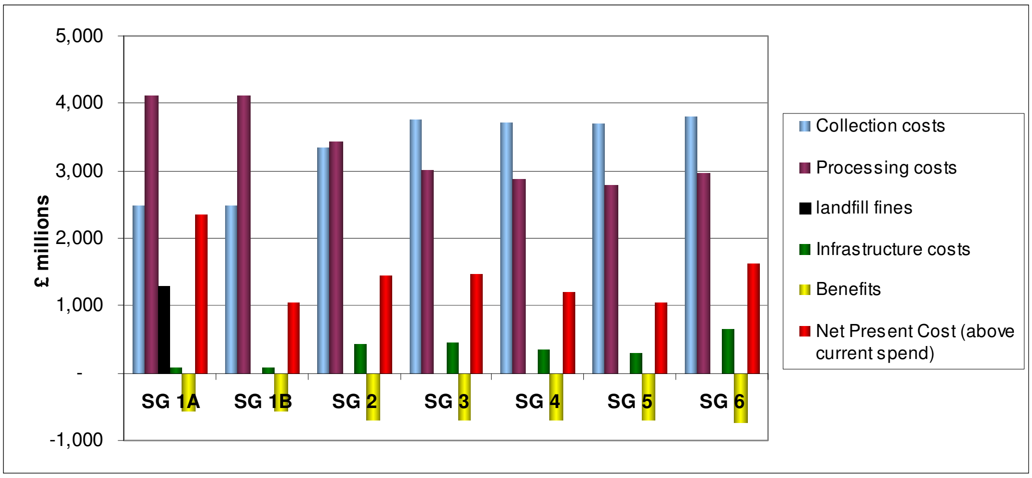
31. To achieve EU statutory obligations (only) would cost £1,445 million above current spending. To also realise the Scottish Government's more ambitious targets (Scenario 3) would cost an extra £22 million over the same waste strategy timeframe with an extra £15 million (NPV) of infrastructure investment assuming only 50% source segregation is achieved.

32. Scenario 1a (Do Nothing with Fines) is the most expensive option due to the landfill fines incurred for missing landfill targets. Scenario 1b (Do Nothing without Fines) is the second most cost efficient scenario, but is still slightly more expensive than the high source segregation Scenario 5. Therefore, even if landfill fines are not imposed, it would still make economic sense to strive for greater source segregation rather than continue with a business as usual policy.

33. Under Scenario 6, it is between £161 million and £582 million more expensive to bring EfW capacity online sooner than the other 'on-target' scenarios, predominantly due to the additional infrastructure investment required.

34. Figure 4 illustrates the costs/benefits associated with implementing each of the waste management scenarios.

Figure 4 - Cost Benefit Analysis Breakdown for Each Scenario



Source: SQW Energy

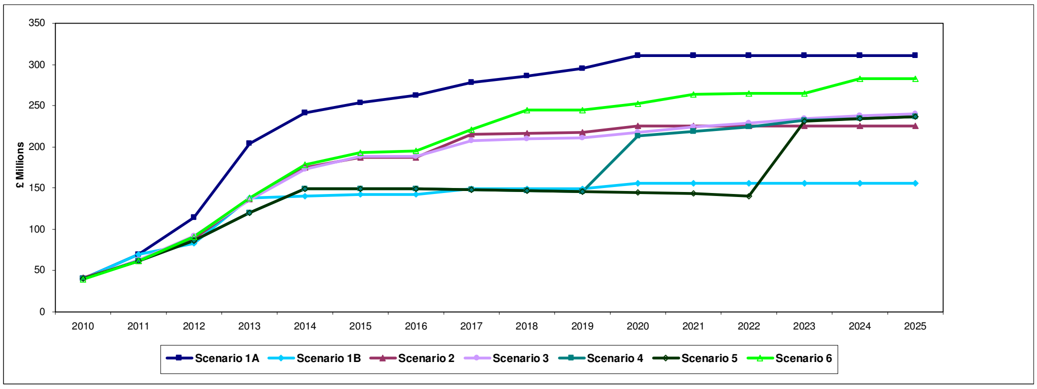
35. It can be seen that although infrastructure investment is significant, by far the most significant factors are collection and processing costs.

36. Even in the best case scenarios, the benefits from waste management are only capable of marginally off-setting the costs of waste management although this may not be the case if non-market benefits are quantified and included in the analysis.

37. Of the three 'meet all targets' scenarios (scenario 3 to 5), the Net Present Cost reduces as more source segregation is done. This is due to a combination of reduced infrastructure required to process residual waste and less processing costs. Processing costs are reduced by gaining efficiencies from current collection infrastructure and increasing source segregation; hence processing costs are shifted towards the waste producer rather than centralised MBT units.

38. Figure 5 shows the additional costs annually of each scenario, on a nominal basis. It illustrates that the timing of expenditure is very different between scenarios and is important in terms of overall cost efficiency. It can be seen that although Scenario 5 costs considerably more after 2022, the Net Present Cost of Scenario 5 has the lowest NPV because the major expenditure is delayed until later years. For this reason, Scenario 5 is more cost efficient than all other scenarios, including Scenario 1B (Do Nothing – without Landfill Fines).

Figure 5 – Additional Costs in Excess of Existing Expenditure (Nominal)



Source: SQW Energy

Conclusions

39. Regardless of what future waste scenario is considered, the cost of managing Scotland's waste will increase.

40. The option of 'doing nothing with landfill fines' is by far the most costly due to landfill penalties and the environmental impact.

41. It is more cost effective to meet the EU statutory obligations and avoid landfill fines. To meet EU obligations (only) would require an NPV investment of £434 million in new infrastructure and cost an additional £1,445 million above current spending levels over the waste strategy period (2010 – 2025).

42. To meet the more ambitious Scottish Government targets for waste management would require a modest increase in investment over that of EU compliance. For Scenario 3, this would mean an NPV investment of £449 million in new infrastructure and cost an additional £1,467 million above current spending levels over the waste strategy period (2010 – 2025).

43. If the EU and Scottish Government targets can be met with more source segregation and less residual processing, investment costs can be reduced through less need for MBTs as illustrated in Scenarios 4 and 5. The 60/10 and 65/5 split of Scenario 4 and 5 both delay the need for infrastructure, particularly MBT, and allow more time to plan for and establish infrastructure.

44. In terms of infrastructure, smaller units may be more affordable for smaller local authorities, but there are significant economies of scale to be attained by choosing larger plants. There are significant potential savings to be made by having co-operation and combined infrastructure solutions between local authorities.

45. Collection and processing drive the overall cost of waste management. To meet all targets in Scenario 3, the infrastructure costs are approximately £449 million NPV. However, this is dwarfed by the operational costs - collection (£3.8 billion NPV) and processing (£3.0 billion NPV). Therefore the largest savings are to be gained in reducing collection and processing

costs through reducing waste arisings, increased source segregation and more efficient infrastructure use (e.g. higher participation, higher capture rates and lower contamination) and further work is recommended in these areas.

46. It is therefore recommended that further work is required to:

- Invest in effective communication and education including on the non-market benefits of investing in prevention, reuse and recycling;
- Better understand the efficiencies in collection infrastructure;
- Improve data collection on costs for collection, processing and infrastructure; and
- Better understand the synergies between MSW and other waste streams in terms of shared infrastructure.

1: Introduction

1.1 The Scottish Government's Waste and Pollution Reduction Division commissioned SQW Ltd to carry out this study to assess the costs associated with the introduction of new waste management infrastructure to meet the EC Landfill Directive and Scottish Government Zero Waste Targets. The Scottish Government (SG) wished to develop a series of costed waste management scenarios to enable them to assess and prioritise investment for delivery through local authorities.

Legislative and Policy context

1.2 Scotland's waste management targets for Municipal Solid Waste (MSW) fall into two main categories. The statutory waste management targets laid down in EU legislation and the more ambitious national targets set out by the Scottish Government.

European legislation

1.3 Scotland must ensure that it meets its share of the statutory UK Landfill Directive targets (required under EC Landfill Directive 1999/31[7]) and the EU's Waste Framework Directive (2008/98/EC). In effect this means that collectively local authorities in Scotland must meet the following targets:

- by 2010 no more than 1.32 million tonnes of biodegradable municipal waste (BMW) can go to landfill;
- by 2013 no more than 880,000 tonnes of BMW;
- by 2020 no more than 620,000 tonnes of BMW; and
- 50% reuse/recycling of household waste and similar by 2020.

As a devolved responsibility this means that Scotland must deliver its own strategy, ensuring the avoidance of infraction procedures from the EU for missed targets.

Waste Planning in Scotland

1.4 In compliance with the landfill directive, Scotland produced its National Waste Strategy Scotland (1999) followed by the eleven Area Waste Plans which were then integrated into the National Waste Plan (2003)[8].

1.5 The Scottish Government has recently reviewed the 2003 National Waste Plan for Scotland and produced Scotland's Zero Waste Plan and associated Strategic Environmental

[7] Official Journal L 182, 16/07/1999 P. 0001-0019, Landfill Directive
[8] Scottish Environment Protection Agency (2003) National Waste Plan

Assessment for consultation[9] (20th August – 13th November 2009), with a view to introducing a new waste strategy for Scotland in 2010.

1.6 In developing this new Zero Waste Plan, the Scottish Government are mindful of the overarching context of sustainable development as set out in "Choosing our Future: Scotland's sustainable development strategy", December 2005[10]. This means that the waste infrastructure requirements and costs will not only be viewed from the economic standpoint but also the environmental and social.

The Government Economic Strategy

1.7 In November 2007 the current administration signalled a step change in policy with The Government Economic Strategy[11]. This refers to the government's overarching aim, to focus the Government and public services on creating a more successful country, with opportunities for all of Scotland to flourish, through increasing sustainable economic growth. To deliver this the Government has identified five strategic objectives: a wealthier and fairer Scotland, a smarter Scotland, a healthier Scotland, a safer and stronger Scotland, and a greener Scotland. These are described in more detail through the fifteen national outcomes which aim to clarify the focus of government, enable priorities to be clearly understood and provide a clear structure for delivery.

1.8 The Zero Waste Strategy falls within the National Outcome which aims to reduce the local and global environmental impact of our consumption and production. The government's role in this will be to 'Vigorously pursue our zero waste policy, setting challenging targets for reduction in municipal waste sent to landfill; allocating £150 million to the Zero Waste Fund and consulting on a range of potential legislative measures'.[12]

1.9 Progress against this Outcome will be measured against the National Indicator to reduce our BMW sent to landfill to 1.32 million tonnes by 2010. It will be achieved in partnership with local authorities, who have responsibility for deciding which facilities and services to fund that are capable of diverting municipal waste from landfill. The Scottish Government has responsibility for monitoring progress through local authority Single Outcome Agreements.

Single Outcome Agreements

1.10 The Single Outcome Agreements, between the Scottish Government and each council, are based on 15 key national outcomes that contribute to the Government's five strategic objectives. The Agreements set out how each council is working locally to progress the 15 national outcomes. On 30 June 2008 all 32 Local Authorities in Scotland finalised their Single Outcome Agreements[13]. Within these agreements the local authorities set out the detail of how they will deliver the National Outcomes including those related to the Zero Waste Strategy.

[9] Scotland's Zero Waste Plan: Consultation, August 2009

[10] www.scotland.gov.uk/Publications/2005/12/1493902/39032

[11] Scottish Government, November 2007, The Government Economic Strategy

[12] http://www.scotland.gov.uk/About/scotPerforms/outcomes/envImpact

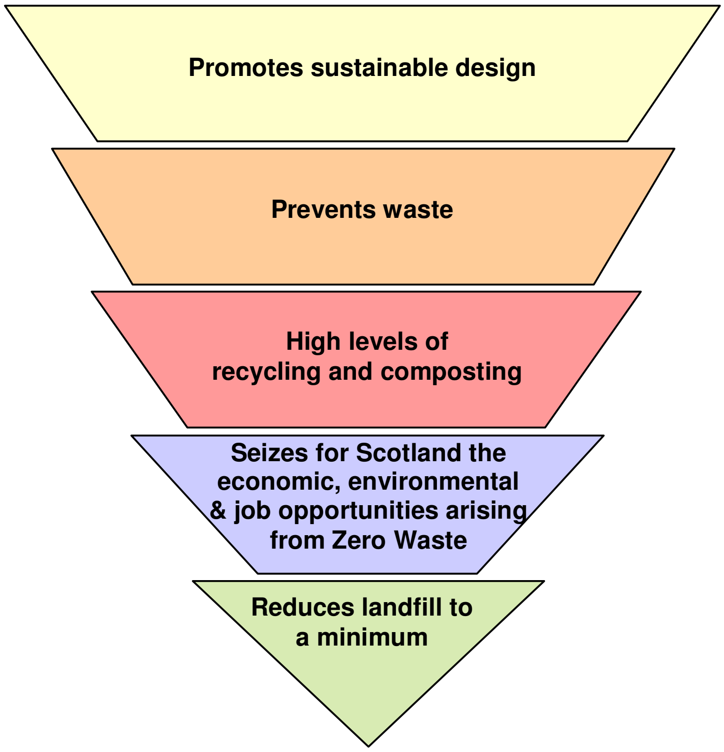
[13] http://www.sustainable-scotland.net/article.asp?article=81

Progress towards zero waste

1.11 The Scottish Government's commitment to a zero waste society is a key component of the Scottish Government's work on addressing climate change. In summary, zero waste means reducing the unnecessary use of raw materials, re-using products where possible and recovering value from products when they reach the end of their lives through recycling, composting or energy recovery.

1.12 The zero waste vision for Scotland is one that follows the approach illustrated in Figure 1-1:

Figure 1-1 Zero Waste Approach



Source: SQW

1.13 In January 2008 the Cabinet Secretary for Environment and Rural Affairs announced tough new targets to stimulate and increase the levels of recycling and composting in Scotland whilst reducing the amount of municipal waste going to landfill. A cap on Energy from Waste (EfW) was also announced. In summary, the targets announced were:

- stop the growth of municipal waste by 2010;
- recycling/composting rates of at least 40% of municipal waste by 2010, rising to 50% by 2013, 60% by 2020 and 70% by 2025;
- by 2025 no more than 5% municipal waste to landfill (assumes all municipal, not just BMW); and
- 25% cap on the amount of waste used to produce energy.

These targets in conjunction with the landfill directive targets form the basis of the Zero Waste Strategy and the parameters for the assessment of infrastructure requirement costs that are the subject of this study.

1.14 The Sustainable Development Commission (SDC) Scotland undertook an assessment of progress by the Scottish Government against sustainable development targets including waste in December 2008[14]. In summary they considered progress on recycling was strong and noted that waste arisings had fallen, however, on the latter it was too early to determine a trend. In terms of overall progress towards sustainable development SDC concluded that there was *'much to be done to deliver a zero waste society'*.

1.15 SDC also welcomed Scottish Government's move to link action on waste to its National Outcome on sustainable production and consumption and advocates more action on waste prevention and business waste.

Energy from Waste

1.16 The Government's priorities to achieve zero waste are resource efficiency, waste prevention, re-use and high levels of composting and recycling. However, it is recognised that recovering recyclate and energy can play an important role as long as it does not compete with the other priorities. In developing the Zero Waste Strategy it has been necessary to review and revise the detail on how the 25% will apply to Energy from Waste (EfW) facilities. Additional information was issued in July 2009[15].

1.17 In summary the 25% cap applies to:

- collected municipal waste
- each local authority as well as Scotland as a whole
- incineration, gasification, plasma and pyrolysis plants taking residual municipal waste (where no further material for recycling and composting can reasonably be extracted)
- the inputs going into the EfW process
- infrastructure which had planning permission and/or a permit on 24 January 2008 but was not operational on 24 January 2008 is subject to the cap at both local and national level.

1.18 The cap does not apply to:

- Waste treatment plants other than incineration, gasification, plasma or pyrolysis
- Non-MSW commercial and industrial waste

1.19 In terms of calculating the cap for residual waste infrastructure in the short term this should use the total municipal waste arising per authority in the financial year 2007/8. In the longer term this may be reviewed to account for changes in waste arisings.

[14] Sustainable Development Commission (2008) Sustainable Development: A review of progress by Scottish Government.
[15] Scottish Government (July 2009) Scotland's Zero Waste Plan Consultation Annex J

1.20 A further key point in Annex J is that bottom ash from EfW can count towards composting and recycling targets (and EfW as input) or in the case of bottom ash to landfill, the landfill cap (and EfW input).

Landfill Allowance Scheme

1.21 Landfill Tax legislation is currently under review with a consultation having taken place in July 2009. The existing Landfill Allowance Scheme was introduced to drive delivery of the targets set to reduce the amount of BMW sent to landfill. Under this Scheme, local authorities exceeding allowances could be subject to penalties, such as fines. Local authorities could trade allowances if they wished and at a price, to avoid penalties. However, Government and the Convention of Scottish Local Authorities (CoSLA) have reviewed the Scheme and it is suspended in principle until May 2011.[16]

Research context

1.22 In delivering this project SQW drew on existing bodies of knowledge where appropriate to inform our research. A full bibliography is contained at the end of the report. However, a list of the reports and studies that were of particular use in this study is shown below:

Data Modelling

1.23 To develop the research context with regard to modelling waste flow and forecasting the study referred to:

- Eunomia Research and Consulting (2007b) Scoping New Municipal Waste Targets for Wales. Report to the Welsh Local Government Association.
- Caledonian Environment Centre (2009) Scottish Recycling Study.

Infrastructure and Technology

1.24 To develop the research context with regard to infrastructure and technology the study referred to:

- Eunomia Research and Consulting (2008) Meeting Ireland's Waste Targets: The Role of MBT.
- Scottish Environment Protection Agency (June 2009) *National Waste Capacity Report for Scotland 2007*

Cost Benefit Analysis

1.25 To inform the cost benefit analysis and identify the costs for infrastructure, processing and collection the study referred to:

- Eunomia Research and Consulting (2008) Food Waste Collection: Update to WRAP Biowaste Cost Benefit Study

[16] Scottish Government, August 2009, Scotland's zero waste plan: consultation

- Eunomia Research and Consulting (2007a) Managing Biowastes from Households in the UK: Applying Life-cycle Thinking in the Framework of Cost-benefit Analysis.
- Eunomia Research and Consulting (no date) Costs for Municipal Waste Management in the EU. Final Report to Directorate General Environment, European Commission.
- Caledonian Environment Centre (2008) Financial Exposure of Scottish Local Authorities Arising from Reductions in Recyclate Material Prices.
- WRAP Improving the Performance of Waste Diversion Schemes: A Good Practice Guide to Monitoring and Evaluation
- WRAP (March 2009) Materials Pricing Report.
- WRAP (2008a) CO_2 impacts of transporting the UK's recovered paper and plastic bottles to China.
- WRAP (2008b) Kerbside Recycling: Indicative Costs and Performance.
- WRAP (2008c) Market Situation Report: Realising the value of organic waste.
- WRAP (2008d) Gate Fees Report: Comparing the Cost of Alternative Waste Treatment Options.
- WRAP (2006a) MRF Costing Model.
- WRAP (2006b) The Costs & Operational Implications of Kerbside Glass Collections.
- Waste and Resources Action Programme (June 2008) Kerbside Recycling: Indicative Costs and Performance Technical Annex

Abbreviations used

1.26 The following abbreviations and acronyms have been used in the report.

- AD – Anaerobic Digestion
- BMW – Biodegradable Municipal Waste
- CBA – Cost Benefit Analysis
- EfW – Energy from Waste
- EU – European Union
- IV – In Vessel
- LA – Local Authority
- MBT – Mechanical Biological Treatment
- MHT – Mechanical Heat Treatment
- MSW – Municipal Solid Waste
- NPC – Net Present Cost
- NPV – Net Present Value
- R+C – Recycling and Composting
- ROC – Renewable Obligation Certificate
- RWT – Residual Waste Treatment
- SDC – Sustainable Development Commission
- SEPA – Scottish Environment Protection Agency
- SG – Scottish Government
- TWA – Total Waste Arising
- UK – United Kingdom
- WRAP – Waste and Resources Action Programme

2: Key Objectives and Research Stages

2.1 This study will inform the new national waste strategy by answering two key questions:

- What new additional infrastructure will be required to meet Scotland's Zero Waste targets for municipal waste?
- What are the costs associated with achieving these targets?

2.2 The main research stages of the study can be broken down into the following steps:

- Establish the cost of a 'do nothing' approach to Scotland's waste management.
- Forecast Scotland's national municipal waste streams to 2025 to meet EU and Scottish Government waste targets.
- Determine the infrastructure required to process these waste streams and meet the targets.
- Quantify the cost involved in meeting the targets through appropriate waste management infrastructure.
- Provide cost-benefit analysis of meeting the targets with the appropriate infrastructure.
- Examine the consequences of different scenarios on meeting the targets and the associated waste infrastructure required.

3: Methodology

Introduction

3.1 This section gives an overview of the methodology, the model, data sources and highlights some of the main assumptions made.

Modelling Overview

3.2 The overall approach adopted in the research was to construct a spreadsheet based model that took Scotland's Municipal Solid Waste (MSW) targets and the historical MSW data from SEPA to accurately forecast the waste streams to 2025.

3.3 The waste infrastructure required to process future waste flows was then calculated by:

- Firstly identifying the existing waste infrastructure and capacities in each of the Waste Strategy Areas (WSA).
- Secondly, estimating the shortfall between existing capacity and future waste flows for each of the WSAs.
- Finally, calculating the additional infrastructure needed to meet forecasted demand for each of the WSAs.

3.4 These WSA estimates were then aggregated to give the national picture. From this, the associated costs and benefits were derived.

3.5 The key elements of the model are described below.

Waste Streams

3.6 Before the capacity of waste infrastructure could be calculated, it was first necessary to examine each of the MSW streams that were subject to waste management targets. There were four such waste streams, measured in tonnes per annum, and they conformed to standard SEPA municipal waste data conventions. The four waste streams examined were:

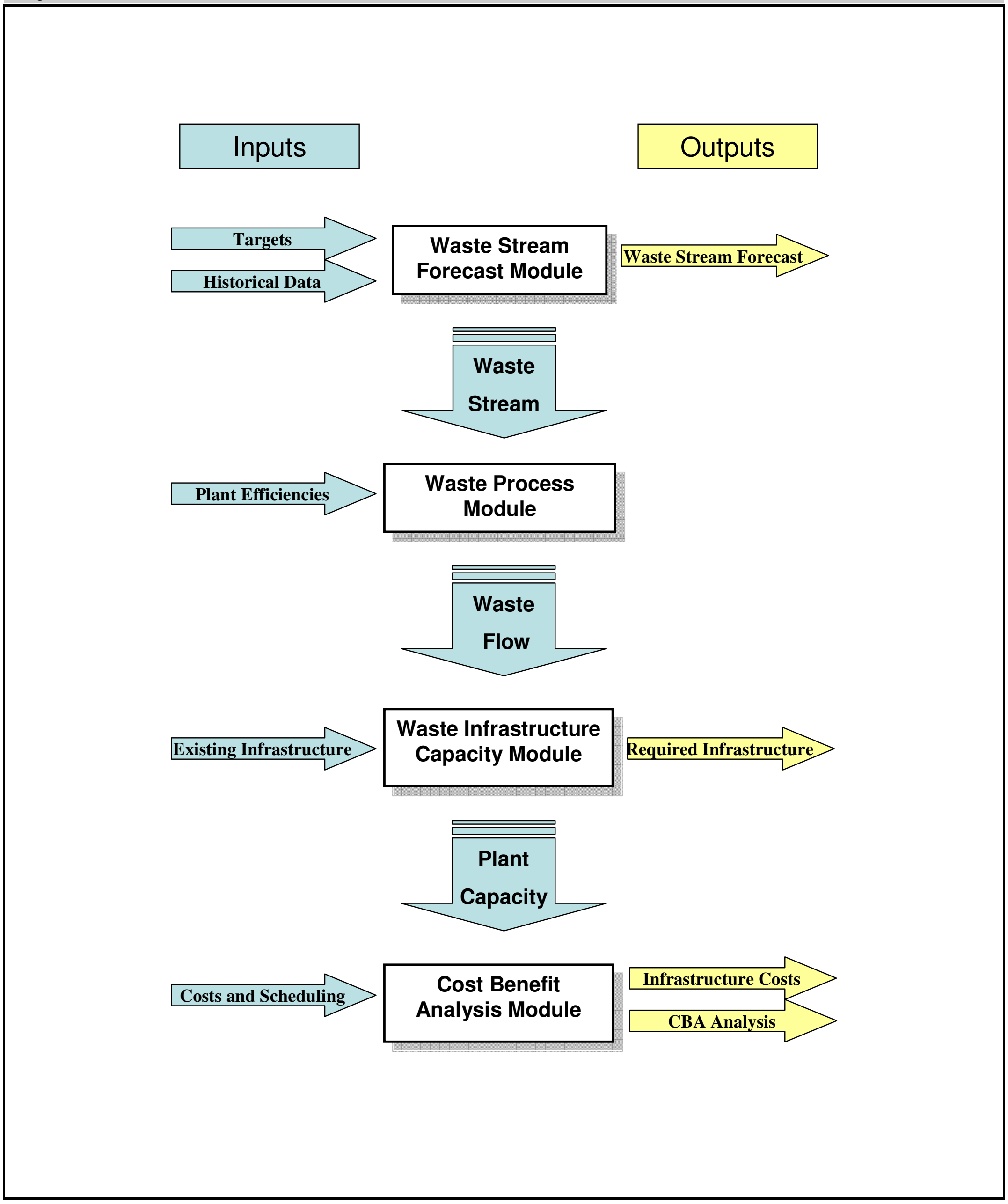
- Recycling
- Composting
- EfW / Incineration
- Landfill

3.7 These four waste streams formed the principal elements for the modelling of municipal waste in Scotland for this study.

Waste Model Schematic

3.8 The SQW Waste Model developed for this research project comprised of four inter-related components (modules) that combine to deliver the key objectives stated in section 2. The structure of the waste model and how its component modules fit together are illustrated in Figure 3-1. The main inputs and outputs from the model are also shown.

Figure 3-1 SQW Waste Model Structure



Source: SQW Energy

Waste Stream Forecast Module

3.9 Before calculating the infrastructure required to meet government targets, it was necessary to establish how much of each waste stream would be produced in any given year out to 2025. This was done by modelling the four individual waste streams in the "Waste Stream Forecast Module" (see Figure 3-1).

3.10 Using SEPA annual historic data (2002 to 2009[17]) at a national and local authority level, Scotland's waste profile was modelled up to and including 2009 to show the waste flow of the four distinct waste streams. The future waste streams were then modelled for each of the six scenarios shown in Table 3-1.

Table 3-1 Waste Forecast Scenarios

Scenario Number	Description
Scenario 1a. **Do Nothing (With Landfill Fines)**	Continue at 2008/2009 levels of municipal waste processing and at present cost levels. No change in waste streams. The appropriate landfill fines are imposed.
Scenario 1b. **Do Nothing (No Landfill Fines)**	Continue at 2008/2009 levels of municipal waste processing and at present cost levels. No change in waste streams. No landfill fines are imposed.
Scenario 2. **EU WFD Only**	Meet all EU statutory obligations (only) such as the Waste Framework Directive and the Landfill Directive (e.g. landfill targets for 2010, 2013 and 2020; and 50% recycling/composting by 2020), but not the Scottish Government targets.
Scenario 3. **EU WFD & SG Targets (50/20)**	Meet all EU statutory obligations and all Scottish Government targets. This scenario assumes a 50/20 split between source segregation and residual waste to meet the 70% recycling and composting target.
Scenario 4. **EU WFD & SG targets (60/10)**	Meet all EU statutory obligations and all Scottish Government targets as per scenario 3 except this scenario assumes a 60/10 split between source segregation and residual waste to meet the 70% recycling and composting target.
Scenario 5. **EU WFD & SG Targets (65/5)**	Meet all EU statutory obligations and all Scottish Government targets as per scenario 3 except this scenario assumes a 65/5 split between source segregation and residual waste to meet the 70% recycling and composting target.
Scenario 6. **EfW cap by 2018**	Meet all EU statutory obligations and all Scottish Government targets as in scenario 3 except that EfW reaches its 25% cap earlier in 2018.

Source: SQW Energy

3.11 Scenario 1a and 1b presents the 'Do Nothing' option as a datum to illustrate the implications of continuing in a 'business as usual' manner with no change in procedure or to the costs of dealing with municipal waste. Scenario 1a includes any landfill fines imposed for missing targets, while Scenario 1b does not take into account landfill fines. Scenario 2 highlights the minimum required to comply with EU statutory obligations only and avoid any penalties. Scenario 3 demonstrates what is needed to meet all EU statutory obligations and achieve the targets set down by the Scottish Government. Scenarios 4, 5 and 6 show variations on Scenario 3.

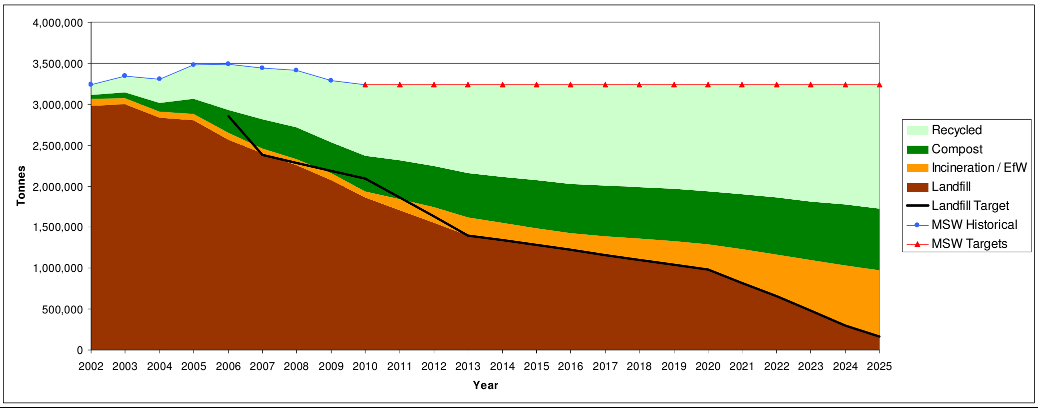
[17] http://www.sepa.org.uk/waste/waste_data/waste_data_digest.aspx

3.12 Scenarios 2 to 6 are concerned with meeting EU and/or Scottish Government targets. The principle drivers of the waste stream forecast are the following targets, which in order of precedence, were applied as follows:

- EU landfill directive targets for BMW;
- EU Waste Framework Directive 50% recycling and composting by 2020;
- SG no growth in total municipal waste arising beyond 2010;
- SG Recycling and composting targets (40% by 2010; 50% by 2013; 60% by 2020; and 70% by 2025);
- SG No more than 5% municipal waste to landfill by 2025; and
- SG 25% EfW cap for municipal waste.

3.13 Given these targets, and the order of precedence in which they need to be achieved, the waste forecast to 2025 that meets all EU and Scottish Government targets effectively becomes a series of simultaneous equations that need to be solved. An example of the output results from the Waste Stream Forecast Module is shown in Figure 3-2.

Figure 3-2 Example Output of Waste Stream Forecast Module – Meet all EU and SG Targets

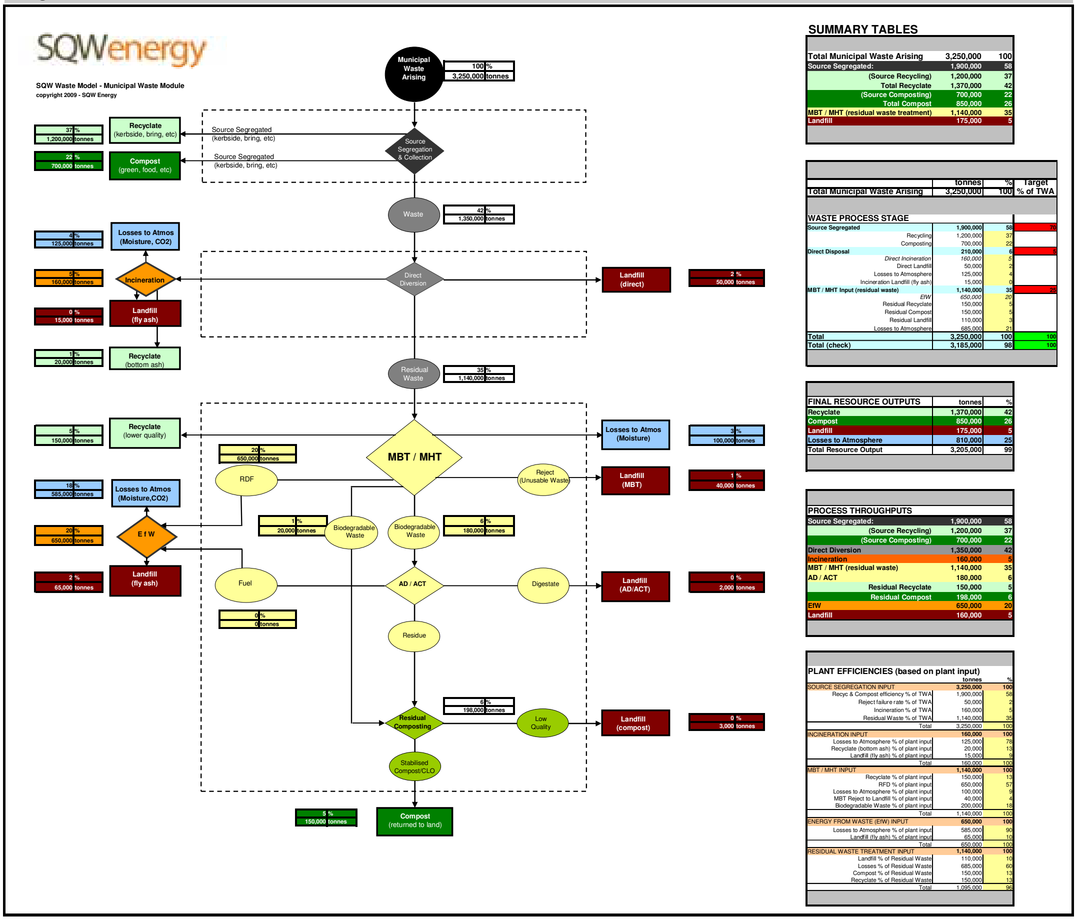


Source: SQW Energy

Waste Process Module

3.14 As shown previously in Figure 3-1, the waste stream output from the Waste Stream Forecast Module feeds into the Waste Process Module. The Waste Process Module is shown in Figure 3-3 and models the physical process of the waste streams taking account of major technology processes, plant efficiencies and the major losses of material from the waste management process – primarily moisture.

Figure 3-3 Waste Process Module



Source: SQW Energy

3.15 The Waste Process Module enabled the overall efficiencies and throughputs of the different waste processes to be determined. In addition, it allowed the impact of different process paths to be visualised and quantified, demonstrating the interaction between them, e.g. if additional EfW is installed then it has the effect of 'pulling' feedstock through an MBT reducing waste reclaimed through source segregated activities or sent direct to landfill/incineration.

3.16 Plant performances were set to reflect a range of factors including the equipment efficiency, downtime, maintenance and waste throughput, e.g. it was assumed that EfW had a load factor of 80% and an efficiency of 60%.

Waste Infrastructure Capacity Module

Current Infrastructure

3.17 Estimates of current infrastructure were drawn from SEPA's National Waste Capacity Report for Scotland[18], published in 2009, and giving data for 2007. This is the most up-to-date and comprehensive overview of waste infrastructure in Scotland.

3.18 The SEPA data was adjusted in two ways:

- For mixed use sites, and
- For incineration/EfW capacity

3.19 The SEPA data includes a class of infrastructure titled "multiple activity" where a site has more than one kind of waste treatment infrastructure in place. SEPA issues a blanket licence for these and the capacities of individual elements of the site (for instance, the capacity to process composting) is unrecorded. For some WSAs these mixed use sites are a major element of their infrastructure, and to ignore them would be to give a misleadingly small estimate of Scottish waste infrastructure.

3.20 We therefore used SEPA's report on the number of activities in Scotland to identify those units "concealed" in mixed use sites and applied national averages (based on stand-alone units in SEPA's reporting) to arrive at estimates of total waste infrastructure capacity for Scotland.

3.21 Civic amenity sites, metal recyclers and transfer stations were grouped together to give estimates of recycling capacity.

3.22 The SEPA reporting for Incineration/EfW infrastructure was not used. These items of infrastructure are both large and expensive and we were concerned not to skew the results by including infrastructure that was not relevant to the analysis (for example, the SEPA data includes a 750,000 tonne incineration plant in the Dumfries & Galloway area that handles only wood waste, not municipal waste[19]). In addition, there are a number of EfW plants about to come on stream whose inclusion will have a significant impact on waste infrastructure requirements. We therefore updated the SEPA data to include EfW plants that have been announced and excluded those plants that do not use MSW based on our own investigations.

Future Additional Infrastructure Required

3.23 Infrastructure capacities for 2007 were used as the starting point for the infrastructure analysis. These were obtained from SEPA[20] and gave infrastructure capacities by local authorities, Waste Strategy Area and the national level. Solving the infrastructure requirements for Scotland as one entity led to an over simplistic solution where 'theoretically' one large piece of infrastructure could have served all of Scotland's needs. To solve the

[18] SEPA (2009) National Waste Capacity Report for Scotland
[19] This plant at Steven's Croft, Lockerbie is operated by E.ON Renewables. E.ON describe the plant as being fuelled by" 60% sawmill co-products and small round wood, 20% short rotation coppice (willow) and 20% recycled fibre (from wood product manufacture)." http://www.eon-uk.com/generation/stevenscroft.aspx

[20] SEPA (2007) National Waste Capacity Report for Scotland

infrastructure requirements for each local authority also led to an over simplistic solution, where each local authority needed at least one of each type of infrastructure, where in reality they would have shared with neighbouring local authorities.

3.24 It was therefore decided to solve the infrastructure requirements based on the WSAs as laid out in SEPA's National Waste Capacity Report for Scotland 2007. Although the WSAs have some flexibility in how they operate 'cross-border', they offer a rational optimisation for the solving of Scotland's infrastructure requirements. In reality, some local authorities will continue to function as WSAs whilst others may work with other authorities and partnerships. WSAs will continue to evolve as they have since WSAs were first introduced to form the National Waste Plan (2003).

3.25 It is not an aim of the research to choose what specific types of waste management technology should be invested in by local authorities, i.e. not to choose winners, but only to identify what categories of infrastructure must be in place to be able to deal with the forecasted waste streams. We therefore grouped the waste infrastructure into the following categories:

- Landfill
- Aerobic Composting
- Anaerobic Composting
- EfW
- MBT/MHT
- Recycling (transfer stations, amenity sites, bring, etc.)

3.26 The decision on what mix of technologies best meets waste targets ultimately lies with the local authorities who have responsibility for managing the municipal waste stream.

3.27 The Waste Infrastructure Capacity Module takes the forecast waste flows for each WSA and compares these with existing infrastructure to identify shortfalls in processing capacity and the years in which these would occur. The following issues should be noted:

- **Landfill.** No requirement for landfill was developed. At a national level, there is assumed to be sufficient capacity to meet requirements – however, at a WSA level, some WSAs are forecast to use up their existing landfill.
- **Mechanical Biological Treatment (MBT).** Currently no MBT infrastructure exists. The waste process module assumes that to reach national objectives, a proportion of recycling, composting and feedstock for EfW will need to come via the MBT as residual waste. The assumption is that a WSA requires the installation of MBT where:

- the proportion of recycling and composting as a percentage of total waste approaches 50% (60% for scenario 4 and 65% for Scenario 5). This represents the use of source segregation approaching its limits[21], or
- the requirement for feedstock for EfW becomes substantial.

Under either of these conditions, a residual waste stream is introduced and a requirement for MBT infrastructure is created.

3.28 Where a shortfall in capacity was identified, the gap was addressed by adding additional infrastructure bases on a table of standard values for different types of infrastructure (EfW, composting etc.) and different scales (small, medium, large). The additional infrastructure specified was of a scale sufficient to close the identified shortfall and to provide additional capacity for the WSA over the next few years.

Cost Benefit Analysis Module

Introduction

3.29 The Cost Benefit Analysis (CBA) module takes the waste stream data and infrastructure capacity information as inputs, and provides estimates for:

- The type and capacity of new infrastructure required to accommodate forecast waste flows, over and above existing infrastructure;
- The cost of the new infrastructure for each WSA and the years in which it is required;
- The collection costs[22] for source segregated and mixed waste for each WSA;
- The processing costs for each waste stream based on the mix of units available in each WSA;
- The cost of any penalties resulting from exceeding EU limits on landfill;
- The benefits arising from each waste stream; and
- Net Present Cost over and above current funding levels to 2025.

3.30 The CBA does not account for non-market benefits (externalities) and deals purely with the market economics of waste.

3.31 These estimates are then taken forward into a Net Present Cost analysis, based on a Green Book compliant calculator[23], and applying a discount rate of 3.5% to yield a final Net Present Cost for these investments. The NPC calculator brings together the estimates for each WSA area of collection and processing costs, off-set by any benefits. The current known level of spending by local authorities (some £404 million per year) is included as income, to allow the total **additional costs** of each scenario to be identified.

[21] Discussions with consultees suggest 50% from source segregation as being within achievable limits. Other scenarios explore the impact of achieving higher levels of source segregation.
[22] WRAP (2008b) Kerbside Recycling: Indicative Costs and Performance
[23] The Northern Irish public sector economic appraisal model (HM Treasury Green Book)

Infrastructure costs

3.32 Infrastructure costs have been estimated based on real-world examples of similar infrastructure (these are given in Annex C). These sources have also been used to estimate the average capacities of such infrastructure. These give an estimate for the total required investment in new infrastructure but, in practice, a buyer of such infrastructure would be able to more closely tailor the capacity, and therefore the cost, of an infrastructure investment to local requirements. In addition, some infrastructure may also benefit from other waste streams such as Industrial and Commercial for EfW. Capital costs of infrastructure are assumed to be spread over the lifetime of the unit. Therefore, for infrastructure brought on in 2025, there would be ongoing capital costs beyond 2025 which are therefore not included in the CBA.

Waste collection costs

3.33 Waste collection costs have been estimated by drawing on two sources:

- WRAP's *Kerbside Recycling: Indicative Costs and Performance Technical Annex* (June 2008)[24] which gives average costs for urban and rural waste collection under a variety of waste management regimes
- The Scottish Government's Urban Rural Classification 2007-2008[25]

3.34 The Urban Rural Classification was used to estimate the urban and rural population for each local authority area (for this purpose, population in remote small towns were classified as "rural") and then the balance between urban/rural population estimated for each of the Waste Strategy Areas (WSA).

3.35 An average of the WRAP *Kerbside* data for urban and rural authorities was then applied to each of the WSAs to give a figure for refuse and for recycling collections. For recycling, a waste management regime of refuse collection once a week and recycling collection every two weeks, using two boxes and kerbside sort, was assumed, reflecting the waste process module requirement that as much waste as possible be source segregated. Total waste collection costs could then be estimated by calculating the volume of refuse and recycling passing through each WSA in each year. Moving to an alternate week refuse collection would present another cost saving.

Processing costs

3.36 Processing costs were estimated primarily by drawing on the 2002 Defra Strategy Unit report *Delivering the Landfill Directive: the role of new & emerging technologies*[26] which gives a comprehensive overview of waste processing costs, including taking into account the impact different sizes of infrastructure have on waste processing costs (larger units having a lower processing cost per tonne).

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[24] Waste and Resources Action Programme (2008) Kerbside Recycling: Indicative Costs and Performance Technical Annex: WRAP.
[25] Scottish Government (date) The Scottish Government's Urban Rural Classification (2008)
[26] DEFRA Strategy Unit (2002),*Delivering the Landfill Directive: the role of new & emerging technologies*

3.37 The costs used are within the ranges estimated by the WRAP Gate Fees Report, 2008[27].

3.38 A base cost of £55, including landfill tax was assumed for 2009. This was increased by £8 per tonne per year until 2013 (£87/tonne); thereafter it remained steady until 2025.

3.39 These figures were then adjusted to bring them into line with the Scottish Local Government Financial Statistics[28].

Financial benefits

3.40 The benefits arising from the processed waste were estimated by applying the following assumptions.

Recyclates

3.41 Recyclates were valued at £26 per tonne. This estimate was based on a four year average and a tonne of municipal waste yielding[29]:

- Paper & cardboard - 18% by weight
- Plastics – 8% by weight
- Glass - 7% by weight
- Scrap metal - 5% by weight

3.42 The value of these waste streams was estimated by applying the four-year average for waste materials provided by WRAP[30]. The Cost Benefit Analysis assumes that the market for these materials remains steady, even as the volume of recyclates increases over time.

Composting

3.43 The value of compost was assumed to be £3.50 per tonne. UK estimates for the value of compost vary from £2.50 to £5 per tonne[31], however there is discussion as to the quality and marketability of the compost produced through the various processes available to those treating organic waste.

3.44 Again, it is assumed that the market for composting products will remain steady as the volume increases.

3.45 It is assumed that all composting, including anaerobic processing, is used to derive composting products. Given the investment, it would however be possible to derive biogas from anaerobic processing.

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27 Waste and Resources Action Programme(2008): *Gate Fees Report, Comparing the cost of alternative treatment options*
28 http://www.scotland.gov.uk/Topics/Statistics/Browse/Local-Government-Finance/PubScottishLGFStats
29 Defra Strategy Unit (2002) *Waste not, want not: a strategy for tackling the waste problem in England*
30 WRAP (February 2009) *Materials Pricing Update* *http://www.wrap.org.uk/wrap_corporate/news/wrap_materials.html*
31 Commercial Composting (2004) *Compost use in agriculture*; Greenfinch Limited

Energy from Waste

3.46 Energy from Waste plants generate electricity and heat from burning waste. It is assumed that each tonne of waste burned gives rise to 0.7 Megawatt hour (MWh), at a wholesale price of £45 per Megawatt (MWh). Each tonne of waste put through an EfW plant is therefore valued at £31.50.

3.47 Energy produced from burning biomass is eligible for support from the Renewable Obligation Certificates (ROCs) regime where it is deemed a good quality system. Currently this is worth an additional £50 per MWh. From an operator's perspective (whether public or private) this is a major incentive to invest in Energy from Waste, however from a national government perspective this is effectively a subsidy. We have therefore included estimates of benefit both with and without ROCs (Annex B).

3.48 An additional potential benefit from Energy from Waste plants is achieved by using the excess heat produced to warm homes and buildings. However, this requires a developed district heating system which is largely absent in Scotland. This benefit has therefore not been included although it is noted that this is a current requirement when applying for planning permission and licensing for EfW.

Landfill

3.49 Landfill can be tapped for biogas and used to generate electricity. The prevalence of infrastructure to capture biogas varies, as does the yield of biogas per tonne of waste and the efficiency with which this is captured.

3.50 It is assumed that one tonne of waste yields 120 m3 of methane which is captured at 16% efficiency[32]. Each cubic metre of methane is assumed to yield 2 kWh[33] of electricity.

3.51 Applying the same estimate of £45 per wholesale MWh, each tonne of landfilled waste would produce £10.80 of electricity.

Additional benefits

3.52 In addition to the market benefits of recovering useful materials from the waste stream, or capturing energy from its disposal, the processing of waste also has the potential to reduce the environmental impact of waste.

3.53 In addition, the Cost Benefit Analysis module also estimates the national contribution to the reduction in greenhouse gases of the different scenarios, based on the work of the U.S. Environmental Protection Agency and their WAste Reduction Model (WARM). Within the study budget, it was not possible to include the UK equivalent model, WRATE; however, any future research may wish to further investigate the emissions implications of these different scenarios.

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[32] Department of Environment and Water Resources (2007) *Review of Methane Recovery and Flaring from Landfills*

[33] Kurian, Joseph *Energy from sustainable landfills* http://www.faculty.ait.ac.th/visu/pdfs/Activities/Participation/ESL.pdf

Data Sources

3.54 The project methodology depended on the availability of suitable secondary data. The scope of the study did not allow for primary research with those organisations involved in collecting, processing or disposing of waste. Where possible, the research team have sought to supplement secondary data with consultations with relevant stakeholders. The robustness of the study's estimates therefore depend on the quality and extent of the available data.

3.55 The base data for the analysis is drawn primarily from SEPA with additional data from Audit Scotland, The General Register Office for Scotland, Scottish Local Authorities and WRAP. Where no data was available, appropriate assumptions were made in agreement with Scottish Government and CoSLA representatives.

3.56 An email survey was carried out with all 32 local authorities in Scotland to ascertain their own future waste forecasts and infrastructure plans to meet the targets set by the EU and Scottish Government.

3.57 Existing infrastructure data was sourced from SEPA. Table 3-2 shows a summary of the Scotland's existing waste infrastructure (2007).

Table 3-2 Total number of operational waste management sites in Scotland by site type 2007

Site Type	Number
Anaerobic digestion plant	1
Civic amenity site	132
Composting site	11
EfW plant / Incinerator	8
Landfill (open)	52
Landfill (restoration)	21
Metal recycler	138
Multiple activity site	157
Other treatment plant	55
Pet cemetery/crematorium	7
Transfer station	223
Total	**805**

Source: SEPA

3.58 In undertaking this study, the following gaps in existing infrastructure data were found:

- Multiple Activity Sites – SEPA was unable to disaggregate the capacity of different types of infrastructure (e.g. composting and recycling, or landfill and recycling) where two or more types of infrastructure exist on the same site;
- There is no data available on the lifespan of existing infrastructure or when it may need to be replaced;

- There is no data available on the types of recycling that can be supported at recycling sites, only the overall capacity; and
- At the time of the study, the latest infrastructure figures were for 2007.

3.59 There is only limited data available in the public domain as to the capital costs of new infrastructure, this appears to be due to:

- Infrastructure already in place has a relatively long life, the addition of new units of infrastructure has occurred less frequently historically than is expected to be the case in future;
- New developments being undertaken by the private sector, where capital costs are commercially sensitive;
- New developments taking place under the Private Finance Initiative, where capital costs are included under the total cost of the contract to the public sector; and
- New technologies, such as MBT and AD, are only now being commissioned.

3.60 Collection costs were sourced from WRAP. This data was given for both urban and rural areas, and estimates for each WSA area were adjusted by each WSA's proportion of urban and rural population

3.61 The Scottish Local Government Financial Statistics for 2007-08 show that the actual total expenditure was:

- £198 million for collection
- £206 million for waste disposal

3.62 The use of the £404 million assumes that existing spending can be redirected to new forms of collection and disposal without incurring any penalty or time lag. In practice, local authorities may be tied into contractual arrangements, or may not themselves be able to reduce the costs of specific costs of collection or processing at the same pace as demand is being reduced, and as a result cannot reallocate funding as flexibly as is assumed. In that event, the overall costs of Scenarios 2 to 6 would rise.

Assumptions

3.63 The study was a desk-based exercise, and therefore limited to the information already in the public domain. In attempting to forecast infrastructure requirements, the study team were therefore limited by a number of factors:

- The data on the size and cost of units of infrastructure had to be derived from those developments that were already in the public domain – in future standard costs and size of units of infrastructure may change;
- Capital costs of infrastructure are assumed to be spread over the lifetime of the unit. Therefore, for infrastructure brought on in 2025, there would be ongoing capital costs beyond 2025 which are therefore not included in the CBA.

- The unit sizes used are based on those already commissioned – in practice a commissioning authority could elect to purchase a 60,000 tonne unit say, rather than a 40,000 or 80,000 tonne unit, which would better meet their anticipated needs;
- There are indications from consultees that future deployments may be of a larger scale than at present, bringing greater efficiencies and reducing costs;
- Waste Strategy Areas (WSAs) may not be the most appropriate geography to deliver certain types of infrastructure – it is possible particularly large or expensive units of infrastructure would be shared between many authorities; and
- Multiple activity sites – the SEPA data on which these estimates are based does not disaggregate sites where there is more than one type of infrastructure. We have therefore had to estimate the size of different types of infrastructure on these sites, and their real capacities may be somewhat larger or smaller.
- Recycling – the SEPA data does not specify what types of waste material can be handled at different sites. The assumption in the Cost Benefit Analysis is that the sites can handle all potentially recyclable materials. Where this is not the case, additional investment will be required in practice.

3.64 Due to the complexity of the analysis, some assumptions were necessary to allow the waste models to be built. Table 3-3 lists some of the main assumptions.

Table 3-3 Waste Modelling Assumptions

Baseline Assumptions
Only municipal solid waste (MSW) is considered.
Financial years are used (e.g. April 2007 to March 2008).
Local Authority Biodegradable Municipal Waste (BMW) to landfill targets up to 2009/2010 are per the Scottish Government allocations.
Local Authority BMW to landfill targets from 2011 to 2020 are based on equal reductions to all LAs in accordance with the EU directive.
Approximately 63% of waste sent to landfill is BMW.
On average twice as much waste is recycled as composted, i.e. Recycling to Compost ratio is 2:1.
No effect on waste from economic cycles is assumed.
Total Waste Arising remains flat beyond 2010.
The 25% cap on EfW applies to incineration, gasification, plasma and pyrolysis.
Existing infrastructure is taken to be that infrastructure which was operational and registered according to SEPA's 2007 National Capacity report.
The reduction in landfill targets is straight line between target years.
The 70% target for recycling and composting cover all recycling and composting materials, both source segregated and residual.

Source: SQW Energy [n.b. any increases in landfill tax after 2013 (as announced in the March 2010 budget) will impact on the costs presented, particularly 1a and 1b where more waste is landfilled]

4: Results

4.1 This chapter briefly outlines the scenarios looked at in the study, states the central assumptions made and then presents the results for each of the scenarios. A more detailed description of the scenarios, assumptions and method of analysis can be found in the methodology section.

Scenarios

4.2 To ascertain what infrastructure is required to meet future waste obligations and how much it will cost, Scotland's future municipal waste streams were forecast. This study modelled and considered six scenarios: these are summarised in Table 4.

Table 4-1 Municipal Solid Waste Forecast Scenarios

Scenario Number	Description
Scenario 1a. **Do Nothing (With Landfill Fines)**	Continue at 2008/2009 levels of municipal waste processing and at present cost levels. No change in waste streams. The appropriate landfill fines are imposed.
Scenario 1b. **Do Nothing (No Landfill Fines)**	Continue at 2008/2009 levels of municipal waste processing and at present cost levels. No change in waste streams. No landfill fines are imposed.
Scenario 2. **EU WFD Only**	Meet all EU statutory obligations (only) such as the Waste Framework Directive and the Landfill Directive (e.g. landfill targets for 2010, 2013 and 2020; and 50% recycling/composting by 2020), but not the Scottish Government targets.
Scenario 3. **EU WFD & SG Targets (50/20)**	Meet all EU statutory obligations and all Scottish Government targets. This scenario assumes a 50/20 split between source segregation and residual waste to meet the 70% recycling and composting target.
Scenario 4. **EU WFD & SG targets (60/10)**	Meet all EU statutory obligations and all Scottish Government targets as per scenario 3 except this scenario assumes a 60/10 split between source segregation and residual waste to meet the 70% recycling and composting target.
Scenario 5. **EU WFD & SG Targets (65/5)**	Meet all EU statutory obligations and all Scottish Government targets as per scenario 3 except this scenario assumes a 65/5 split between source segregation and residual waste to meet the 70% recycling and composting target.
Scenario 6. **EfW cap by 2018**	Meet all EU statutory obligations and all Scottish Government targets as in scenario 3 except that EfW reaches its 25% cap sooner in 2018.

Source: SQW Energy

4.3 Scenario 1a and 1b presents the 'Do Nothing' option as a datum to illustrate the implications of continuing in a 'business as usual' manner with no change in procedure or to the costs of dealing with municipal waste. Scenario 1a includes any landfill fines imposed for missing targets, while Scenario 1b does not take into account landfill fines. Scenario 2 highlights the minimum required to comply with EU statutory obligations and avoid any penalties. Scenario 3 demonstrates what is needed to meet all EU statutory obligations and achieve the targets set down by the Scottish Government. Scenarios 4, 5 and 6 show variations on Scenario 3.

4.4 The annual net cost of collecting and processing all the municipal waste in Scotland according to the most recent publicly available data (2007/2008) is £404 million[34]. This study modelled Scotland's future waste management requirements to assess the financial impacts above existing spending levels under the six scenarios through to 2025.

4.5 Detailed costs and benefits of implementing the six MSW scenarios were then evaluated in line with the approach recommended in the HM Treasury Green Book[35]. This included the capital cost of new infrastructure; the cost of collecting; processing; penalties and the benefits arising from processed waste (e.g. recyclate revenue, generated electricity, etc).

4.6 The costs and benefits for each scenario are set out in a table representing the totals from 2010 to 2025. This includes the Net Present Cost which equates to the balance of costs to benefits (or overall financial impact) of that scenario over and above current funding levels to 2025.

Assumptions

4.7 The main assumptions made for all the scenarios were as follows:

- Only Municipal Solid Waste was considered.
- No growth in total Municipal Solid Waste arising beyond 2010.
- 2:1 split for recycling to composting to meet the recycling and composting targets.
- No more than 25% of total waste arising goes to EfW.

4.8 Following consultations with local authorities, it was forecast that Total Waste Arisings (TWA) would fall until 2010. For the purposes of this study, it was assumed that TWA would remain flat beyond 2010.

[34] http://www.scotland.gov.uk/Topics/Statistics/Browse/Local-Government-Finance/PubScottishLGFStats
[35] HM Treasury, The Green Book, 2009 http://www.hm-treasury.gov.uk/d/green_book_complete.pdf

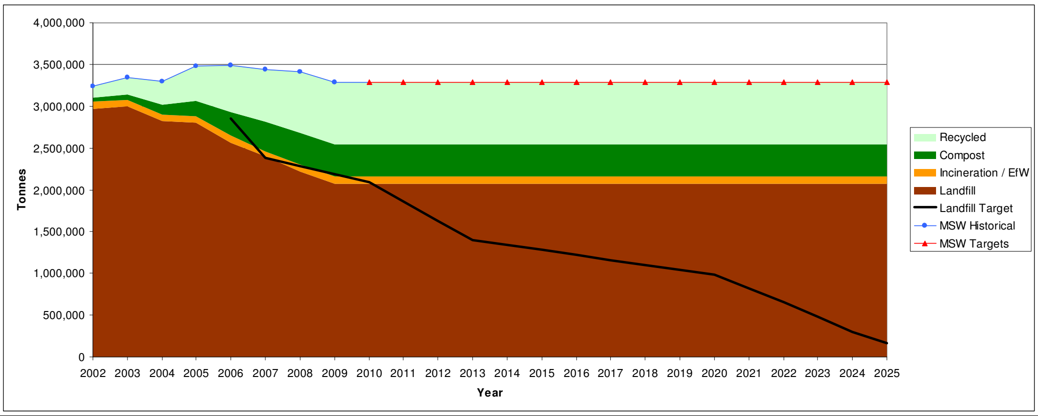
Results

4.9 This section reports the results for each of the scenarios in turn.

Scenario 1a & b – Do Nothing

4.10 Figure 4-1 (a) shows the theoretical forecasted MSW streams to 2025 if there was a 'Do Nothing' approach and waste streams continued at current levels. Although this scenario corresponds to unlikely conditions (waste streams and processes will undoubtedly change over time), it is presented to give a datum against which other scenarios can be compared.

Figure 4-1 (a) MSW Forecast Scenario 1 a and b – Do Nothing



Source: SQW Energy

4.11 Before carrying out the Cost Benefit Analysis of the "Do Nothing" scenario, it is worth setting the context using current levels of spending. The cost of collecting and processing all the municipal waste in Scotland according to the most recent publicly available data (2007/2008) is £404 million[36]. Ignoring inflation and all other factors for a moment, if there is no further infrastructure investment and there are no changes in waste management practice in any year until 2025, this would give a theoretical nominal operational cost for municipal waste management sustained at current levels to 2025 of **£6,464 million**. Although a crude calculation, this gives an indication (in the most simple terms) of the scale of funding required by simply continuing the status quo.

4.12 In addition to the **£404 million** operational costs spent in 2007/2008, **£42 million**[37] of capital was invested in new infrastructure. Using this information, a full Cost Benefit Analysis of Scenario 1a and b "Do Nothing" was modelled to assess the financial impacts over and above the existing spending levels.

[36] http://www.scotland.gov.uk/Topics/Statistics/Browse/Local-Government-Finance/PubScottishLGFStats
[37] http://www.scotland.gov.uk/Topics/Statistics/Browse/Local-Government-Finance/PubScottishLGFStats

4.13 Table 4-2 shows the costs and benefits of Scenario 1a and b "Do Nothing" to 2025:

Table 4-2 Scenario 1a and b "Do Nothing" Cost Benefit Analysis 2010 to 2025 (all figures NPV)

Cost / Benefit Category	**1a) with Fines (millions)**	**1b) no Fines (millions)**
Collection Costs	£2,480	£2,480
Processing Costs	£4,115	£4,115
(of which Landfill Costs)	£3,597	£3.597
Landfill Fines	£1,288	0
Infrastructure Costs	£91	£91
Benefits	£559	£559
Total Net Present Costs	£7,415	£6,127
Net Present Cost (over and above current spending levels to 2025)	**£2,346**	**£1,058**

Source: SQW Energy

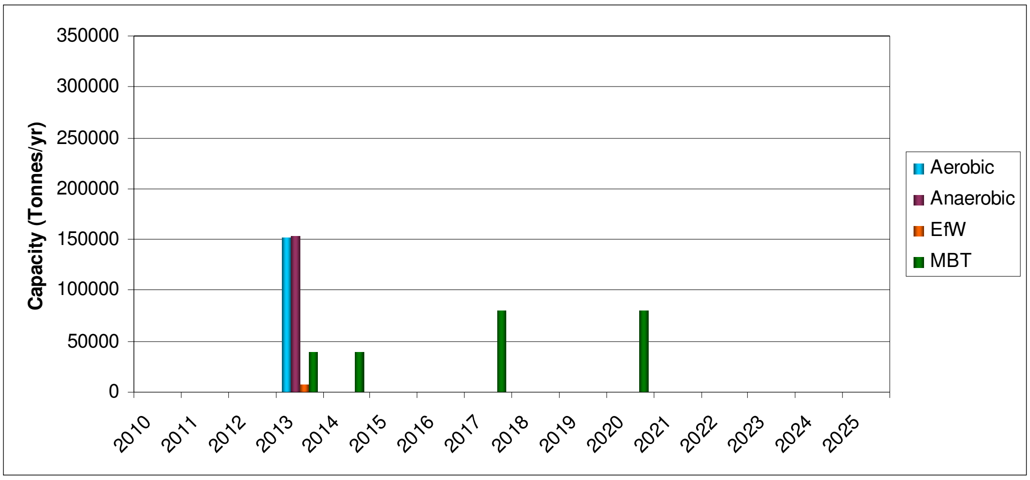
4.14 It can be seen from Table 4-1 that Scenario 1a "Do Nothing with Landfill Fines" would cost an additional £2,346 million from 2010 to 2025 over and above that of existing spending levels. This is primarily due to the significant Landfill Fines which would total £1,288 million NPV. With the landfill fines removed, the cost of Scenario 1b is substantially less at £1,058 NPV over the time period.

4.15 The main drivers of costs are those of collection and processing. Infrastructure costs are modest with only £91 million being required over the period. This reflects the "Do Nothing" premise of the scenario and acknowledges that in 2007/2008 spending also included some investment in new technology. In effect the annual investment in new technology would replace aging infrastructure or be invested to improve efficiency.

4.16 The levels of market benefits are modest in comparison to costs with £559 million benefits over the period, primarily from the generation of electricity from landfill and the sale of recyclate. (n.b. the value of ROCs has been excluded as this is considered a subsidy at national level. Details of the benefits with ROCs are provided in Annex B.)

4.17 Figure 4-1(b) illustrates the capacity for additional infrastructure required and the year by which it must be operational to continue in a 'business as usual fashion'. This is the same for both Scenario 1a and 1b.

Figure 4-1(b) Infrastructure Capacity Requirement for "Do Nothing" (Scenario 1)



Source: SQW Energy

4.18 To be consistent, the same assumptions relating to how waste is handled are applied to the "Do Nothing" scenario as other scenarios. Where waste streams exceed estimated existing capacity over the study period, it is assumed that the local authorities will put in place infrastructure to accommodate this. This is consistent with the 'business as usual' principle of Scenario 1 since there is currently capital expenditure made on new infrastructure each year. In addition, there is a time mismatch in the data for existing capacity (2007) and waste levels (2009). The difference in time explains the immediate need for capacity in 2013, particularly composting, some of which may already have been installed in the interim.

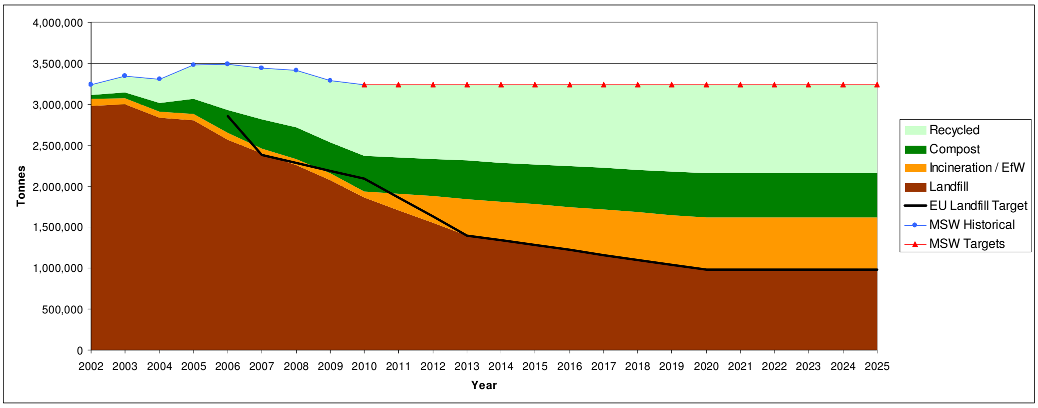
Scenario 1 Conclusion

4.19 To "Do Nothing" may require the least in terms of infrastructure costs, but the landfill fines and the impact on the environment make it an expensive option. Even without the landfill fines, scenario 1b is not the most cost efficient of the scenarios analysed.

Scenario 2 – Meet EU Obligations Only

4.20 Figure 4-2(a) shows the forecasted MSW streams to 2025 to meet the EU statutory obligations (only) such as the Waste Framework Directive and the Landfill Directive (i.e. landfill targets for 2010, 2013 and 2020; and 50% recycling/composting by 2020), but not the Scottish Government targets. In effect, to do just enough to avoid EU penalties and infractions.

Figure 4-2(a) MSW Forecast Scenario 2 – Meet EU Obligations Only



Source: SQW Energy

4.21 It can be seen in Figure 4-2 that the EU targets require a significant reduction in the amount of waste sent to landfill compared to historical levels. In addition, significant increases in recycling and composting are required to achieve the obligations set under the Waste Framework Directive.

4.22 Table 4-3 shows the costs and benefits to 2025 of Scenario 2 "Meet EU Obligations Only":

Table 4-3 Scenario 2 "Meet EU Obligations Only" Cost Benefit Analysis 2010 to 2025 (all figures NPV)

Cost / Benefit Category	**(millions)**
Collection Costs	£3,347
Processing Costs	£3,431
(of which Landfill Costs)	£2,059
Landfill Fines	0
Infrastructure Costs	£434
Benefits	£697
Total Net Present Costs	£6,514
Net Present Cost (over and above current spending levels to 2025)	**£1,445**

Source: SQW Energy

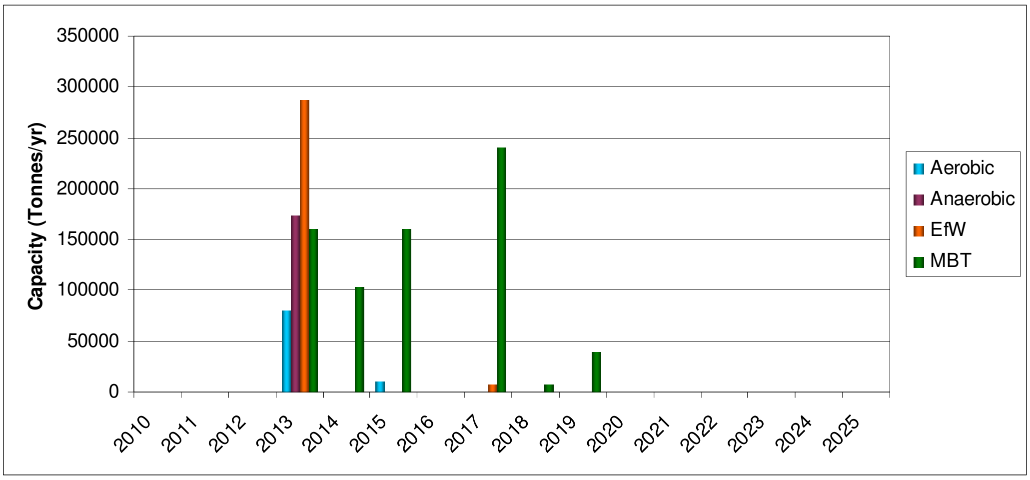
4.23 It can be seen from Table 4-3 that Scenario 2 "Meet EU Obligations Only" would cost an additional £1,445 million over and above existing spending levels from 2010 to 2025. Although the collection and processing costs are higher than scenario 1, the avoidance of landfill fines makes Scenario 2 significantly cheaper than scenario 1a, but more expensive than scenario 1b.

4.24 Infrastructure Costs are significantly higher than those of Scenario 1. This is due to the investment in new technology required to achieve the waste stream levels needed to meet EU targets.

4.25 The benefits have also increased compared to Scenario 1. The benefits are still mostly due to landfill electricity generation (excluding ROCs) and recyclate sales in equal measure.

4.26 Figure 4-2(b) illustrates the capacity for additional infrastructure required and the year by which it must be operational to meet the EU obligations as outlined in Scenario 2.

Figure 4-2(b) Infrastructure Capacity Requirement to meet EU Obligations Only (Scenario 2)



Source: SQW Energy

4.27 It can be seen that there is a significant requirement for additional infrastructure to be operational by the year 2013. Assuming a minimum two to three year lead time for most infrastructure projects, steps must be taken now if the 2013 targets are to be met.

4.28 The EU target for 50% recycling and composting is not applicable until 2020 and Scotland is already on target to meet its recycling target of 40% by 2010 target. With ten years to go until the 2020 EU target needs to be achieved, the EU recycling and composting target is not the main driver in this scenario. The main driver is the landfill directive. As such, the largest and most immediate requirement is for EfW plants that will be required to take the waste diverted from landfill to achieve the landfill objective. There is also a requirement for MBT infrastructure in 2010, primarily to produce feedstock for the EfW plants, but also to produce recyclate.

4.29 Also required in 2010 is anaerobic composting to process food waste that is diverted from landfill. Some additional aerobic capacity will also be required to cope with the increase levels of composting.

4.30 Beyond 2010, the requirement is primarily for MBT. This is due to a continued requirement to produce feedstock for the EfW capacity and also to help achieve the additional recycling levels required.

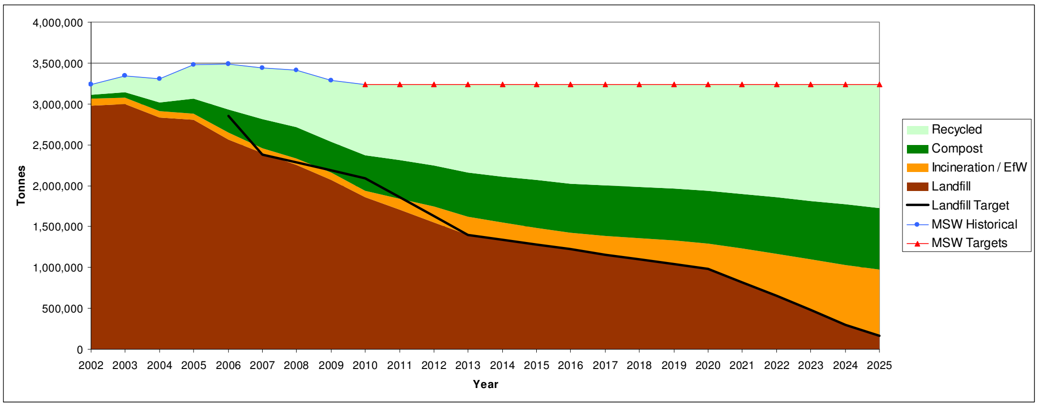
Scenario 2 Conclusion

4.31 To meet only the EU obligations will require significant investment in infrastructure, particularly EfW and MBT. The avoidance of landfill fines makes it a cheaper option than the Do Nothing with Landfill Fines, however, there is a significant 'infrastructure hurdle' to clear in 2013 if targets are to be met.

Scenario 3 – Meet all EU and Scottish Government Targets (50/20 split)

4.32 Figure 4-3(a) shows the forecasted MSW streams to 2025 that are required to meet all EU statutory obligations and Scottish Government targets. In this scenario it is assumed that the 70% target for recycling and composting will compose of a 50/20 split between source segregation (50) and residual treatment (20).

Figure 4-3(a) MSW Forecast Scenario 3 – Achieve all EU Obligations and Scottish Government Targets (50/20 split)



Source: SQW Energy

4.33 It can be seen from Figure 4-3(a) that the targets set down by the Scottish Government present a more ambitious challenge for Scotland's waste management sector.

4.34 To meet all targets and obligations (Scenario 3), each waste stream forecast to 2025 is effectively determined by the order of precedence in which the targets must be achieved. The EU landfill targets must be met first as they are legally binding and limit the absolute quantity of biodegradable municipal waste sent to landfill. Following this, the targets for recycling and composting must be achieved and these are expressed as a percentage of the total municipal waste arising. The goal of no growth beyond 2010 of the total municipal waste arising puts an upper limit on future forecasts.

4.35 This leaves the EfW waste stream. The maximum that can go to EfW is the waste that remains once the other targets are satisfied. In Scenario 3, EfW does not reach its cap of 25% until 2025. In effect, if the national targets are to be met exactly (no more, no less), the sizes of Scotland's municipal waste streams to 2025 are pre-defined by the targets.

4.36 Table 4-4 shows the costs and benefits to 2025 of Scenario 3 "Meet all EU and Scottish Government Targets (50/20 split)":

Table 4-4 Scenario 3 "Meet all EU and Scottish Government Targets (50/20 split) Cost Benefit Analysis 2010 to 2025 (all figures NPV)	
Cost / Benefit Category	**(millions)**
Collection Costs	£3,763
Processing Costs	£3,006
(of which Landfill Costs)	£1,815
Landfill Fines	0
Infrastructure Costs	£449
Benefits	£682
Total Net Present Costs	£6,536
Net Present Cost (over and above current spending levels to 2025)	**£1,467**

Source: SQW Energy

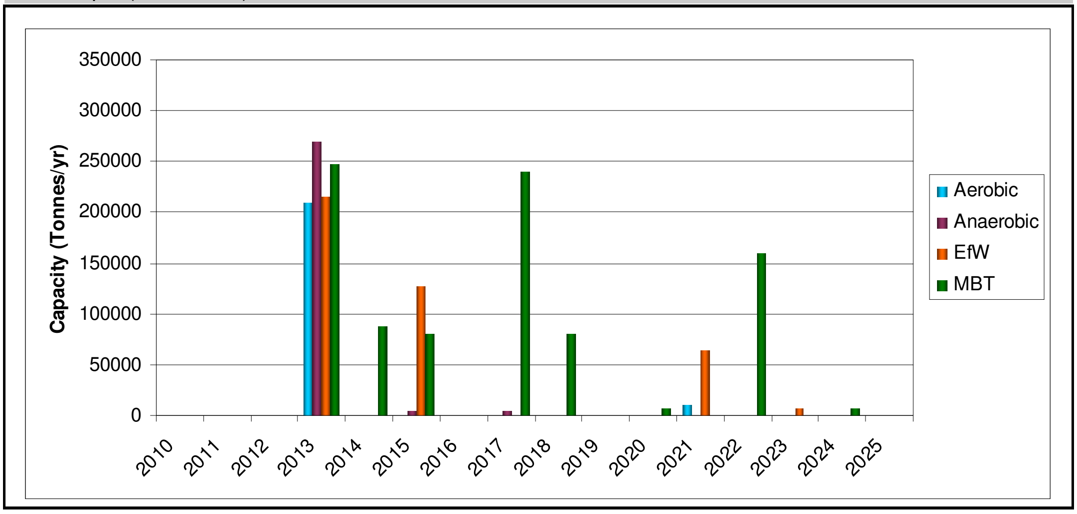
4.37 At a Net Present Cost of £1,467 million over and above current spending to 2025, it is only marginally more expensive to achieve the Scottish Government targets than it is to meet the EU targets only.

4.38 Although collection costs are significantly higher because of the more ambitious recycling and composting targets set by the Scottish Government, the processing costs are reduced because of the reduced EfW and landfill processing costs, i.e. Scotland would recycle and compost more waste rather than burn and landfill.

4.39 To meet the additional Scottish Government targets, infrastructure costs are £15 million higher than meeting the EU obligations only.

4.40 Figure 4-3(b) illustrates the capacity of additional infrastructure required and the year by which it must be operational to meet all EU and Scottish Government waste management targets with a 50/20 split.

Figure 4-3(b) Infrastructure Capacity Requirement to meet all EU & Scottish Government Targets with 50/20 split (Scenario 3)



Source: SQW Energy

4.41 It can be seen that there is a significant requirement for additional infrastructure to be operational by the year 2013. Assuming a minimum two to three year lead time for most infrastructure projects, steps must be taken now if the 2013 targets are to be met.

4.42 Although all four technologies analysed require similar capacities to be operational by 2013, both EfW and MBT, will require additional capacity to be commissioned between 2013 and 2025.

4.43 There is a growing requirement for MBT infrastructure, chiefly composed of medium and large units, as source segregation approaches its maximum capture rates (for Scenario 3 - assumed to be 50% of Total Waste Arising) and as demand for EfW feedstock comes on stream.

4.44 Once the appropriate capacity of Aerobic and Anaerobic infrastructure is commissioned by 2013, there is little requirement for additional composting infrastructure to meet composting targets to 2025.

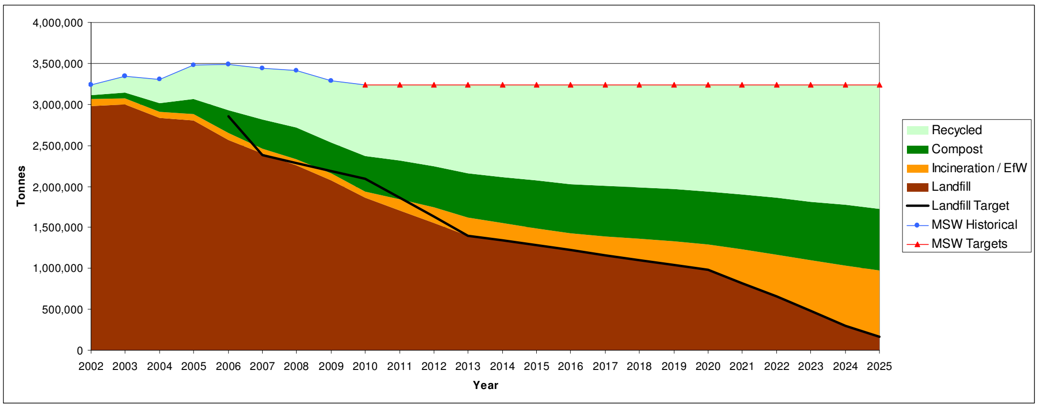
Scenario 3 Conclusion

4.45 To achieve the more ambitious Scottish Government targets over and above the EU obligations, the marginal cost is relatively small; particularly when considering the significant gains that would be made in waste management, i.e. for a little extra investment, we achieve disproportionally higher results.

Scenario 4 – Meet all EU and Scottish Government Targets (60/10 split)

4.46 Figure 4-4(a) shows the forecasted MSW streams to 2025 that are required to meet all EU statutory obligations and Scottish Government targets. In this scenario it is assumed that the 70% target for recycling and composting will compose of a 60/10 split between source segregation (60) and residual treatment (10).

Figure 4-4(a) MSW Forecast Scenario 4 – Achieve all EU Obligations and Scottish Government Targets (60/10 split)



Source: SQW Energy

4.47 The only difference between Scenario 4 and the previous one is that in this scenario, 60% of TWA will be source segregated for use in recycling or composting while the remainder (10% of TWA) can be obtained through residual treatments. This has the effect of delaying the need for MBTs.

4.48 Table 4-5 shows the costs and benefits to 2025 of Scenario 4 "Meet all EU and Scottish Government Targets (60/10 split)":

Table 4-5 Scenario 4 "Meet all EU and Scottish Government Targets (60/10 split)
Cost Benefit Analysis 2010 to 2025 (all figures NPV)

Cost / Benefit Category	**(millions)**
Collection Costs	£3,724
Processing Costs	£2,888
(of which Landfill Costs)	£1,815
Landfill Fines	0
Infrastructure Costs	£342
Benefits	£682
Total Net Present Costs	£6,271
Net Present Cost (over and above current spending levels to 2025)	**£1,203**

Source: SQW Energy

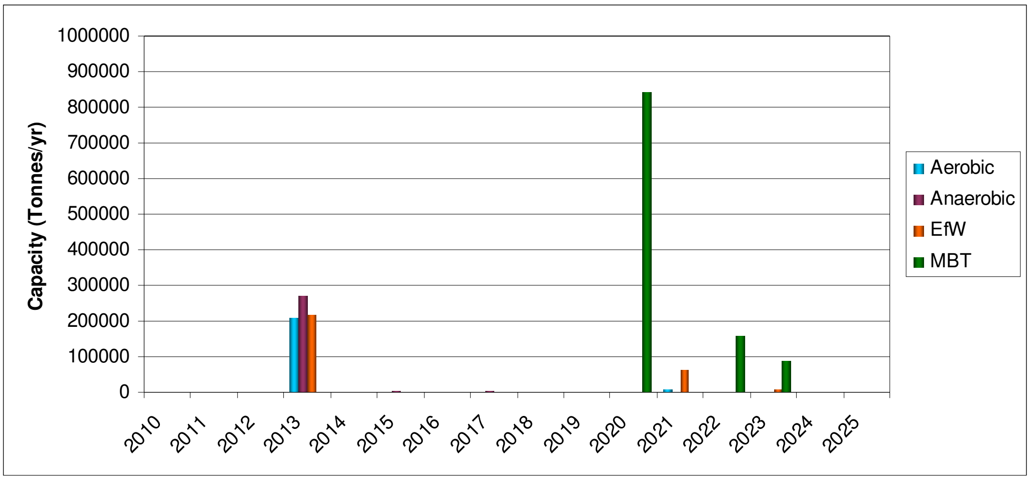
4.49 The Net Present Cost over and above current spending levels to 2025 of Scenario 4 is £1,203. This is less than the equivalent scenario 3 with the 50/20 split due mainly to a combination of reduced infrastructure required to process residual waste and less processing costs.

Processing costs are reduced by gaining efficiencies from current collection infrastructure and increasing source segregation; hence processing costs are shifted towards the waste producer rather than centralised MBT units.

4.50 Infrastructure costs are reduced as there is less need for plant to carry out residual treatment.

4.51 Figure 4-4(b) illustrates the capacity of additional infrastructure required and the year by which it must be operational to meet all EU and Scottish Government waste management targets with a 60/10 split.

Figure 4-4(b) Infrastructure Capacity Requirement to meet all EU & Scottish Government Targets with 60/10 split (Scenario 4)



Source: SQW Energy

4.52 It can be seen that the need for infrastructure investment by 2013 is similar to scenario 3 for aerobic, anaerobic and EfW. However, the requirement for MBT is reduced and delayed by increasing the levels of source segregation. In effect, by continuing to improve the capture rates of current source segregation infrastructure, costs are shifted towards the waste producer rather than a centralised MBT unit.

4.53 There is a requirement for significant MBT capacity in 2020 as source segregation approaches its maximum capture rate assumption (for Scenario 4 -assumed to be 60% of Total Waste Arising).

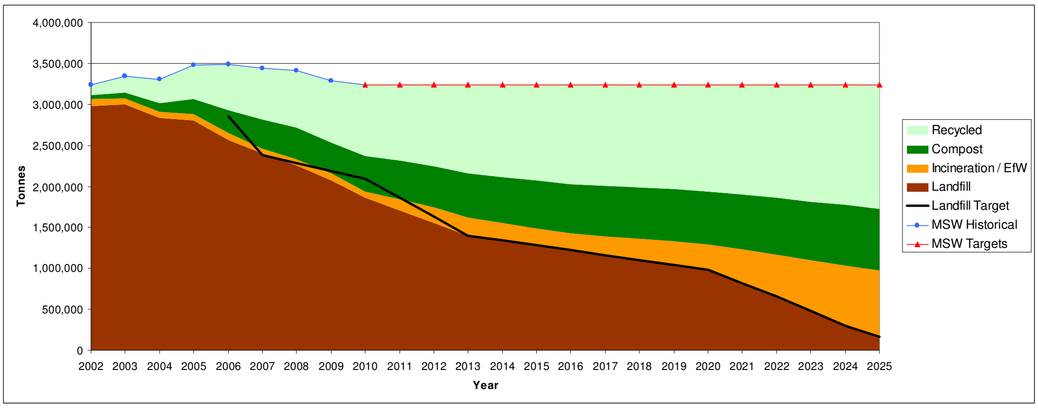
Scenario 4 Conclusion

4.54 Increased source segregation reduces the cost of meeting EU and Scottish Government targets. Infrastructure investment is also reduced as there is less need for large centralised MBT plants for residual treatment.

Scenario 5 – Meet all EU and Scottish Government Targets (65/5 split)

4.55 Figure 4-5(a) shows the forecasted MSW streams to 2025 that are required to meet all EU statutory obligations and Scottish Government targets. In this scenario it is assumed that the 70% target for recycling and composting will compose of a 65/5 split between source segregation (65) and residual treatment (5).

Figure 4-5(a) MSW Forecast Scenario 5 – Achieve all EU Obligations and Scottish Government Targets (65/5 split)



Source: SQW Energy

4.56 In this scenario, 65% of TWA will be source segregated for use in recycling or composting while the remainder (5% of TWA) can be obtained through residual treatments. This has the effect of delaying the need for MBTs.

4.57 Table 4-6 shows the costs and benefits to 2025 of Scenario 5 "Meet all EU and Scottish Government Targets (65/5 split)":

Table 4-6 Scenario 5 "Meet all EU and Scottish Government Targets (65/5 split)
Cost Benefit Analysis 2010 to 2025 (all figures NPV)

Cost / Benefit Category	**(millions)**
Collection Costs	£3,695
Processing Costs	£2,799
(of which Landfill Costs)	£1,815
Landfill Fines	0
Infrastructure Costs	£303
Benefits	£682
Total Net Present Costs	£6,114
Net Present Cost (over and above current spending levels to 2025)	**£1,046**

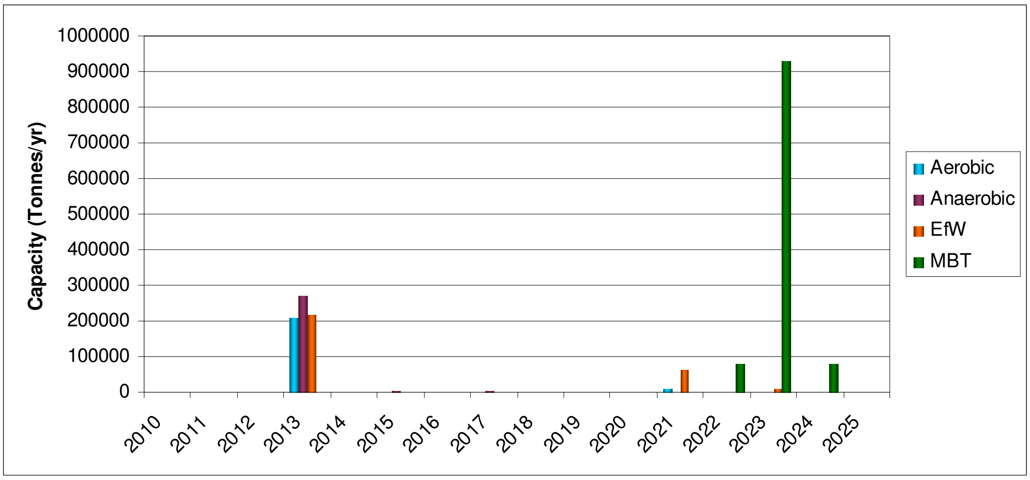
Source: SQW Energy

4.58 The Net Present Cost over and above current spending levels to 2025 of Scenario 5 is £1,046. This makes it the least expensive of all the scenarios that were modelled. Again, this is due to a combination of reduced infrastructure required to process residual waste and less processing costs. Processing costs are reduced by gaining efficiencies from current collection infrastructure and increasing source segregation; hence processing costs are shifted towards the waste producer rather than centralised MBT units.

4.59 Infrastructure costs are reduced as there is less need for plant to carry out residual treatment.

4.60 Figure 4-5(b) illustrates the capacity of additional infrastructure required and the year by which it must be operational to meet all EU and Scottish Government waste management targets with a 65/5 split.

Figure 4-5(b) Infrastructure Capacity Requirement to meet all EU & Scottish Government Targets with 65/5 split (Scenario 5)



Source: SQW Energy

4.61 It can be seen that the need for infrastructure investment by 2013 is similar to scenario 3 and 4 for aerobic, anaerobic and EfW. However, the requirement for MBT is further delayed. In effect, by continuing to improve the capture rates of current source segregation infrastructure, costs are shifted towards the point of waste collection rather than a centralised MBT unit.

4.62 There is a requirement for significant MBT capacity in 2023 as source segregation approaches its maximum capture rates (for Scenario 5 -assumed to be 65% of Total Waste Arising). The capacity of MBT required, although delayed, is still relatively high. This is due to the fact that many WSAs will need an MBT, but it may not be as heavily utilised. In this case it may be more efficient for WSAs to combine their MBT requirements.

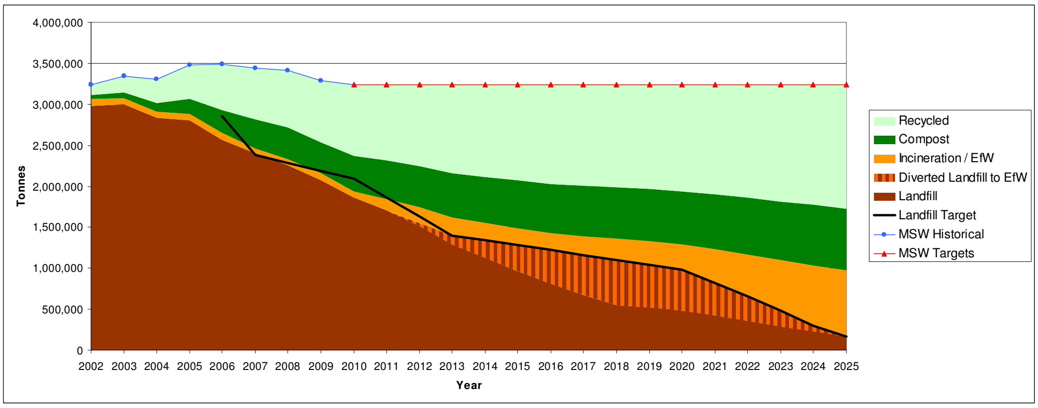
Scenario 5 Conclusion

4.63 Increased source segregation reduces the cost of meeting EU and Scottish Government targets. Scenario 5 produced the lowest cost method of meeting all EU and Scottish Government targets.

Scenario 6 – Meet all EU and Scottish Government targets with EfW reaching its 25% cap earlier in 2018

4.64 Figure 4-6(a) shows the forecasted MSW streams to 2025 that are required to meet all EU statutory obligations and Scottish Government targets. In this scenario, EfW capacity is commissioned earlier and waste is diverted from landfill to the EfW plant. Source segregation to residual split is 50/20 as in scenario 3.

Figure 4-6(a) MSW Forecast Scenario 6 – Achieve all EU Obligations and Scottish Government Targets with EfW reaching its 25% cap in 2018



Source: SQW Energy

4.65 It can be seen that by bringing EfW online earlier, waste is diverted from landfill and the landfill targets are exceeded. However, it is worth noting that to achieve the recycling and composting targets, all the additional waste for EfW must come from landfill. If any waste is diverted from recycling or composting, then these targets will be missed.

4.66 Table 4-7 shows the costs and benefits to 2025 of Scenario 6 "Meet all EU and Scottish Government Targets with EfW reaching its 25% cap earlier in 2018":

Table 4-7 Scenario 6 "Meet all EU and Scottish Government Targets with EfW reaching its 25% cap earlier in 2018" - Cost Benefit Analysis 2010 to 2025 (all figures NPV)

Cost / Benefit Category	**(millions)**
Collection Costs	£3,811
Processing Costs	£2,981
(of which Landfill Costs)	£1,397
Landfill Fines	0
Infrastructure Costs	£646
Benefits	£741
Total Net Present Costs	£6,697
Net Present Cost (over and above current spending levels to 2025)	**£1,628**

Source: SQW Energy

4.67 The Net Present Cost over and above current spending levels to 2025 of Scenario 6 is £1,628. This makes it more expensive than all the scenarios apart from Scenario 1a "Do Nothing with

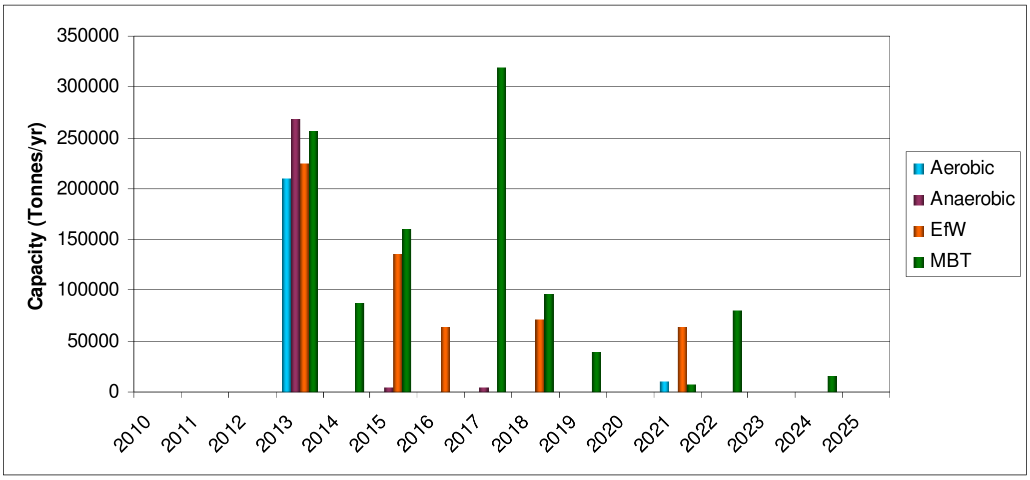
Landfill Fines". This is due to the increase in collection, processing and infrastructure costs associated with bringing the EfW capacity sooner.

4.68 Infrastructure costs are increased as more EfW plant is brought online sooner, making Scenario 6 the most expensive in terms of infrastructure investment alone.

4.69 Scenario 6 gives the biggest return in benefits of any scenario. However the increase in benefits is more than offset by the increase in costs. (n.b. the value of ROCs has been excluded as this is considered a subsidy from government.)

4.70 Figure 4-6(b) illustrates the capacity of additional infrastructure required and the year by which it must be operational to meet all EU and Scottish Government waste management targets with EfW reaching its 25% cap by 2018.

Figure 4-6(b) Infrastructure Capacity Requirement to meet all EU & Scottish Government Targets with EfW reaching its 25% cap by 2018 (Scenario 6)



Source: SQW Energy

4.71 It can be seen that the need for infrastructure investment by 2013 is similar to scenario 3. However, there is additional requirement for EfW and MBT in subsequent years to deal with the increased levels of EfW waste as it reaches its 25% cap by 2018.

4.72 The additional MBT infrastructure is required to produce the feedstock for the EfW plants.

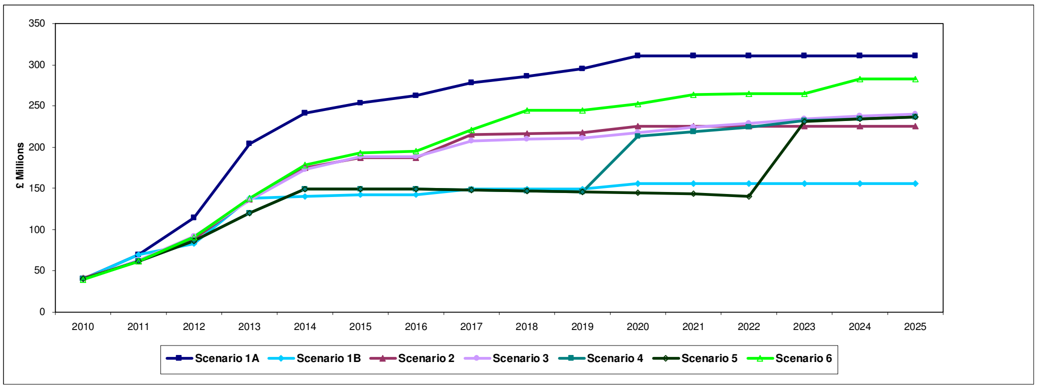
Scenario 6 Conclusion

4.73 By bringing EfW plant on earlier, there is also an increased need for MBT, which in turn drives up processing and infrastructure costs. Although there are additional benefits in this scenario, these are more than offset by the increased costs, making scenario 6 the most expansive scenario after Scenario 1a "Do Nothing with Landfill Fines". By accelerating EfW installation, the result may be to increase competition between EfW and recycling and composting, which may in turn jeopardise recycling and composting targets.

Annual Nominal Additional Cost

4.74 Figure 4.7 shows the additional costs annually of each scenario, on a nominal basis. It illustrates that the timing of expenditure is very different between scenarios and is important in terms of overall cost efficiency. It can be seen that although Scenario 5 costs considerably more after 2022, the Net Present Cost of Scenario 5 has the lowest NPV because the major expenditure is delayed until later years. For this reason, Scenario 5 is more cost efficient than all other scenarios, including Scenario 1B (Do Nothing – without Landfill Fines). A table of the graph data can be found in Appendix B.14

Figure 4.7 – Additional Costs in Excess of Existing Expenditure (Nominal)



Source: SQW Energy

Results Summary

4.75 Although progress to date has been encouraging, the advances made so far will most likely prove to be the easiest steps on the road to a Zero Waste society as the more straightforward gains are achieved first. Consequently, future municipal waste management will prove more challenging and require further changes in our approach to waste management. Existing infrastructure capacity will be insufficient to meet these targets through to 2025.

4.76 It can be seen that there is a significant requirement for additional infrastructure to be operational by the year 2013 although the imperative is not as great for scenarios 4 and 5. Some waste management technologies will prove more challenging to bring online than others, e.g. MBT and AD will prove more challenging than EfW plants from a technology point of view, however the opposite may be true from a planning standpoint. EfW may be chosen as the easier short-term solution, when in fact it may have the effect of exacerbating the waste management difficulties in the future through competition with recycling and composting. Assuming a minimum two to three year lead time for most infrastructure projects, steps must be taken now if the 'waste target hurdle' of 2013 is to be cleared.

4.77 Increased levels of source segregation significantly reduce the amount of new infrastructure required and the processing costs. The 60/10 and 65/5 split of Scenario 4 and 5 both delay the need for infrastructure, particularly MBT, and allow more time for appropriate planning.

4.78 Once the appropriate capacity of Aerobic and Anaerobic infrastructure is commissioned by 2013, there is little requirement for additional composting infrastructure to meet composting targets to 2025 in any of the scenarios.

Cost Benefit Analysis

4.79 Table 4-8 shows the Cost Benefit Analysis figures for all the scenarios.

Table 4-8 – Cost Benefit Analysis (2010 to 2025)

Scenario	Collection (£ million)	Processing (£ million)	Landfill Fines (£ million)	Infrastr. Investment (£ million)	Benefits (£ million)	Total Net Present Cost (£ million)	Net Present Cost above current spend levels [£5,069] (£ million)
1a. Do Nothing (with Fines)	£2,480	£4,115	£1,288	£91	£559	£7,415	£2,346
1a. Do Nothing (No Fines)	£2,480	£4,115	0	£91	£559	£6,127	£1,058
2. EU Only	*£3,347*	£3,431	0	£434	£697	£6,514	£1,445
3. EU & SG Targets (50/20)	*£3,763*	£3,006	0	£449	£682	£6,536	£1,467
4. EU & SG Targets (60/10)	*£3,724*	£2,888	0	£342	£682	£6,271	£1,203
5. EU & SG Targets (65/5)	*£3,695*	£2,799	0	£303	£682	£6,114	£1,046
6. EfW Cap by 2018	*£3,811*	£2,981	0	£646	£741	£6,697	£1,628

Source: SQW Energy

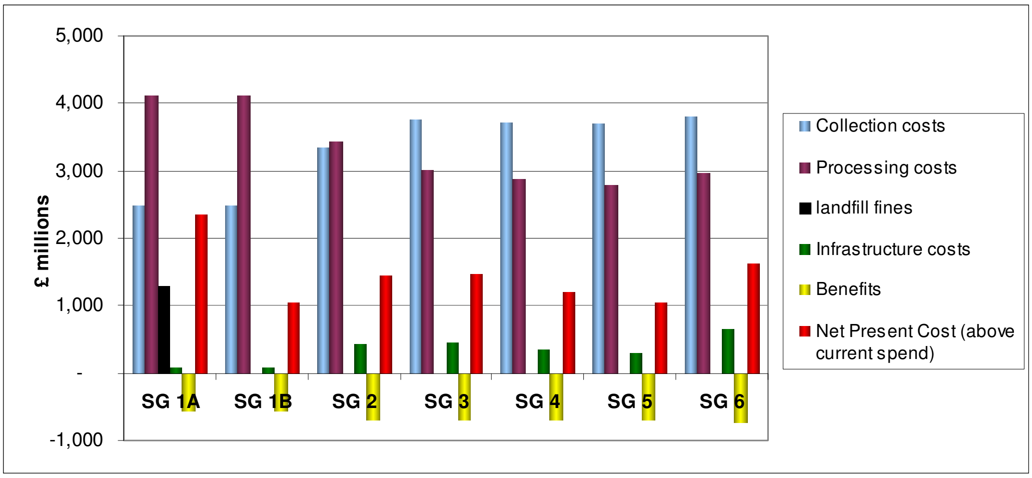
4.80 Scenario 5 is the most cost efficient scenario, primarily due to the increased levels of source segregation.

4.81 Scenario 1 (Do Nothing) is the most expensive option due to the landfill fines incurred for missing landfill targets and the non-market cost to the environment. Under Scenario 6, it is between £161 million and £583 million more expensive to bring EfW capacity online sooner than the other 'on-target' scenarios predominantly due to the additional infrastructure investment required.

4.82 Scenario 1a and 1b have the highest processing costs due primarily to landfill processing costs. Scenario 1b is significantly less expensive than scenario 1a due to the absence of landfill fines. In Scenarios 2 to 6, achieving the landfill targets means that landfill fines are avoided, and as such, overall processing costs are reduced.

4.83 Figure 4-8 illustrates the costs/benefits associated with implementing each of the waste management scenarios.

Figure 4-8 - Cost Benefit Analysis Breakdown for Each Scenario



Source: SQW Energy

4.84 It can be seen that although infrastructure investment is significant, by far the most significant factors are collection and processing costs.

4.85 Even in the best case scenarios, the benefits from waste are only capable of marginally off-setting the costs of waste management.

4.86 Of the three 'meet all targets' scenarios (scenario 3 to 5), the Net Present Cost reduces as more source segregation is done. This is due to a combination of reduced infrastructure required to process residual waste and less processing costs as sorting and processing costs are shifted towards the point of waste collection making more efficient use of existing collection infrastructure.

Conclusions

4.87 Regardless of what future waste scenario is considered, the cost of managing Scotland's waste will increase.

4.88 The option of scenario 1a 'doing nothing with landfill fines' is by far the most costly due to landfill penalties. In scenario 1b 'doing nothing without landfill fines' is significantly cheaper, but is still slightly more expensive than the least expensive scenario – Scenario 5 – due primarily to the high levels of source segregation.

4.89 It is more cost effective to meet the EU statutory obligations and avoid landfill fines. To meet EU obligations (only) would require an investment of £434 million in new infrastructure and cost an additional £1,445 million above current spending levels over the waste strategy period (2010 – 2025).

4.90 To meet the more ambitious Scottish Government targets for waste management would require a modest increase in investment over that of EU compliance. For Scenario 3 compared to Scenario 2, this would mean an additional investment of £15 million in new infrastructure and cost an additional £22 million over the waste strategy period (2010 – 2025).

4.91 Increasing source segregation from 50% of TWA to 60% or 65% provide the most cost effective solution. The timing of expenditure to 2025 is essential. By delaying the need for additional infrastructure and the associated expenditure, the Net Present Cost is reduced significantly by increasing source segregation. However, it may have to be considered whether these levels of source segregation are achievable and if so, whether any additional cost would be necessary, e.g. education and public awareness campaigns.

4.92 By accelerating EfW installation (Scenario 6), the result may be to increase competition between EfW and recycling and composting, which may in turn jeopardise recycling and composting targets, i.e. if waste is pulled towards EfW plant to satisfy accelerated EfW installations instead of going to recycling and composting, then this would mean lower recycling and composting rates at the expense of satisfying new EfW capacity.

5: Conclusions

5.1 Although progress to date has been encouraging, the advances made so far in meeting Scotland's waste targets will most likely prove to be the easiest steps on the road to a Zero Waste society as the more straightforward gains are achieved first. Consequently, future municipal waste management will prove more challenging and require further changes in our approach to waste management. It will be important to maintain a strategic overview of the long term requirements so that infrastructure is developed in time to meet EU targets. Existing infrastructure capacity will be insufficient to meet the targets through to 2025.

47. Table 4-7 shows the Cost Benefit Analysis figures for all the scenarios. The Net Present Cost figure represents the amount over and above the current level of spending that would be required through to 2025 to implement each of the scenarios. To meet all EU and Scottish Government waste management targets, Scenario 5 (with 65% source segregation) gave the most cost effective solution and required the following from 2010 to 2025:

- NPV Infrastructure Investment = **£303 million**
- Net Present Cost funding over and above present levels = **£1,046 million**

5.2 Regardless of what future waste scenario is considered, the cost of managing Scotland's waste will increase.

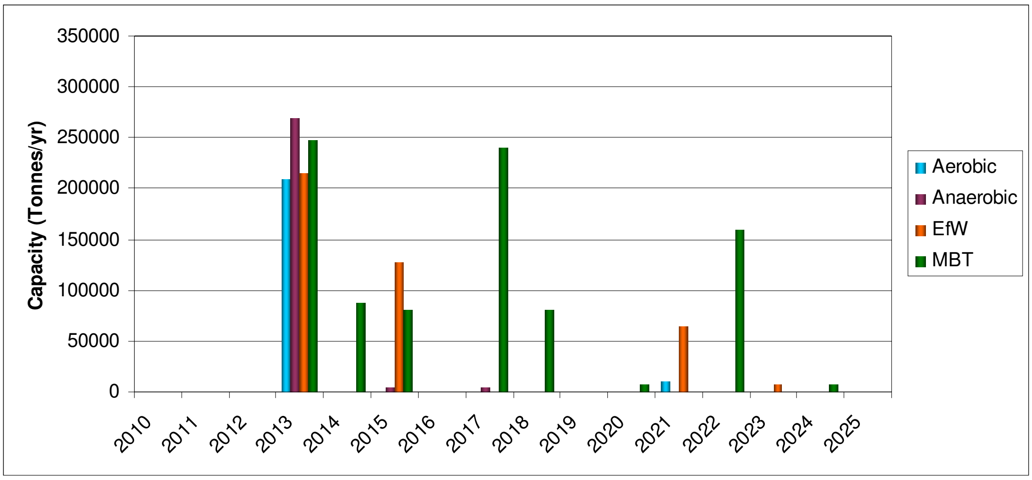
5.3 The option of 'doing nothing' is by far the most costly due to landfill penalties. Without landfill penalties, 'do nothing' costs significantly less, but is still more expensive than Scenario 5 with high levels of source segregation.

5.4 By bringing EfW capacity online sooner in Scenario 6, the Net Present Costs and costs of infrastructure are increased significantly. Additionally, bringing EfW online sooner may jeopardise recycling/composting targets through competition by diverting waste to EfW.

5.5 It can be seen that although infrastructure investment is significant, by far the most significant factors are collection and processing costs.

5.6 Figure 5-1 illustrates the capacity of additional infrastructure required and the year by which it must be operational to meet all EU and Scottish Government waste management targets with source segregation levels of 50% (Scenario 3).

Figure 5-1 Infrastructure Capacity Requirement to meet EU & Scottish Government Targets (Scenario 3)



Source: SQW Energy

5.7 It can be seen that there is a significant requirement for additional infrastructure to be operational by the year 2013. Assuming a minimum two to three year lead time for most infrastructure projects, steps must be taken now if the 'waste infrastructure hurdle' of 2013 is to be cleared.

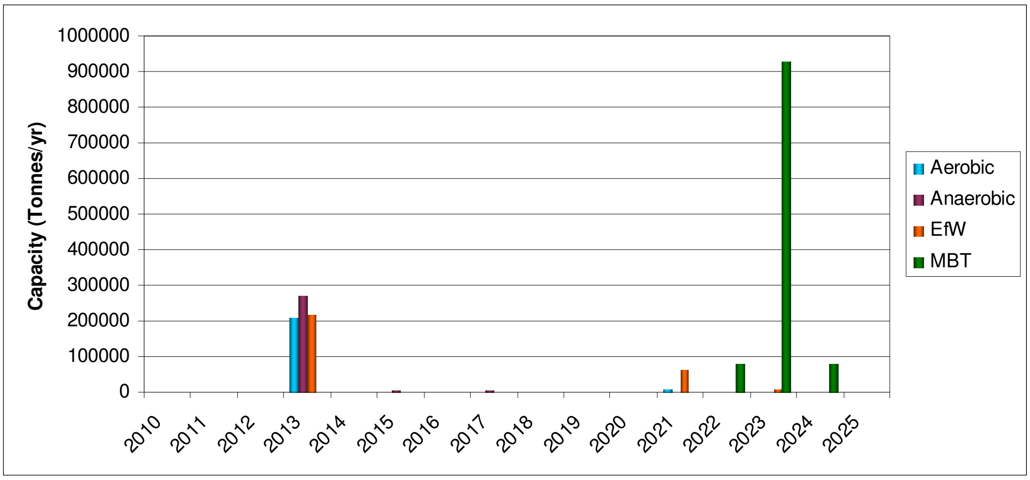
5.8 If it is too late to develop the necessary infrastructure in time, then the only other way to meet the 2013 targets is by simultaneously increasing source segregation.

5.9 In terms of infrastructure, smaller units may be more affordable for smaller local authorities, but there are significant economies of scale to be attained by choosing larger plants. There are significant potential savings to be made by having co-operation and combined infrastructure solutions between local authorities.

5.10 Collection and processing drive the overall cost of waste management. To meet all targets in Scenario 3, the infrastructure costs are approximately £449 million NPV. However, this is dwarfed by the operational costs - collection (£3.8 billion NPV) and processing (£3.0 billion NPV). Therefore the largest savings are to be gained in reducing collection and processing costs through reducing waste arisings and more efficient infrastructure use (e.g. higher participation, capture and lower contamination) and further work is recommended in these areas.

5.11 Scenario 5 has source segregation levels of 65%. Figure 5-2 shows the capacity of additional infrastructure required and the year by which it must be operational to meet all EU and Scottish Government waste management targets set out in Scenario 5.

Figure 5-2 Infrastructure Capacity Requirement to meet EU & Scottish Government Targets (Scenario 5) with 65% source segregation.



Source: SQW Energy

5.12 Scenario 5 is the most cost efficient scenario, primarily due to the increased levels of source segregation. Increased levels of source segregation significantly reduce the amount of new infrastructure required and the processing costs. Of the three 'meet all targets' scenarios (scenario 3 to 5), the Net Present Cost reduces as more source segregation is done. This is due to a combination of reduced infrastructure required to process residual waste and less processing costs as sorting and processing costs are shifted towards the point of waste collection.

5.13 If the EU and Scottish Government targets can be met with more source segregation and less residual processing, investment costs can be reduced through less need for MBTs as illustrated in Scenarios 4 and 5. The 60% and 65% source segregation of Scenario 4 and 5 both delay the need for infrastructure, particularly MBT, and allow more time to plan for and establish infrastructure. However, it may have to be considered whether these levels of source segregation are achievable and if so, whether any additional cost would be necessary, e.g. education and public awareness campaigns.

5.14 It is therefore recommended that further work is required to:

- Invest in effective communication and education including on the non-market benefits of investing in prevention, reuse and recycling;
- Better understand the efficiencies in collection infrastructure;
- Improve data collection on costs for collection, processing and infrastructure; and
- Better understand the synergies between MSW and other waste streams in terms of shared infrastructure.

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Annex B: Scenarios and Results

Scenarios

Table B-1 Waste Forecast Scenarios

Scenario Number	Description
Scenario 1a. **Do Nothing (With Landfill Fines)**	Continue at 2008/2009 levels of municipal waste processing and at present cost levels. No change in waste streams. The appropriate landfill fines are imposed.
Scenario 1b. **Do Nothing (No Landfill Fines)**	Continue at 2008/2009 levels of municipal waste processing and at present cost levels. No change in waste streams. No landfill fines are imposed.
Scenario 2. **EU WFD Only**	Meet all EU statutory obligations (only) such as the Waste Framework Directive and the Landfill Directive (e.g. landfill targets for 2010, 2013 and 2020; and 50% recycling/composting by 2020), but not the Scottish Government targets.
Scenario 3. **EU WFD & SG Targets (50/20)**	Meet all EU statutory obligations and all Scottish Government targets. This scenario assumes a 50/20 split between source segregation and residual waste to meet the 70% recycling and composting target.
Scenario 4. **EU WFD & SG targets (60/10)**	Meet all EU statutory obligations and all Scottish Government targets as per scenario 3 except this scenario assumes a 60/10 split between source segregation and residual waste to meet the 70% recycling and composting target.
Scenario 5. **EU WFD & SG Targets (65/5)**	Meet all EU statutory obligations and all Scottish Government targets as per scenario 3 except this scenario assumes a 65/5 split between source segregation and residual waste to meet the 70% recycling and composting target.
Scenario 6. **EfW cap by 2018**	Meet all EU statutory obligations and all Scottish Government targets as in scenario 3 except that EfW reaches its 25% cap earlier in 2018.

Source: SQW Energy

Cost Benefit Analysis Results (2010 to 2025) - NPV

Table B-2 – Cost Benefit Analysis (2010 to 2025) – All Figures NPV

Scenario	Collectn (£ m's)	Processing (£ m's)	Landfill Fines (£m's)	Infrastr. Investment (£ m's)	Benefits ROC Off (£ m's)	NPC above current spend ROCs OFF (£ m's)	Benefits ROC On £ m's	NPC above current spend ROCs ON (£ m's)
1a. Do Nothing (with Fines)	£2,480	£4,115	£1,288	£91	£559	2,346	907	1,997
1a. Do Nothing (No Fines)	£2,480	£4,115	0	£91	£559	1,058	907	709
2. EU Only	*£3,347*	£3,431	0	£434	£697	1,445	1,104	1,038
3. EU & SG Targets (50/20)	*£3,763*	£3,006	0	£449	£682	1,467	998	1,152
4. EU & SG Targets (60/10)	*£3,724*	£2,888	0	£342	£682	1,203	998	887
5. EU & SG Targets (65/5)	*£3,695*	£2,799	0	£303	£682	1,046	998	730
6. EfW Cap by 2018	*£3,811*	£2,981	0	£646	£741	1,628	1,122	1,247

Source: SQW Energy

Adding ROCs has the effect of reducing the NPC for all the scenarios. The order of the scenarios remains the same, except for Scenario 1b which now becomes the most competitive, being slightly more cost competitive than Scenario 5.

Scenario 1a and 1b - Infrastructure Requirement Table

Table B-3 Additional waste infrastructure required in Scotland (Scenario 1a and 1b)

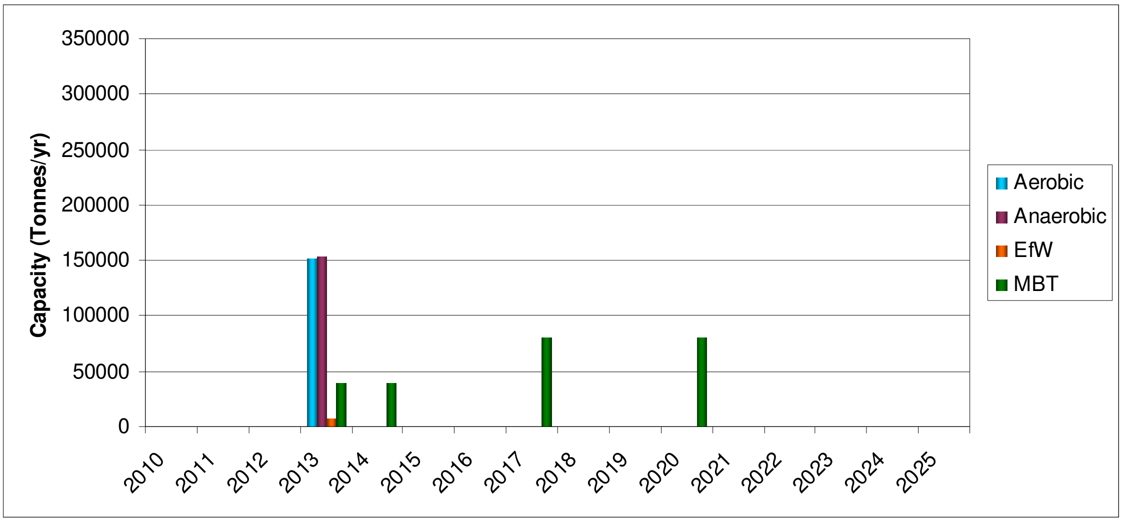
Waste infrastructure required	No. of units	Operational capacity per unit*	Total Capacity*
aerobic (1,000t)	2	1,000	2,000
aerobic (10,000t)	0	10,000	0
aerobic (25,000t)	5	25,000	125,000
aerobic (50,000t)	0	50,000	0
anaerobic (1,000t)	3	1,000	3,000
anaerobic (5,000t)	8	5,000	40,000
anaerobic (30,000t)	2	30,000	60,000
anaerobic (50,000t)	1	50,000	50,000
EfW (8,000t)	1	8,000	8,000
EfW (64,000t)	0	64,000	0
EfW (200,000t)	0	200,000	0
MBT (8,000t)	0	8,000	0
MBT (40,000t)	2	40,000	80,000
MBT (80,000t)	2	80,000	160,000

* Energy from Waste and MBT plants are assumed to operate at 80% of total stated capacity to reflect downtime for maintenance and repairs.

Source: SQW Energy

Scenario 1a and 1b - Infrastructure Requirement Chart

Figure B-1 Infrastructure Capacity Requirement (Scenario 1a and 1b)



Source: SQW Energy

Scenario 2 - Infrastructure Requirement Table

Table B-4 Additional waste infrastructure required in Scotland (Scenario 2)

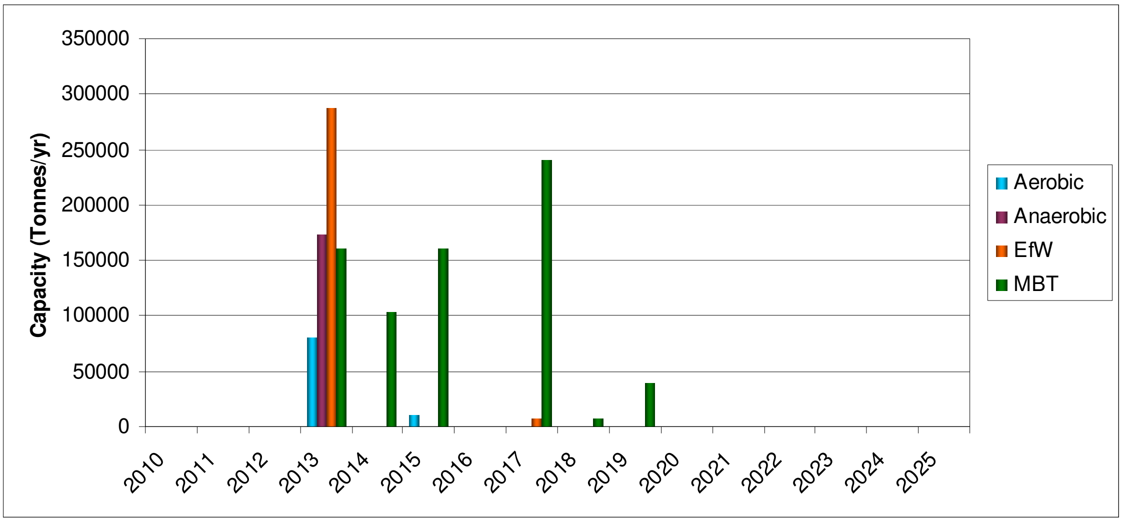
Waste infrastructure required	No. of units	Operational capacity per unit*	Total Capacity*
aerobic (1,000t)	0	1,000	0
aerobic (10,000t)	4	10,000	40,000
aerobic (25,000t)	2	25,000	50,000
aerobic (50,000t)	0	50,000	0
anaerobic (1,000t)	3	1,000	3,000
anaerobic (5,000t)	12	5,000	60,000
anaerobic (30,000t)	2	30,000	60,000
anaerobic (50,000t)	1	50,000	50,000
EfW (8,000t)	5	8,000	40,000
EfW (64,000t)	4	64,000	256,000
EfW (200,000t)	0	200,000	0
MBT (8,000t)	4	8,000	32,000
MBT (40,000t)	3	40,000	120,000
MBT (80,000t)	7	80,000	560,000

* Energy from Waste and MBT plants are assumed to operate at 80% of total stated capacity to reflect downtime for maintenance and repairs.

Source: SQW Energy

Scenario 2 - Infrastructure Requirement Chart

Figure B-2 Infrastructure Capacity Requirement (Scenario 2)



Source: SQW Energy

Scenario 3 - Infrastructure Requirement Table

Table B-5 Additional waste infrastructure required in Scotland (Scenario 3)

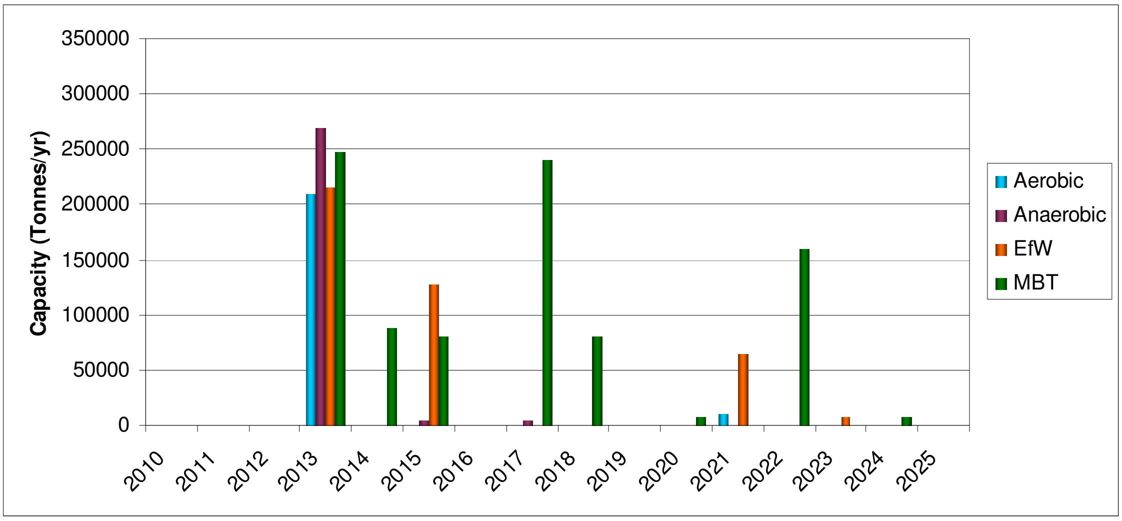
Waste infrastructure required	No. of units	Operational capacity per unit*	Total Capacity*
aerobic (1,000t)	0	1,000	0
aerobic (10,000t)	2	10,000	20,000
aerobic (25,000t)	2	25,000	50,000
aerobic (50,000t)	3	50,000	150,000
anaerobic (1,000t)	4	1,000	4,000
anaerobic (5,000t)	5	5,000	25,000
anaerobic (30,000t)	5	30,000	150,000
anaerobic (50,000t)	2	50,000	100,000
EfW (8,000t)	4	8,000	32,000
EfW (64,000t)	6	64,000	384,000
EfW (200,000t)	0	200,000	0
MBT (8,000t)	4	8,000	32,000
MBT (40,000t)	4	40,000	160,000
MBT (80,000t)	9	80,000	720,000

* Energy from Waste and MBT plants are assumed to operate at 80% of total stated capacity to reflect downtime for maintenance and repairs.

Source: SQW Energy

Scenario 3 - Infrastructure Requirement Chart

Figure B-3 Infrastructure Capacity Requirement (Scenario 3)



Source: SQW Energy

Scenario 4 - Infrastructure Requirement Table

Table B-6 Additional waste infrastructure required in Scotland (Scenario 4)

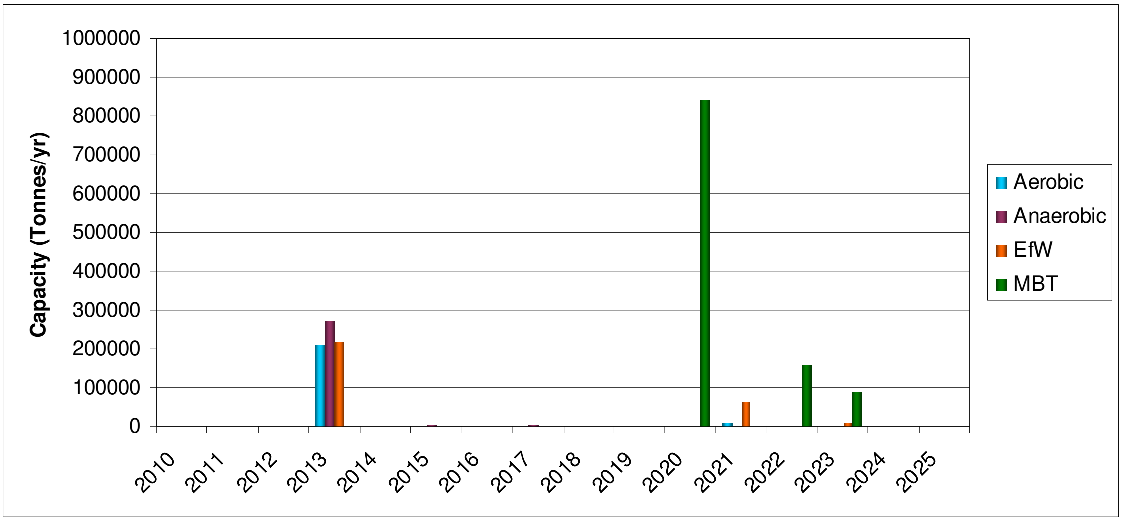
Waste infrastructure required	No. of units	Operational capacity per unit*	Total Capacity*
aerobic (1,000t)	0	1,000	0
aerobic (10,000t)	2	10,000	20,000
aerobic (25,000t)	2	25,000	50,000
aerobic (50,000t)	3	50,000	150,000
anaerobic (1,000t)	4	1,000	4,000
anaerobic (5,000t)	5	5,000	25,000
anaerobic (30,000t)	5	30,000	150,000
anaerobic (50,000t)	2	50,000	100,000
EfW (8,000t)	4	8,000	32,000
EfW (64,000t)	4	64,000	256,000
EfW (200,000t)	0	200,000	0
MBT (8,000t)	1	8,000	8,000
MBT (40,000t)	3	40,000	120,000
MBT (80,000t)	12	80,000	960,000

* Energy from Waste and MBT plants are assumed to operate at 80% of total stated capacity to reflect downtime for maintenance and repairs.

Source: SQW Energy

Scenario 4 - Infrastructure Requirement Chart

Figure B-4 Infrastructure Capacity Requirement (Scenario 4)



Source: SQW Energy

Scenario 5 - Infrastructure Requirement Table

Table B-7 Additional waste infrastructure required in Scotland (Scenario 5)

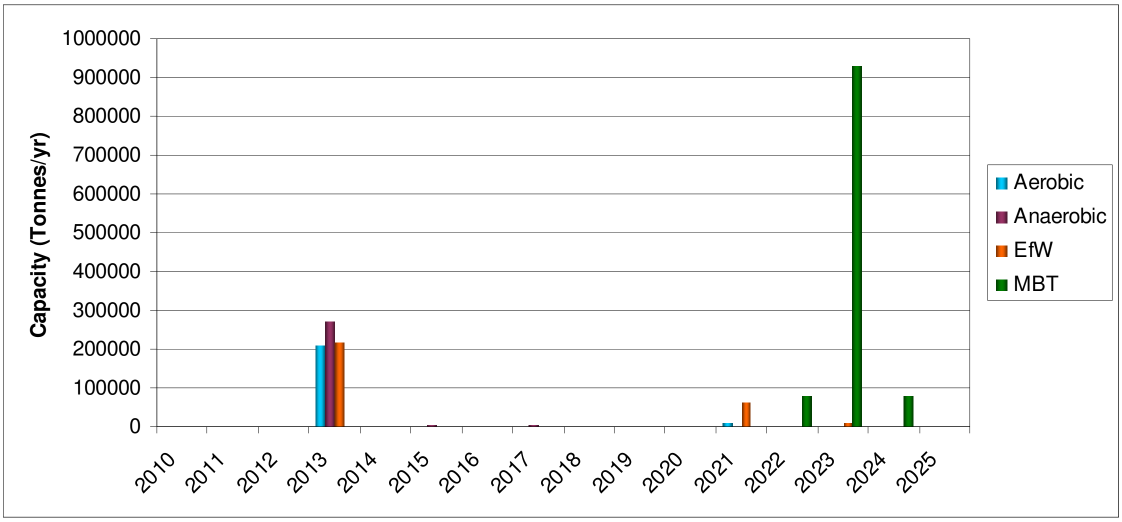
Waste infrastructure required	No. of units	Operational capacity per unit*	Total Capacity*
aerobic (1,000t)	0	1,000	0
aerobic (10,000t)	2	10,000	20,000
aerobic (25,000t)	2	25,000	50,000
aerobic (50,000t)	3	50,000	150,000
anaerobic (1,000t)	4	1,000	4,000
anaerobic (5,000t)	5	5,000	25,000
anaerobic (30,000t)	5	30,000	150,000
anaerobic (50,000t)	2	50,000	100,000
EfW (8,000t)	4	8,000	32,000
EfW (64,000t)	4	64,000	256,000
EfW (200,000t)	0	200,000	0
MBT (8,000t)	1	8,000	8,000
MBT (40,000t)	3	40,000	120,000
MBT (80,000t)	12	80,000	960,000

* Energy from Waste and MBT plants are assumed to operate at 80% of total stated capacity to reflect downtime for maintenance and repairs.

Source: SQW Energy

Scenario 5 - Infrastructure Requirement Chart

Figure B-5 Infrastructure Capacity Requirement (Scenario 5)



Source: SQW Energy

Scenario 6 - Infrastructure Requirement Table

Table B-8 Additional waste infrastructure required in Scotland (Scenario 6)

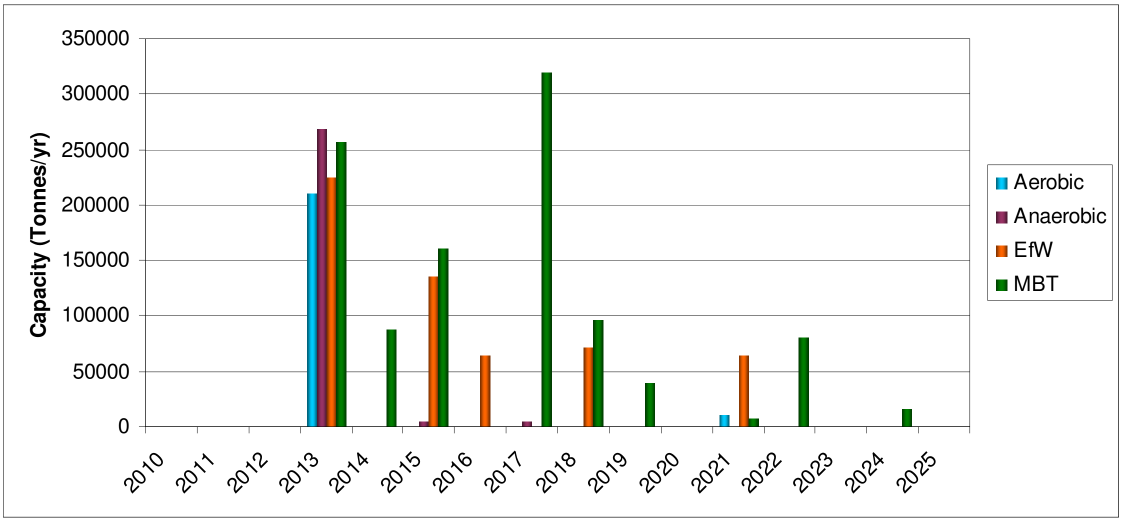
Waste infrastructure required	No. of units	Operational capacity per unit*	Total Capacity*
aerobic (1,000t)	0	1,000	0
aerobic (10,000t)	2	10,000	20,000
aerobic (25,000t)	2	25,000	50,000
aerobic (50,000t)	3	50,000	150,000
anaerobic (1,000t)	4	1,000	4,000
anaerobic (5,000t)	5	5,000	25,000
anaerobic (30,000t)	5	30,000	150,000
anaerobic (50,000t)	2	50,000	100,000
EfW (8,000t)	6	8,000	48,000
EfW (64,000t)	8	64,000	512,000
EfW (200,000t)	0	200,000	0
MBT (8,000t)	8	8,000	64,000
MBT (40,000t)	5	40,000	200,000
MBT (80,000t)	10	80,000	800,000

* Energy from Waste and MBT plants are assumed to operate at 80% of total stated capacity to reflect downtime for maintenance and repairs.

Source: SQW Energy

Scenario 6 - Infrastructure Requirement Chart

Figure B-6 Infrastructure Capacity Requirement (Scenario 6)



Source: SQW Energy

Annual Nominal Additional Cost

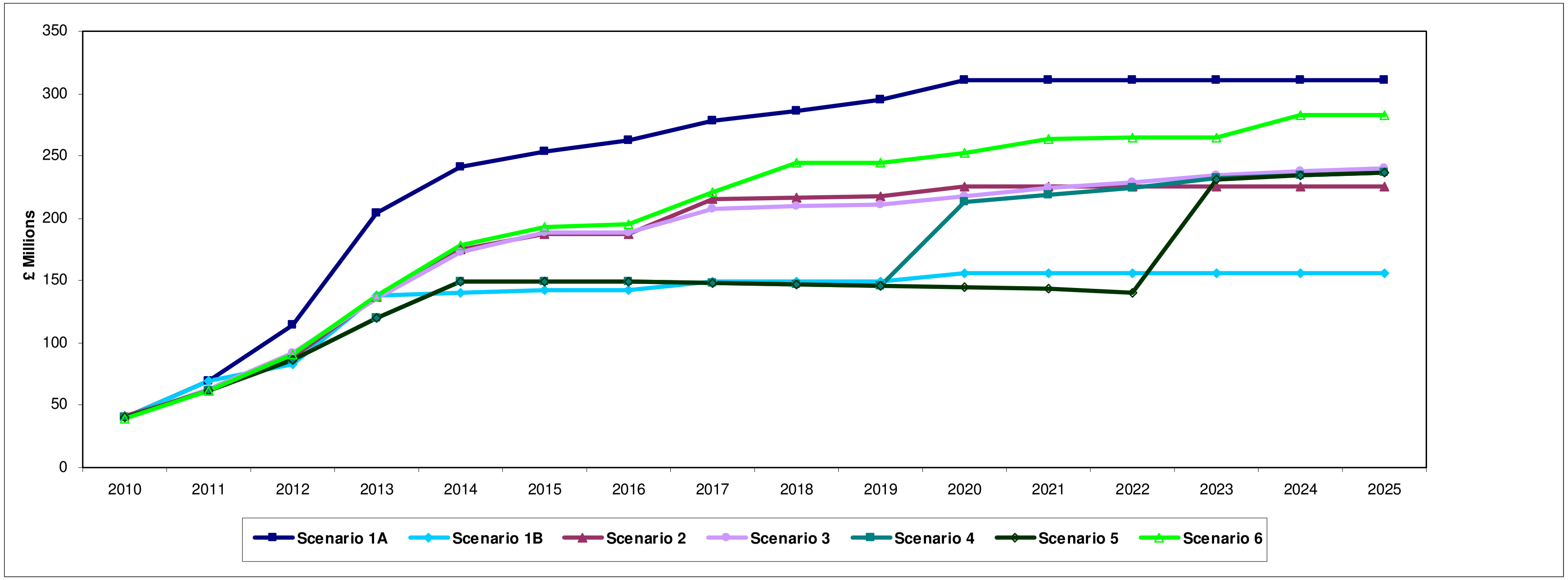
Table B-9 - Annual Additional Costs in Excess of Existing Expenditure (Nominal)

Scenario	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1a	40	69	115	205	242	253	262	278	287	295	311	311	311	311	311	311
1b	40	69	83	138	140	143	143	149	149	149	156	156	156	156	156	156
2	41	62	89	137	175	187	187	215	216	217	225	225	225	225	225	225
3	41	63	92	136	172	189	189	208	210	211	218	224	229	235	237	240
4	41	62	87	120	149	149	149	148	147	146	213	219	224	232	234	237
5	41	62	87	120	149	149	149	148	147	146	144	143	140	231	234	237
6	39	62	91	138	178	193	195	221	244	245	252	264	264	265	282	283

Source: SQW Energy

Annual Nominal Additional Cost

Figure B-7 – Annual Additional Costs in Excess of Existing Expenditure (Nominal)

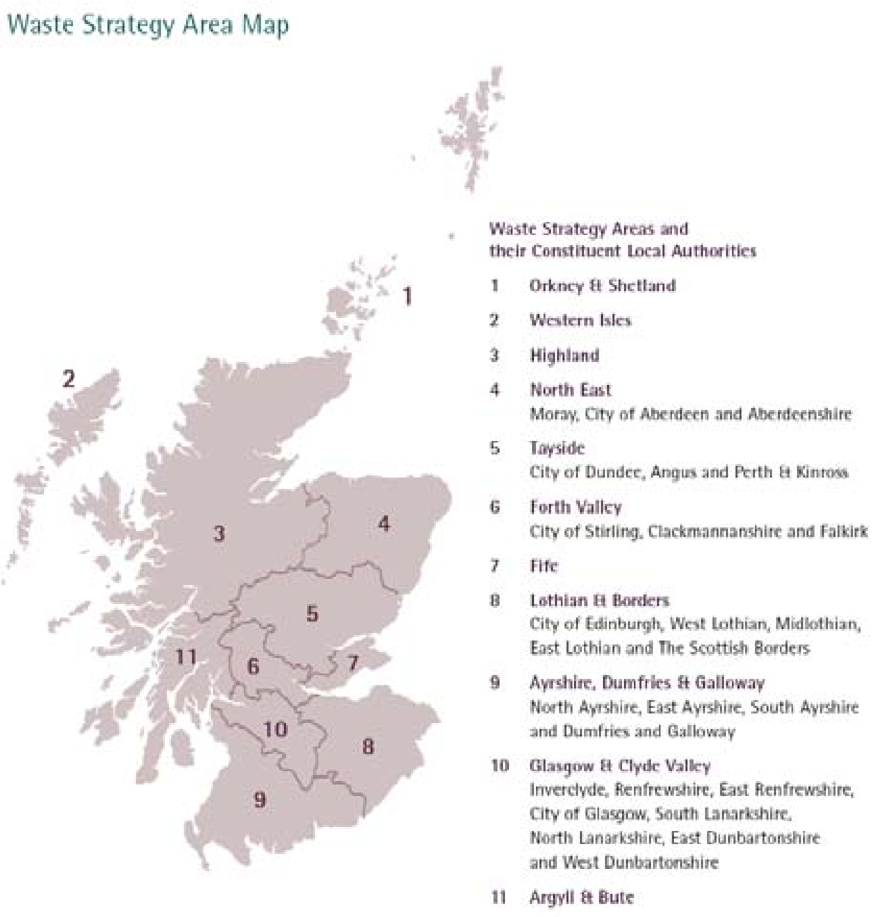


Source: SQW Energy

Annex C: Technical Annex

Waste Strategy Areas

Figure C-1 Scotland's Waste Strategy Areas



Source: SEPA

Selected cost data

Table C-1 Defra-derived processing cost estimates (£)

Category	Cost per tonne (2002 prices)	Cost per tonne with inflation (SQW estimate)
Composting Small	19	22.8
Composting Large	14	16.8
Anaerobic digestion, small	28	33.6
Anaerobic digestion, large	14	16.8
MBT small	42.5	51
MBT large	32.5	39
EfW small	52.5	63
EfW large	44	52.8

Source: Defra: Delivering the landfill directive (2002)

Table C-2 Assumptions underlying landfill gas estimates

Element	Value
Methane yield per tonne	120
KWh per cubic metre	2
Price per MWh	£45
Value per tonne of landfill	£10.8

Source: Kurian, Joseph, Energy from sustainable landfills

Table C-3 In-Vessel Composting - sources for infrastructure costs/capacity

Site	Capacity	Capital cost	Source
East Riding Council	30,000	3,500,000	http://www.thisishullandeastriding.co.uk/environment/3-5-hi-tech-composting-plant/article-1043021-detail/article.html
Gwynedd County Council	5,000	1,600,000	http://www.recycle.co.uk/news/747000.html
Longwood Quarry	50,000	12,000,000	http://www.thisislincolnshire.co.uk/news/12m-composting-plant-plan-village-quarry/article-788269-detail/article.html
Blaise Farm Quarry	50,000	12,000,000	http://www.letsrecycle.com/do/ecco.py/view_item?listid=37&listcatid=217&listitemid=51979&section=composting
Galdenoch Composting plant	18,000		http://www.dumgal.gov.uk/index.aspx?articleid=4636
Bristol	30,000		http://www.letsrecycle.com/do/ecco.py/view_item?listid=37&listcatid=322&listitemid=9799

Source: SQW

Table C-4 Windrow composting - sources for infrastructure costs/capacity			
Site	**Capacity**	**Capital cost**	**Source**
J M Clarke & Son, Theddingworth	10,000	£405,340	http://www.wrap.org.uk/wrap_corporate/news/wrap_funded.html

Source: SQW

Table C-5 Energy from Waste - sources for infrastructure costs/capacity			
Site	**Capacity**	**Capital cost**	**Source**
Tees Valley	250,000		http://www.sita.co.uk/local-authorities/integrated-waste/teesside
Billingham	256,000	120,000,000	http://www.newenergyfocus.com/do/ecco.py/view_item?listid=1&listcatid=105&listitemid=1825
Newport	120000	57,000,000	http://www.letsrecycle.com/do/ecco.py/view_item?listid=37&listcatid=5270&listitemid=31340
North Ayrshire	80000	40,000,000	http://www.builderandengineer.co.uk/construction-scotland/features/a-load-of-hot-ayr-3634.html

Source: SQW

Table C-6 Mechanical Biological Treatment - sources for infrastructure costs/capacity			
Site	**Capacity**	**Capital cost**	**Source**
Milton Keynes	115,000	36,000,000	

Source: SQW