Appendix D

Best Practicable Environmental Option for the Management of Municipal Waste in Warwickshire

CONTENTS

1 ASSESSMENT METHODOLOGY

This document is an assessment of the Best Practical Environmental Option (BPEO) that will form part of Warwickshire's municipal waste management strategy and contains the proposals for addressing the key issues surrounding future waste management in Warwickshire. The assessment methodology incorporates environmental, economic and planning criteria and follows the step-wise approach suggested in the UK Waste Strategy 2000 (WS2000), which states:

> *"Decisions on waste management, including decision on suitable sites and installations for treatment and disposal, should be based on a local assessment of the Best Practicable Environmental Option."*

The BPEO concept was defined in the 12th Report of the Royal Commission on Environmental Pollution as:

> *"the outcome of a systematic and consultative decision-making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefits or the least damage to the environment as a whole, at acceptable cost, in the long term as well as in the short term".*

The BPEO concept incorporates two further principles that need to be taken into account when making waste management decisions, and also guide the development of future waste management scenarios:

- The waste hierarchy
- The proximity principle

The step-wise approach to determining the BPEO as set out in WS2000 and in subsequent guidance[1] is summarised below.

1. Define and agree assessment criteria
2. Develop strategic waste management scenarios
3. Model and assess strategic waste management scenarios
4. Sustainability assessment - Rank and value performance
5. Total valued performance and weighting of the indicators
6. Sensitivity analysis and scenario refinement

[1] Land Use Consultants and ERM – "Strategic planning for sustainable waste management", Office of the Deputy Prime Minister, http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/pdf/odpm_plan_pdf_606386.pdf

1.1 STEP 1 - Assessment Criteria

The Guidance recommends 12 objectives with 21 indicators as assessment criteria. These objectives are grouped into three principal assessment categories:

- Environmental objectives
- Socio-economic objectives
- Operational objectives

Furthermore, the Warwickshire authorities have added one additional assessment criteria (proportion of biodegradable municipal waste diverted from landfill) within the operational objectives. Each of the objectives is further defined by a range of indicators, which provide a quantitative or qualitative measure of the performance of the scenario against that objective.

1.1.1 Environmental Objectives

The environmental objectives and their respective indicators are listed in Table 1. Indicator values are either determined from modelling outputs (i.e. WISARD[2] which is the industry standard life cycle assessment tool developed and recommended by the Environment Agency & WASTEFLOW[3]) or a 'performance score'4 based on professional judgement.

Table 1: Environmental Objectives

Objectives	Indicators
1. To ensure prudent use of land and other resources	Resource depletion (avoided burden in million years) – WISARD output
	Landtake (hectares) (performance score)
2. To reduce greenhouse gas emissions	Emissions of greenhouse gases (000 tonnes equivalent of CO2) – WISARD output
3. To minimise air quality impacts	Emissions which are injurious to public health (Human Toxicity Index) – WISARD output
	Air acidification (tonnes equivalents of H+) – WISARD output
	Ozone depletion (tonnes equivalents of CFC-11) – WISARD output
	Extent of odour problems (performance score)
	Extent of dust problems (performance score)
4. To conserve landscapes and townscapes	Visual and landscape impacts (performance score)
5. To protect local amenity	Extent of noise problems (performance score)
	Extent of litter and vermin problems (performance score)
6. To minimise adverse effects on water quality	Eutrophication (million grams equivalents of PO4) – WISARD output
	Extent of water pollution (performance score)
7. To minimise local transport impacts	Total Transport Distance (thousand kilometres)
	Proportion of non-motorway/non-dual carriageway (thousand kilometres)

To allow modelling of the scenarios specific locations are required to determine distances and the associated transport impacts. The use of specific locations does not prejudice the future use of a site. The sites used to carry out the modelling were selected as exemplar sites that were in an appropriate geographical location. The sites identified in this report are either

[2] WISARD is the Environment Agency's software tool for assessing the environmental life cycle impacts of waste management options

[3] WASTEFLOW is a waste management model developed by the consultants (AEA Technology) who were commissioned to conduct the BPEO study.

[4] The performance scores are based on professional judgement and reflect aspects that cannot be easily assessed on an objective measurement such as planning issues or risk issues.

existing waste management facilities or sites, which have previously been used for industrial activities or have been identified in the current Waste Local Plan. The use in the modelling does not affect any specific planning applications or prejudice its current or future use.

1.1.2 Socio-Economic Objectives

The principal objectives and indicators are noted in Table 2. An estimate of the number of jobs created to operate the required waste management infrastructure has been made based on the amount of waste likely to be handled and/or processed by the treatment and disposal facilities. The cost of the waste management service can be measured in many ways depending on the time and the elements considered. In this assessment the aggregate cost of the service from 2007 until 2032 has been used determined by using the WASTEFLOW model

Table 2: Socio-economic objectives

Objectives	**Indicators**
8. To provide local employment opportunities	Number of jobs created (jobs estimated)
9. To provide opportunities for public involvement / education	Potential for participation in recycling and composting (% households with kerbside collection of recyclables)
10. To minimise costs of waste management	Overall costs (£million 2007 - to 2032) – WASTEFLOW

1.1.3 Operational Objectives

The two principal criteria of the operational objectives shown in Table 3 are the 'reliability of delivery' and performance against waste policy. The former aims to provide a measure of the degree to which each scenario is proven and deliverable. This takes into account various uncertainties and risks such as gaining permission to develop sites, and the technical difficulty of financing, building and operating the waste management process. The waste management system must also comply with the various targets for recycling, recovery and landfill diversion. Objective 12 provides a measure of the performance of the various scenarios against these targets.

Table 3: Operational Objectives

Objectives	Indicators
11. To ensure reliability of delivery	Maturity of technology (performance score)
	Public acceptance/ achievement of planning permission (performance score)
	Public Involvement required (participation rate)
12. To conform with waste policy	Percentage of material recovered (%)
	Percentage of material recycled/composted (%)
	Percentage of BMW diverted from landfill (%)

1.2 STEP 2 - Development of Scenarios

The principles of proximity and regional self-sufficiency have been important considerations in developing the scenarios described below. The proximity principle requires that waste be managed as near as possible to its origin. This principle recognises the desire to avoid passing financial and environmental costs onto communities not responsible for the waste generated, whilst reducing the impact of transportation. However, it is clear that it is impractical for all waste to be managed at the actual point of arising, and due consideration needs to be taken of costs, the site and processing capacity availability.

In order to adhere to the principles of self-sufficiency and proximity the scenarios for BPEO assessment have been developed to consider only the MSW arising for which Warwickshire is responsible. Any consideration of synergies with plans/policies in neighbouring authorities may be undertaken only after determining the BPEO for Warwickshire alone. The key variables in the scenarios are level of recycling and the choice of residual treatment facility.

1.2.1 Waste Management Scenarios

Seven scenarios have been developed for the BPEO assessment, which focus on residual waste treatment and the potential impact of different treatment technologies and facilities. The introduction of kitchen waste (biowaste) collection from 2009 has been considered in 6 of the 7 scenarios. A summary of the scenarios is provided in the following tables, including proposed collection frequency and arrangements for recycling, composting and disposal of waste. The main differences between scenarios are highlighted.

Base Case A – Achievement of 40% recycling by 2010 and continuation of the current landfilling of residual waste.

Waste type	Collection frequency	Treatment/disposal
Kitchen waste + green waste	Fortnightly	In-vessel composting
Dry recyclables	Fortnightly	Reprocessors
Residual waste	Fortnightly	Landfill

Base Case B – Achievement of 40% recycling by 2010 and continuation of the current landfilling of residual waste.

Waste type	Collection frequency	Treatment/disposal
Kitchen waste + green waste	Fortnightly	In-vessel composting
Dry recyclables	Fortnightly	Reprocessors
Residual waste	Weekly	Landfill

Scenario 1a – Achievement of 40% recycling by 2010 and a centralised Energy from Waste (EfW) facility in Warwickshire (operational by 2011)

Waste type	Collection frequency	Treatment/disposal
Kitchen waste + green waste	Fortnightly	In-vessel composting
Dry recyclables	Fortnightly	Reprocessors
Residual waste	Fortnightly	EfW (200ktpa)

Scenario 1b – Achievement of 40% recycling by 2010 and two decentralised EfW facilities located in the North and South of Warwickshire (operational by 2011)

Waste type	Collection frequency	Treatment/disposal
Kitchen waste + green waste	Fortnightly	In-vessel composting
Dry recyclables	Fortnightly	Reprocessors
Residual waste	Fortnightly	EfW (110ktpa and 90ktpa)

Scenario 1c – Achievement of 30% recycling by 2010 and a centralised EfW facility in Warwickshire (operational by 2011)

Waste type	Collection frequency	Treatment/disposal
Green waste	Fortnightly	In-vessel composting
Dry recyclables	Fortnightly	Reprocessors
Residual waste	Fortnightly	EfW (230ktpa)

Scenario 2 – Achievement of 40% recycling by 2010 and a centralised gasification/pyrolysis facility in Warwickshire (operational by 2011)

Waste type	Collection frequency	Treatment/disposal
Kitchen waste + green waste	Fortnightly	In-vessel composting
Dry recyclables	Fortnightly	Reprocessors
Residual waste	Fortnightly	Gasification/pyrolysis (200ktpa)

Scenario 3 – Achievement of 40% recycling by 2010 and a centralised Mechanical Biological Treatment (MBT) facility in Warwickshire with generation of compost and export of RDF to third party (operational by 2011)

Waste type	Collection frequency	Treatment/disposal
Kitchen waste + green waste	Fortnightly	In-vessel composting
Dry recyclables	Fortnightly	Reprocessors
Residual waste	Fortnightly	MBT (200ktpa)

1.3 STEP 3 - Modelling

Modelling of the waste management scenarios was conducted using the WASTEFLOW models to predict the performance and costs.

1.3.1 Recycling Performance

The scenarios are set around increasing the recycling rate through:

- Improvements at the household waste recycling centres
- Improvements to the bring bank network
- Improvement of kerbside collection of dry recyclables
- Introduction of kerbside collections of organics for composting
- Additional recycling through disposal/ treatment facility.

Figure 1 shows the amount of waste generation predicted and counted as recycled under the current Best Value Performance Indicator guidance. The recycling target of 24% in 2005 will be met as predicted given the current level of recycling in Warwickshire at kerbside and household recycling centres. Recycling can be increased through the introduction of kitchen waste collection and improved recycling performance. In addition, metals segregated prior to gasification/pyrolysis are included in the recycling performance, hence scenario 2 (gasification/pyrolysis) having a slightly higher recycling rate than the EfW scenarios.

However, the metals and aggregates recovered from ash in EfW facilities are specifically excluded from contributing to the recycling target.

All scenarios (except scenario 1c) were modelled to achieve 40% recycling with the kerbside collection of dry recyclables, bring schemes and recycling at HWRC sites. In addition, the current service of garden waste kerbside collection in all districts was extended to collect also kitchen waste staring in 2009. Scenario 1c was modelled with the same performance of kerbside dry recyclables, bring schemes and HWRC sites, but the current service of garden waste collection remained unchanged although continuously improving its performance. Therefore Figure 1 shows that in 2015 only scenario 1c does not meet the 40% recycling target as it was modelled to reach 30% recycling. Scenario 2 shows slightly higher recycling levels, because the metals separated before the gasification/pyrolysis can count towards the recycling performance. The MBT-RDF process has the highest recycling performance given 25% of the processed materials is either recycled or composted.

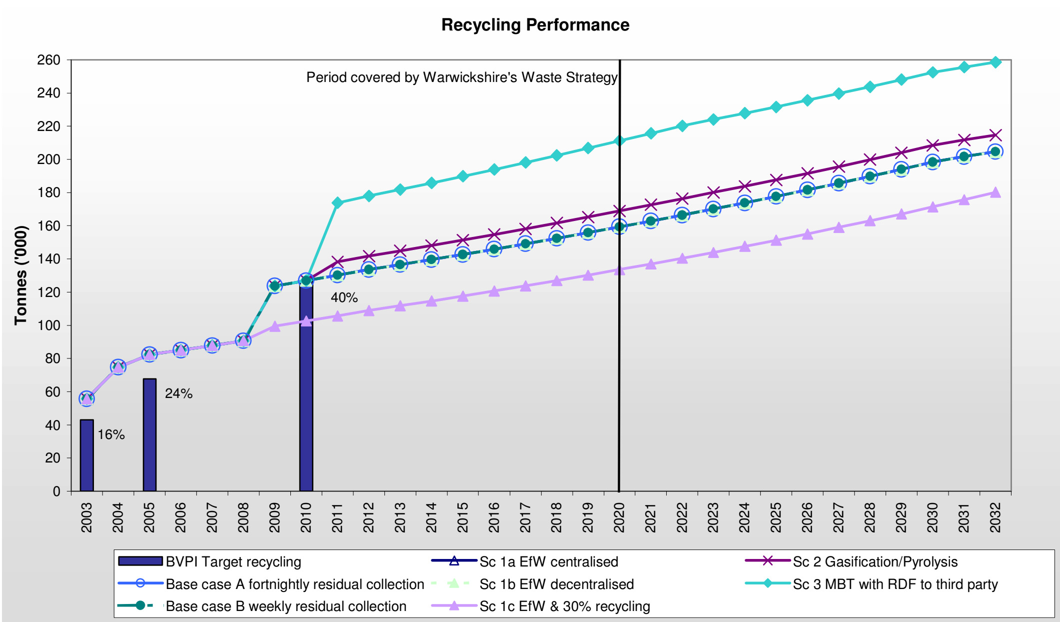

Figure 1: Achievement of recycling targets

1.3.2 Landfill Directive Targets

The Landfill Directive will impose demanding requirements to limit the amount of biodegradable municipal waste (BMW) being landfilled in the UK. The Government has implemented this Directive by issuing allowances to landfill BMW, which can be traded between local authorities. Warwickshire has been allocated reducing annual allowances from 2005 - 2020. Figure 2 shows the allocated amount allowed for landfilling for each year (area shaded in yellow).

Figure 2 indicates that when the treatment processing technologies such as EfW, MBT and gasification/pyrolysis are adopted in 2011 the diversion rates of BMW from landfill are within the allocation of LATS. There is variation in the performance between the technologies with regard to BMW diversion. For example Scenario 3 MBT with RDF sold to third party performs worse than EfW or gasification/pyrolysis, because it produces more active material that requires landfilling during the treatment process. However, all scenarios perform within the allocation of LATS for Warwickshire except Base Cases A and B.

Furthermore, Figure 2 indicates that prior to the introduction of residual treatment a recycling level of 40% with the kitchen waste collection is required to reduce the need for purchasing landfill allowances.

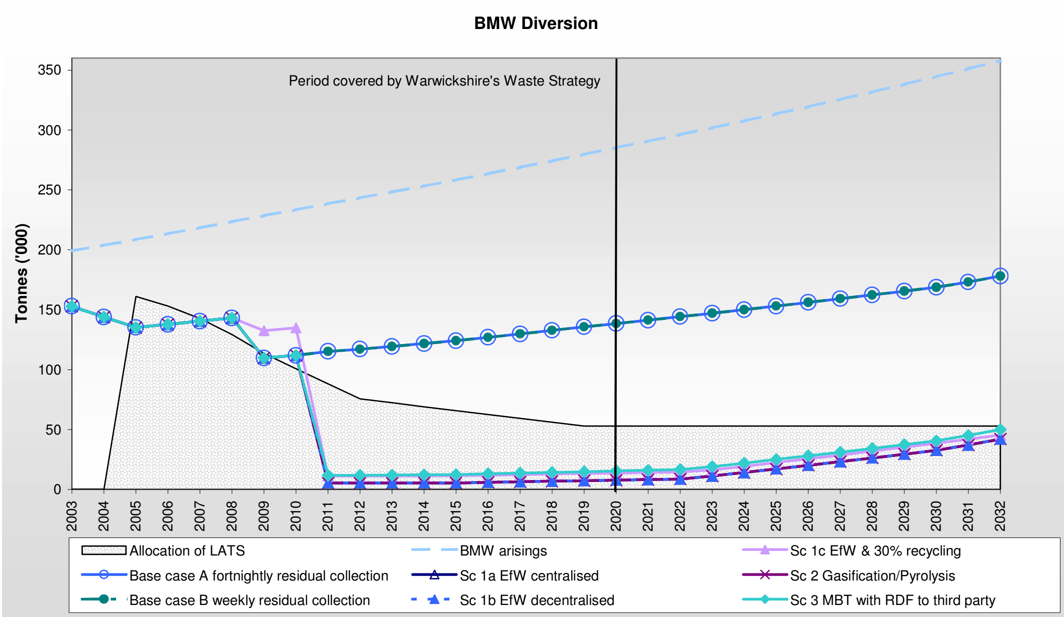

Figure 2: Progress to meeting Landfill Directive BMW diversion targets BMW

1.3.3 Costs of Waste Management

Figure 3 shows the total annual cost profile for each scenario including bulk collection and disposal. The collection cost for the District/Borough Councils is included in the total waste management cost. However, it should be noted that these costs do not include the costs for the educational support programmes to achieve the 40% to 45% recycling target 2010.

In Scenario 1c (EfW with 30% recycling) the costs are lower than all the other scenarios, because the kerbside collected green waste continues to go to the existing windrow facilities and no new in-vessel composting facilities are required. Therefore only the cost of purchasing extra windrow composting capacity is required and high capital investment and higher operational cost of in-vessel composting are avoided. Hence, although a slightly larger EfW capacity for residual waste is required as no kitchen waste is collected for composting, this still results in lower costs than scenario 1a which needs additional capital cost for in-vessel composting facilities.

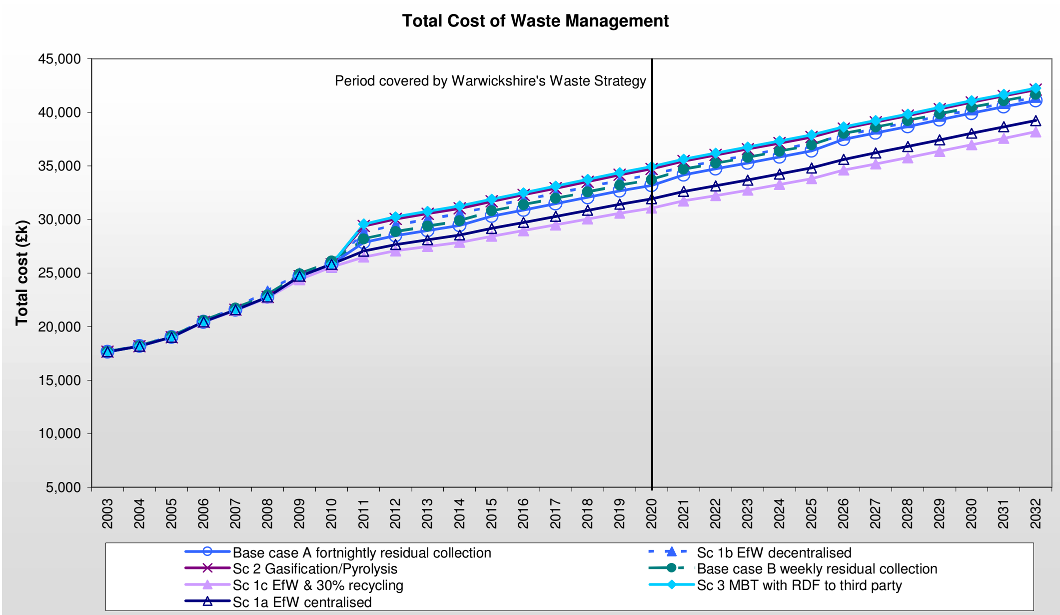

Figure 3: Cost projection

The decentralised scenario 1b has two smaller EfW facilities. Therefore the total costs are higher than for scenario 1a with one large EfW due to the 'economies of scale' effect. The costs for one large gasification/pyrolysis plant are fairly similar to the costs of two smaller EfW facilities although it should be taken into consideration that gasification/pyrolysis is a new technology and has no track record of being used to treat large volumes of residual waste in the UK. Therefore, there is an additional uncertainty in allocating costs for such technologies and the technical risk element needs to be considered carefully within the costs. In summary, scenario 1b may provide a political benefit of following the proximity principle but this comes with higher cumulative costs in comparison to the centralised option. Similarly, new technologies such as gasification/pyrolysis may provide a benefit regarding public perception and therefore in the planning process but this has higher costs associated due to uncertainties of technology delivery.

Generally, waste processing by thermal treatment is less expensive than processing waste via MBT technology. It should also be recognised that without an established market for the RDF there is a significant uncertainty as to the viability of the product as a fuel.

1.4 STEP 4 – Sustainability Assessment

This section presents the outputs of the WISARD (environmental) and WASTEFLOW (costs and performance against targets) modelling assessments. The actual numerical values from the modelling assessment are presented. In order to 'value' the performance of the evaluated criteria, the criteria scores can be converted to a value score by allocating a score between 0 (worst performing) and 1 (best performing). Figure 4 illustrates the process of converting the criterion score to a values score[5].

[5] For a set of 'n' scores x1 to xn, the normalised value yi of xi is given by: $y_i = \frac{x_i - \mathrm{Min}[x_1, x_2, \ldots x_n]}{\mathrm{Max}[x_1, x_2, \ldots x_n] - \mathrm{Min}[x_1, x_2, \ldots x_n]}$

This formula sets the highest value at one, the lowest at zero, and the rest in a relative position between one and zero. If the highest value actually represents the worst option, the numbers must be inverted, as follows:

$$y_i = 1 - \frac{x_i - \mathrm{Min}[x_1, x_2, \ldots x_n]}{\mathrm{Max}[x_1, x_2, \ldots x_n] - \mathrm{Min}[x_1, x_2, \ldots x_n]}$$

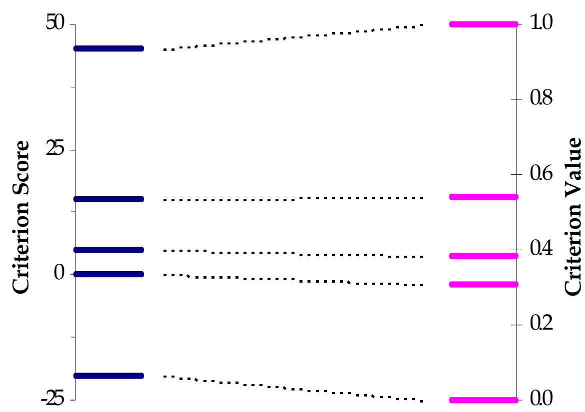

Figure 4: Illustration of normalising criterion scores

The conversion of the criterion score to a normalised criterion value score allows the various scenarios to be compared. By summing the normalised criterion value scores to give a total valued score the various scenarios can be ranked according to performance.

A valued performance score, and a ranking of scenarios, has been determined for each of the three principal objectives (environmental objectives, socio-economic objectives and operational objectives).

1.4.1 Environmental Objectives

The final row of Table 4 sums the numerical performance scores for each scenario. This provides a simple overall measure of the environmental performance of the scenarios and allows them to be ranked so the best performing scenario can be identified.

On the basis of environmental objectives alone and equal weighting of the parameters it is seen that scenario 1c (EfW with 30% recycling) performs best. This is mainly due to the absence of three in-vessel composting facilities which have an environmental impact on planning issues such as odour, noise, dust etc.

All the scenarios modelled (except Base Case A and B) benefit from the diversion of biodegradable waste from landfill to varying degrees. However, in the WISARD analysis thermal treatment benefit from the additional energy production and offsetting of other fuels. WISARD assumes that additional electricity generation replaces coal-fired electricity as the older less efficient facilities are replaced first. In the longer term other power plants will be replaced and a mixture of coal, oil and nuclear will be decommissioned. However, coal will dominate this mixture for many years to come. In summary, the additional electricity generation provides the largest benefits for the thermal treatment scenarios.

The MBT scenario 3 displays a less effective benefit in terms of environmental performance, although it offers the potential for energy generation, this is to a lower extent than thermal treatment.

Scenario 1b (decentralised EfW) performs slightly better than scenario 1a with one centralised EfW plant. Generally, a centralised approach is likely to have fewer problems with planning issues, because the environmental impact is assumed to be less than the sum of impacts of separately located, individual technologies. However, the two EfW facilities in the decentralised scenario 1b share the sites with two in-vessel composting facilities, Therefore the environmental impacts of both EfW and composting together are lower in total for each site. Furthermore, one less transfer station is required when using two residual treatment facilities. In addition, the decentralised scenario 1b scores lower in the transport distances due to the nearer locations of the EfW.

Base Case B scores slightly better than Base Case A although the only difference is within the local transport impacts. The total distance travelled includes a calculation of the collection round including the trip to the first delivery point (transfer station, landfill or treatment facility) for residual waste with either a weekly or fortnightly collection service. AEA Technology's in-house proprietary Collection and Arisings Model (CAMOD) has been used to calculate the collection costs and distances travelled for each district. In this BPEO assessment the fortnightly collection shows slightly longer total distance travelled, however, there is less than 1% difference when compared to weekly collection. Experience would indicate that fortnightly collection, once optimisation of the round structure for housing type and other infrastructure has been carried out, should normally either keep the distance travelled on the collection round the same or slightly reduced, which is opposite to what the modelling is showing in this case. As the calculation of the collection rounds is based on the CAMOD model outputs, the difference of 1% is well within the error range of the model, which should be considered in assessing the Base Case A and B. However, the normalising process converts the calculated distances into a value score to allow the comparison of the scenarios which accentuates the differences between Base Case A and B.

Table 4: Environmental objectives – value performance[6]

Objectives	Criterion	Base case A – fortnightly collection	Base case B - weekly collection	Sc 1a - EfW	Sc 1b – decentralised EfW	Sc 1c – EfW + 30% recycling	Sc 2 – Gasification/ Pyrolsis	Sc 3 – MBT (composting)
1. To ensure prudent use of land and other resources	Resource depletion (avoided burden in million years) – WISARD output	0.01	0.00	0.91	0.91	0.87	0.90	1.00
	Landtake (hectares) (performance score)	0.00	0.00	0.99	0.99	0.93	1.00	0.54
2. To reduce greenhouse gas emissions	Emissions of greenhouse gases (000 tonnes equivalent of CO2) – WISARD output	0.00	0.00	0.67	0.67	0.68	1.00	0.81
3. To minimise air quality impacts	Emissions which are injurious to public health (Human Toxicity Index) – WISARD output	0.00	0.00	0.70	0.70	0.75	1.00	0.35
	Air acidification (tonnes equivalents of H+) – WISARD output	0.00	0.00	0.65	0.65	0.69	1.00	0.33
	Ozone depletion (tonnes equivalents of CFC-11) – WISARD output	0.00	0.00	0.96	0.96	0.98	1.00	0.80
	Extent of odour problems (performance score)	0.04	0.04	0.50	1.00	0.54	0.51	0.00
	Extent of dust problems (performance score)	0.00	0.00	0.73	1.00	0.82	0.75	0.33
4. To conserve landscapes and townscapes	Visual and landscape impacts (performance score)	0.85	0.85	0.23	0.00	1.00	0.23	0.26
5. To protect local amenity	Extent of noise problems (performance score)	1.00	1.00	0.00	0.39	0.15	0.02	0.14
	Extent of litter and vermin problems (performance score)	0.00	0.00	0.47	1.00	0.53	0.49	0.21
6. To minimise adverse effects on water quality	Eutrophication (million grams equivalents of PO4) – WISARD output	0.00	0.00	0.55	0.55	1.00	0.55	0.09
	Extent of water pollution (performance score)	0.24	0.24	0.45	0.14	1.00	0.47	0.00
7. To minimise local transport impacts	Total Transport Distance (thousand kilometres)	0.94	1.00	0.53	0.68	0.83	0.53	0.00
	Proportion of non-motorway/non-dual carriageway	0.49	0.51	0.71	0.00	1.00	0.71	0.62
TOTAL		3.57	3.64	9.03	9.64	11.76	10.16	5.49
Rank		7	6	4	3	1	2	5

6 The scenario, which scores the highest, is best performing. A rank of 1 shows the best performing scenario, a rank of 7 shows the worst performing scenario. The results should not be regarded as a precise overall measure of performance; the two decimal places are retained only for consistency.

1.4.2 Socio-Economic Objectives

Table 5 shows the normalised performance score for the socio economic objectives. The potential for participating in recycling and composting are assumed to be the same for all scenarios as the same level of kerbside collection service is required in order to achieve the recycling performance.

The estimated number of jobs varies between 372 jobs in the Base Case A to 445 jobs in scenario 2 (gasification/pyrolysis). Generally, scenarios requiring some kind of mechanical separation, combustion of RDF, collection of kitchen waste, provision of a transfer station score higher in the number of jobs.

The costs are shown as cumulative cost from 2007 to 2032, which indicates that scenario 1c (EfW with 30% recycling) has the lowest cumulative cost. The costs are lower than all the other scenarios, because the kerbside collected green waste continues to go to the existing windrow facilities and no new in-vessel composting facilities are required. The decentralised scenario 1b has two EfW facilities, hence the total costs are higher than for scenario 1a with one large EfW. The costs for one large gasification/pyrolysis plant are in a similar range although it should be recognised that it is a new technology not yet established in the UK with large treatment capacities for residual waste. The most expensive scenario is scenario 3 (MBT), because rejects from the MBT treatment still have to be landfilled, hence less landfill allowances are available for sale reducing the potential income for Warwickshire.

In terms of the overall assessment of socio-economic objectives scenario 1c (EfW with 30% recycling) scores the highest, predominantly due to lowest cumulative cost. The Base Case A is the least favourable option, because it combines fairly high costs but also the lowest number of jobs.

1.4.3 Operational Objectives

The normalised value scores are listed in Table 6.

The deliverability of service solution is based on professional judgement but centres around the potential hurdle of obtaining planning permission for sites, status of technologies as well as achieving the anticipated level of recycling/composting. Due to public perception the EfW scenarios are likely to experience more difficulties in obtaining planning permission. The publics perception is assumed to be better for newer technologies such as gasification/pyrolysis and MBT, however it is likely that opposition will be raised against any proposed waste treatment facility. The rate of recycling and composting depends on the level of public involvement and participation rate.

MBT technology improves recycling performance due to recycling of metals and the generation of compost. The metals recycled prior to gasification/pyrolysis also count towards the recycling target. Scenario 1c has the lowest recycling performance as no kitchen waste is collected and the recycling performance is set at 30% to be achieved in 2010 by the Districts/Boroughs (difference between scenario 1a and 1c).

The results show that scenario 1a (centralised EfW) is the best performing option. This is attributed to the high percentage of material recovered and BMW diverted but also to the maturity of EfW technology compared to gasification/pyrolysis and MBT. Scenario 1a has the benefit of only one application for EfW compared to the decentralised scenario 1b with two EfW facilities.

The worst scoring scenario is scenario 1c (EfW with 30% recycling). This is due to the scenario achieving the lowest recycling rate but also to the higher public involvement required to achieve the 30% recycling with garden waste collection excluding kitchen waste.

Table 5: Socio-economic objectives – value performance[7]

Objectives	Criterion	Base case A –fortnightly collection	Base case B - weekly collection	Sc 1a - EfW	Sc 1b – decentralised EfW	Sc 1c – EfW + 30% recycling	Sc 2 – Gasification /Pyrolsis	Sc 3 – MBT (composting)
8. To provide local employment opportunities	Number of direct jobs created (jobs estimated)	0.00	0.21	0.48	0.64	0.27	1.00	0.78
9. To provide opportunities for public involvement /education	Potential for participation in recycling and composting (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10. To minimise costs of waste management	Overall costs (£million 2007 – 2032)	0.39	0.24	0.76	0.19	1.00	0.05	0.00
TOTAL		0.39	0.45	1.24	0.83	1.27	1.05	0.78
Rank		**7**	**6**	**2**	**4**	**1**	**3**	**5**

Table 6: Operational Objectives – Value Performance[7]

Objectives	Criterion	Base case A –fortnightly collection	Base case B - weekly collection	Sc 1a - EfW	Sc 1b – decentralised EfW	Sc 1c – EfW + 30% recycling	Sc 2 – Gasification /Pyrolsis	Sc 3 – MBT (composting)
11. To ensure reliability of delivery	Maturity of technology/markets	1.00	1.00	0.88	0.88	0.88	0.00	0.13
	Public acceptance/ achievement of planning permission	0.90	1.00	0.20	0.00	0.25	0.30	0.40
	Public involvement required (participation rate)	1.00	1.00	1.00	1.00	0.00	1.00	1.00
12. To conform with waste policy	Percentage of material recovered (%)	0.00	0.00	1.00	1.00	1.00	1.00	0.80
	Percentage of material recycled/composted (%)	0.35	0.35	0.35	0.35	0.00	0.47	1.00
	Percentage of BMW diverted from landfill (%)	0.00	0.00	1.00	1.00	0.94	1.00	0.94
TOTAL		**3.25**	**3.35**	**4.42**	**4.22**	**3.06**	**3.76**	**4.26**
Rank		**6**	**5**	**1**	**3**	**7**	**4**	**2**

[7] The scenario, which scores the highest, is best performing. A rank of 1 shows the best performing scenario, a rank of 7 shows the worst performing scenario. The results should not be regarded as a precise overall measure of performance; the two decimal places are retained only for consistency.

1.5 STEP 5 – Total valued performance and criteria weighting

The total value performance scores of the scenarios for each of the main objectives are summarised in Table 7 to give an overall measure of performance. This shows that scenario 1c (EfW with 30% recycling) performs best followed by scenario 2 (gasification/pyrolysis) with the Base Case A scoring the worst.

Table 7: Total value performance

Objectives	Base case A – fortnightly collection	Base case B - weekly collection	Sc 1a - EfW	Sc 1b – decentral. EfW	Sc 1c – EfW + 30% recycling	Sc 2 – Gasific./ pyrolsis	Sc 3 - MBT
Environmental	3.57	3.64	9.03	9.64	11.76	10.16	5.49
Socio-economic	0.39	0.45	1.24	0.83	1.27	1.05	0.78
Operational	3.25	3.35	4.42	4.22	3.06	3.76	4.26
Total	7.20	7.43	14.69	14.69	16.10	14.97	10.53
Rank	**7**	**6**	**3**	**4**	**1**	**2**	**5**

1.5.1 Criteria Weighting

The assessment so far has been undertaken on the basis that the appraisal indicators are of equal importance. As there are 24 indicators, it should be recognised that each contributes about 4% to the outcome of the appraisal. Decision-makers and/or stakeholders are likely to attach more importance to some indicators or criteria than to others. Some indicators may be of critical importance and could 'swing' the outcome of the appraisal whilst others may be of interest, but be of much less consequence. Applying 'weights' to the value performance information can assist in assessing the relative importance of indicators. The weighting factors used for the BPEO assessment for Warwickshire were derived as an average from the weighting factors set by the technical Officers from the five Districts and from the Finance Department and Waste Department of Warwickshire County Council. The weighting factor of the 12 main objectives set by the public in 5 consultation workshops has also been taken into account. The weighting factors for each individual party and the average for Warwickshire County Council are listed in Table 8 and are applied to the following tables.

Table 8: BPEO criteria weighting for Warwickshire

Objectives	Criterion	North Warwickshire	Nuneaton	Rugby	Warwick	WCC Waste	WCC Finance	Public Consul-tation	AVERAGE
1. To ensure prudent use of land and other resources	Resource depletion (avoided burden in million years) – *WISARD output*	4%	3.0%	4%	7%	5.0%	4%	4.50	4.53
	Landtake (hectares) *(performance score)*	2%	1.0%	1%	1%	3.0%	1%	4.50	3.00
2. To reduce greenhouse gas emissions	Emissions of greenhouse gases (000 tonnes equivalent of CO_2) – *WISARD output*	7%	5.0%	5%	10%	6.0%	7%	12.20	9.42
3. To minimise air quality impacts	Emissions which are injurious to public health (Human Toxicity Index) – *WISARD output*	6%	1.0%	3%	8%	4.0%	5%	2.68	3.59
	Air acidification (tonnes equivalents of H^+) – *WISARD output*	2%	1.0%	2%	6%	2.0%	2%	2.68	2.59
	Ozone depletion (tonnes equivalents of CFC-11) – *WISARD output*	2%	1.0%	2%	8%	2.0%	1%	2.68	2.65
	Extent of odour problems *(performance score)*	2%	1.0%	1%	1%	2.5%	1%	2.68	2.07
	Extent of dust problems *(performance score)*	2%	1.0%	2%	1%	2.5%	1%	2.68	2.16
4. To conserve landscapes and townscapes	Visual and landscape impacts *(performance score)*	3%	5.0%	2%	2%	4.0%	1%	6.20	4.52
5. To protect local amenity	Extent of noise problems *(performance score)*	4%	3.0%	6%	2%	2.0%	2%	2.70	2.91
	Extent of litter and vermin problems *(performance score)*	4%	2.0%	6%	2%	2.0%	2%	2.70	2.83
6. To minimise adverse effects on water quality	Eutrophication (million grams equivalents of PO_4) – *WISARD output*	1%	2.0%	2%	5%	2.0%	2%	5.30	3.79
	Extent of water pollution *(performance score)*	3%	4.0%	6%	5%	3.0%	2%	5.30	4.54
7. To minimise local transport impacts	Total Transport Distance (thousand kilometres)	3%	4.0%	4%	6%	7.0%	2%	3.10	3.69
	Proportion of non-motorway/non-dual carriageway (thousand kilometres)	4%	2.0%	2%	3%	4.0%	1%	3.10	2.84
8. To provide local employment opportunities	Number of jobs created (jobs estimated)	3%	1.0%	1%	2%	1.0%	2%	2.00	1.81

9. To provide opportunities for public involvement / education	Potential for participation in recycling and composting (%)	5%	6.0%	4%	3%	5.0%	4%	14.20	9.33
10. To minimise costs of waste management	Overall costs (£million 2007 - to 2032) - *WASTEFLOW*	9%	12.0%	5%	5%	10.0%	20%	7.00	8.56
11. To ensure reliability of delivery	Maturity of technology (performance score)	10%	8.0%	6%	6%	7.5%	9%	2.60	5.18
	Public acceptance/ achievement of planning permission (performance score)	5%	7.0%	8%	3%	6.0%	7%	2.60	4.33
	Public Involvement required (participation rate)	3%	10.0%	6%	3%	3.5%	3%	2.60	3.65
12. To conform with waste policy	Percentage of material recovered (%)	6%	5.0%	7%	5%	6.0%	7%	2.00	4.00
	Percentage of material recycled/composted (%)	5%	10.0%	8%	4%	4.0%	6%	2.00	4.08
	Percentage of BMW diverted from landfill (%)	5%	5.0%	7%	4%	6.0%	8%	2.00	3.92

Applying these weightings to the scores given above provides the following overall scores shown in Table 9.

Table 9: Overall weighted performance

Objectives	Base case A – fortnightly collection	Base case B - weekly collection	Sc 1a - EfW	Sc 1b – decentral. EfW	Sc 1c – EfW + 30% recycling	Sc 2 – Gasific./ pyrolsis	Sc 3 - MBT
Environmental	12.82	13.05	33.15	33.54	43.77	38.69	23.05
Socio-economic	3.30	2.46	7.39	2.77	9.05	2.20	1.41
Operational	14.13	14.56	18.36	17.49	13.29	14.76	16.97
Total	30.26	30.08	58.89	53.81	66.11	55.64	41.44
Rank	6	7	2	4	1	3	5

Table 9 shows that scenario 1c (EfW with 30% recycling) scores highest followed by scenario 1a (centralised EfW) and scenario 1b (decentralised EfW). The Base Case A and B with weekly or fortnightly residual collection score the lowest. In summary, the scenarios with thermal treatment are favoured and can form the BPEO for Warwickshire. The MBT plant with in-vessel composting of the organic fraction are seen to have higher environmental impacts within WISARD than thermal treatment facilities due to the composting component and lower energy generation. Therefore, the scenario adopting the MBT scores less favourably than the thermal conversion technologies.

Minimising overall cost and the maturity of technology are identified as the most influential objectives within the BPEO assessment. Therefore EfW scenarios perform well, because they combine overall lower costs of waste management with a generally high maturity of technology. Scenario 1c (EfW with 30% recycling) scores highest on minimising overall cost because no in-vessel composting facilities are needed, which is weighted as the most important objective. In addition, scenario 1c scores well on the environmental impacts related to planning issues due to the absence of in-vessel composting facilities.

1.6 STEP 6 – Sensitivity of overall scores

The above results show that weighting influences the overall scores. The weightings are measures of how important the various issues (criteria) are to the stakeholders in Warwickshire and there can be large differences between different groups such as environmental groups, operational staff and the members with responsibility for financial control. Therefore, it is important to assess how robust the findings are by looking at the impacts of variations in the weighting on the overall result.

We have run a model that varies the weightings of each of the criteria by 100% (i.e. between zero and double the values in Table 8), such that the robustness of the decision can be determined. Figure 5 the range of weighted scores for each scenario under the varied weighting values. Scenario 1a and scenario 1c display the highest scores under the varied weighted values although with a significant overlap of scenario 1b and scenario 2.

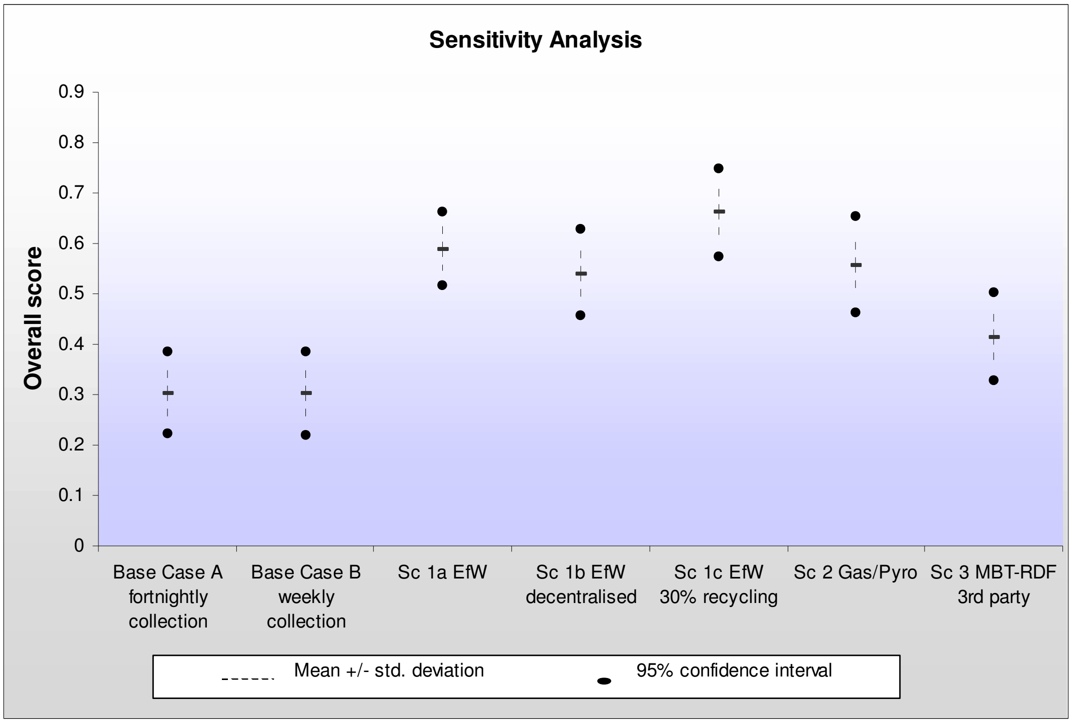

Figure 5: Sensitivity of overall scores

Further analysis can examine the ranking of the scenarios during the sensitivity analysis as shown in Figure 6. This does not alter the conclusions of the earlier analysis, but it increases the differential of scenario 1c over the other thermal options. However, this result only emphasises the need to optimise the costs when selecting treatment technologies as long as the other key aspects that form the BPEO are taken into account.

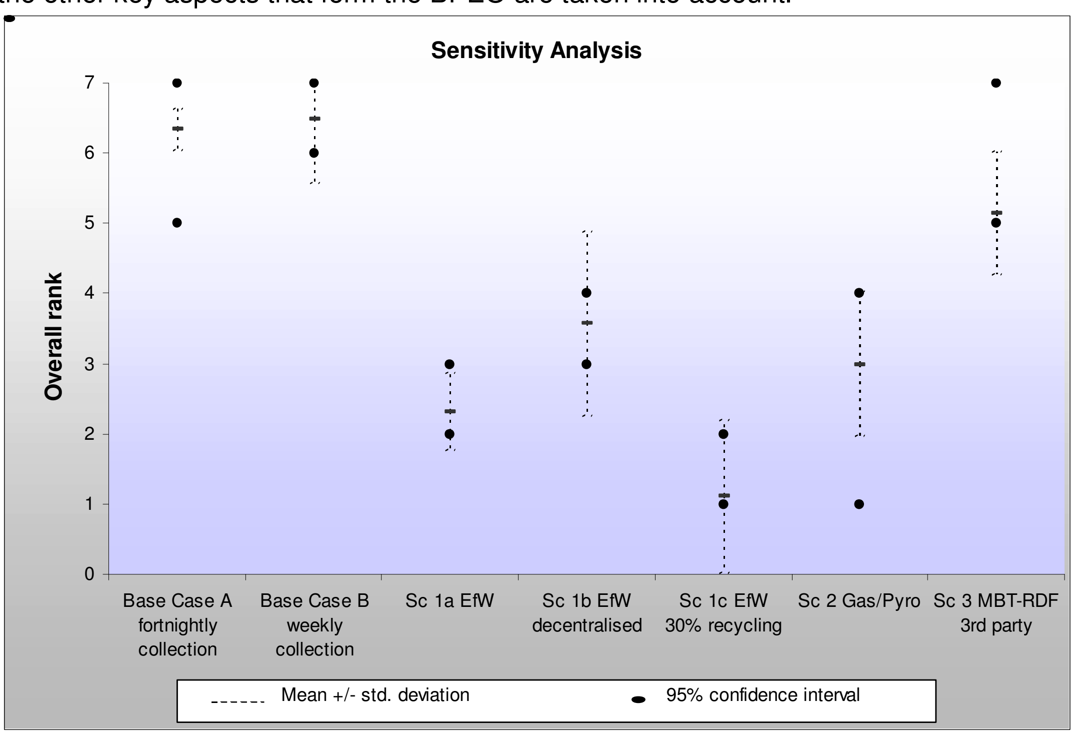

Figure 6: Variation in ranking during sensitivity analysis

1.7 Conclusions

To assess the BPEO for Warwickshire seven scenarios of various combinations of residual waste treatment and recycling activities have been evaluated against an agreed set of criteria. The principal variables for the scenarios were the choice of residual treatment facilities and the introduction of kitchen waste collection. The infrastructure to deliver these scenarios were evaluated and assessed against a range of criteria based on environmental, socio-economic and operational issues in line with government guidance. Weighting factors were applied to the assessments to reflect the relative importance of each criterion, which subsequently enabled overall scores for each scenario to be determined.

The analysis shows that scenario 1c (EfW with 30% recycling) is ranked the highest. The scenario is the highest ranked option in both the environmental and socio-economical objectives, however it performs lowest in the operational objectives due to lower recycling level and a higher need for public involvement. The higher environmental score is primarily due to the absence of in-vessel composting facilities and subsequently less environmental issues related to planning. The cost is slightly less than other scenarios due to not requiring additional in-vessel composting facilities.

However, it should be acknowledged that scenario 1c requires high public involvement to achieve the 30% recycling when kitchen waste is excluded. The experience of Daventry District Council indicates that it may be possible to achieve a high recycling rate with garden waste collection, but the performance depends on local factors such as education, public awareness of recycling, type of housing and also the waste composition. Compositional analysis can provide an indication of what recycling levels may be achieved by collecting garden waste at the kerbside. However, scenario 1c is preferred due to its high level recovery (including recycling) and it is this factor which provides a larger benefit compared to the risk associated with the required public participation rate.

Furthermore, scenario 1c performs best, because it has the lowest overall cost of waste management which was ranked the most important criteria by the Warwickshire authorities. However, this result only emphasises the need to optimise the costs when selecting treatment technologies as long as the other key aspects that form the BPEO are taken into account. The overall costs will be evaluated further within the tendering process which may also include in-vessel composting. Furthermore, the cost implications of not achieving or maintaining the anticipated recycling target in the long-term and the sensitivity to LATS values should be assessed within the tendering process. The sensitivity analysis undertaken in section 1.6. indicates that disposal cost will increase if the anticipated recycling target will not be achieved although the political risk of not achieving planning permission for a larger residual treatment facility also needs to be considered. The disposal costs are also sensitive to the market value of LATS.

The delivered BPEO waste management solution is not necessarily one of the scenarios assessed here, but the modelled scenarios are merely to illustrate the key policies that will be typified by the BPEO solution. Examination of the key aspects of the results shows that the most important elements of a BPEO waste management system for Warwickshire will include the following:

The use of the smallest number of waste management sites for delivering the service
Maximising energy recovery – consequently through thermal treatment as this provides the most energy per unit of waste
Low overall cost of waste management (including collection and disposal)
Reliable deliverability through the use of mature and established technologies
High potential for delivery (encompassing planning and public participation issues)

Maximising the utilisation of waste in a beneficial manner (i.e. recycling or recovery of materials)

These aspects are expressed predominantly in scenario 1c (EfW with 30% recycling) although if higher recycling levels are required, kitchen waste collection may also be necessary. However, the key aspects will be further considered in the procurement process for recycling and residual treatment technologies in order to provide the BPEO for Warwickshire. There are many other influences outside of this evaluation such as the ability of the market to deliver, additional funding options and the overall deliverability of any solution. Other funding streams (PFI, local performance agreements etc) are likely to be only supported if higher recycling is achieved and these funds may be sufficient to counteract the differences in this BPEO assessment.