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West of England Waste Management and Planning Partnership

Options Appraisal Summary Report

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1 INTRODUCTION

The West of England Waste Management and Planning Partnership (the Partnership) comprises Bath and North East Somerset Council (B&NES), Bristol City Council (BCC), North Somerset Council (NS), and South Gloucestershire Council (SG).

The Partnership is developing a Joint Residual Municipal Waste Management Strategy (JRMWMS) and a Joint Waste Development Plan Document (JWDPD). An Options Appraisal (OA) forms a stage in the process of developing and implementing the JRMWMS and the JWDPD. This Options Appraisal Summary Report summarises Sections 4, 6 7, 8 and 10 of the OA. For full details of the process the OA should be consulted.

Several potential technology options for the management of residual municipal waste produced within the Partnership were devised in consultation with Partnership Officers and the Member Project Board (which serves the Partnership). These technology options are shown in the table below.

Table 1.1: Options for the management of residual municipal waste within the Partnership

Option	Description	Acronyms
SQ	The Status Quo	SQ
PSI	Programmed Service Improvements	PSI
1	Energy from Waste (EfW)	EfW
2	Biological Mechanical Treatment + In-Vessel Composting of waste derived compost + 3rd Party Thermal Treatment of solid recovered fuel (SRF)	BMT + IVC + TT (3rd)
3	Mechanical Biological Treatment + 3rd Party Thermal Treatment of SRF + Landfill of stabilised output	MBT + TT (3rd) + Lf
4	Autoclave + Anaerobic Digestion of Fibres	AC + AD
5	Mechanical Treatment + 3rd Party Thermal Treatment of SRF + Anaerobic Digestion of waste derived compost + maturation of digested compost product	MT + TT (3rd) + AD + Mtn
6	Autoclave + Thermal Treatment of Fibre	AC + TT (gas)
7	Pyrolysis / Gasification (with mechanical fuel preparation)	MT + TT (pyrolysis/ gas)

These waste management technology options, and the SQ option, were compared to one another by scoring them against a series of decision-making evaluation criteria. These criteria evaluated the environmental, socio-economic, technical, and financial factors affecting each technology option. The application of decision-making evaluation criteria enables the Partnership to engage and involve stakeholders in the decision making process.

To provide a process that is transparent, accountable and robust, the selection of the evaluation criteria involved a wide range of stakeholders through consultation.

Stakeholders considered a long list of decision-making evaluation criteria with a view to short-listing and selecting the most representative and applicable criteria on which to assess the technology options. In addition, stakeholders further considered the relative weighting (i.e. relative importance) that should be applied to each criterion. This was done during a Criteria Consultation Day involving stakeholder groups.

The Member Project Board subsequently reviewed and considered the outcomes from the Criteria Consultation Day recommending the short-listed criteria and determining the relative weightings. The weighting for each criterion being assessed could then been used within the decision-making process as a means of determining which waste management option performed best.

2 OPTIONS APPRAISAL EVALUATION CRITERIA

Each waste technology option was evaluated against a series of environmental, socio-economic, technical and financial criteria.

To provide a process that is transparent, accountable and robust, the selection of the evaluation criteria involved a wide range of stakeholders through consultation. A wide range of stakeholder representatives were consulted at key stages of the Options Appraisal (OA) process, including participation at the evaluation criteria. In addition to the four Unitary Authority (UA) Executive Members on the Partnership's Member Project Board, appropriate Scrutiny Panel Councillors also took part. Representatives from umbrella organisations in the West of England were also invited for consultation, including environmental interest groups, waste industry, regional government and agencies, health trusts and parish councils, housing associations, pensioners' forums, residents' groups, citizens' panels and local strategic partnerships.

Stakeholders were asked to consider a long list of criteria with a view to short-listing and selecting the most representative and applicable criteria on which to assess the technology options. In addition, stakeholders further considered the weighting i.e. importance, that should be applied to each criterion. The Member Project Board subsequently reviewed and considered the outcomes from the Criteria Consultation Day recommending the short-listed criteria and determining the weightings. The weighting for each criterion being assessed could then been used within the decision-making process as a means of determining which waste management option performed best.

The acronyms for the technology options assessed are shown in the table below.

Table 2.1: Acronyms for the technologies assessed

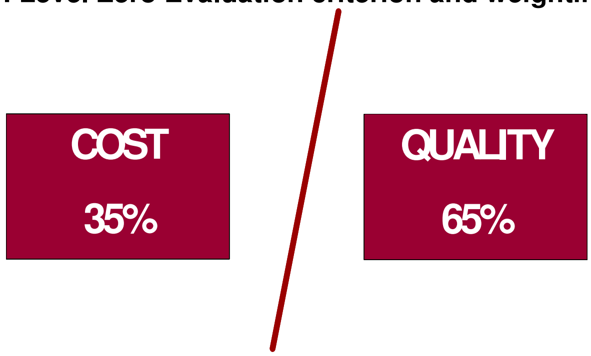
AD	Anaerobic Digestion
AC	Autoclave
BMT	Biological Mechanical Treatment
EfW	Energy from Waste
IVC	In Vessel Composting
LF	Landfill
MBT	Mechanical ~ Biological Treatment (systems)
MRF	Materials Recovery Facility (or Recycling or Factory)
MT	Mechanical Treatment
MTN	Maturation
SRF	Solid Recovered Fuel
TT	Thermal Treatment (pyrolysis, gasification, EfW etc)

The criteria selection and weightings process was carried out in a series of logical and accountable steps, the following schematics illustrate the criteria (Level Zero, One and Two), their weightings and their interrelationships.

2.1 LEVEL ZERO CRITERION

At Level Zero the Member Project Board proposed the weighting between Cost and Quality Criteria. Quality, which includes environmental, technical and socio-economic sub-criteria was provided with a 65% weighting, and cost a 35% weighting.

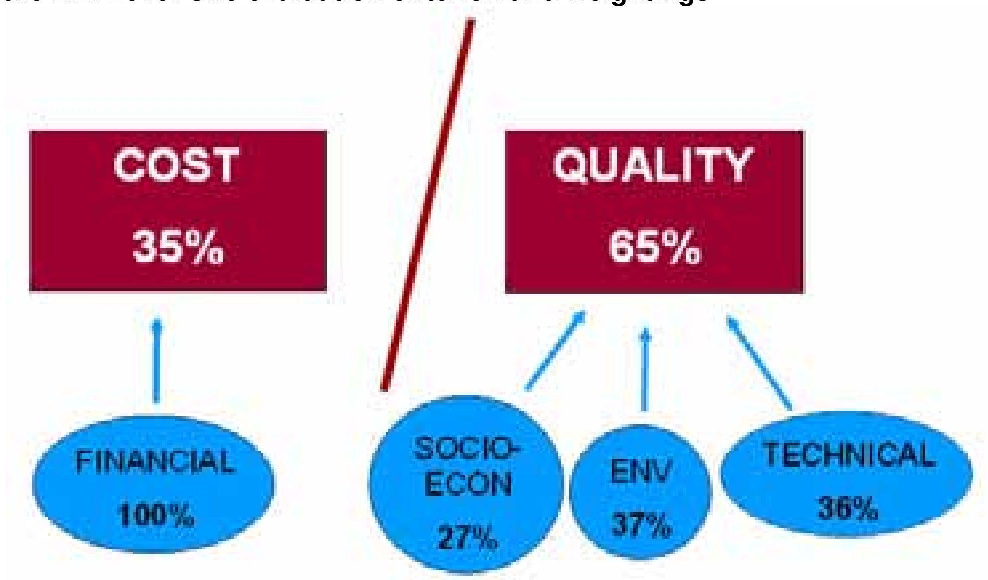
Figure 2.1: Level Zero Evaluation criterion and weightings for Cost and Quality



2.2 LEVEL ONE CRITERION

The Level Zero Criteria were then split down into Level One Criteria by the Member Project Board. The Board recommended the criteria and weightings for the Level One Criteria, and provided environmental, technical, and socio-economic criteria with a weighting of 27%, 37%, and 36% respectively. The financial criterion is the only Level One criterion under Cost, and is therefore provided with a weighting of 100%.

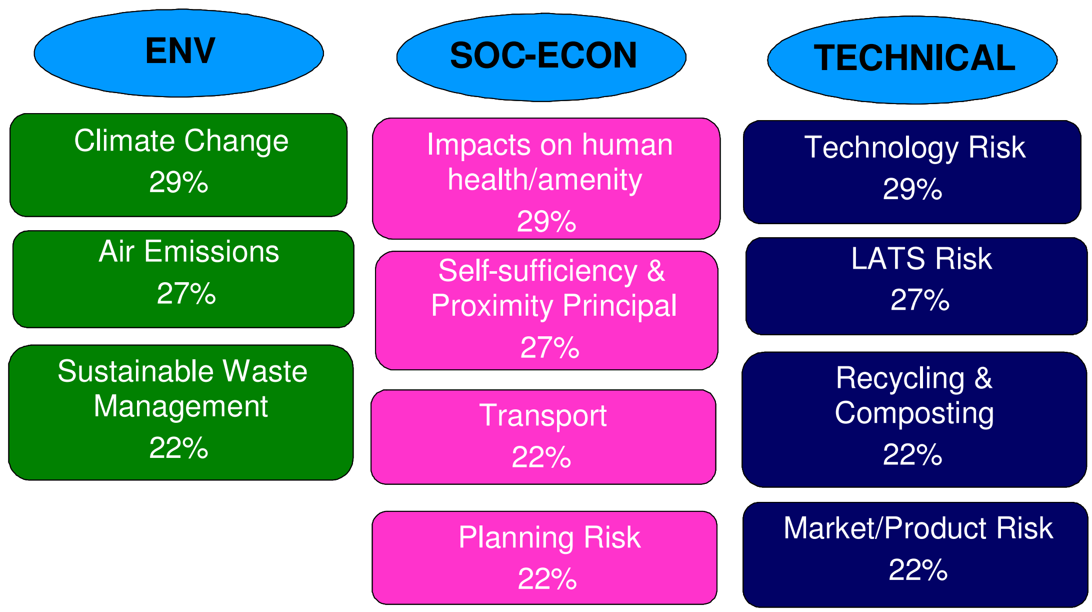
Figure 2.2: Level One evaluation criterion and weightings



2.3 LEVEL TWO CRITERION

Within the Level One Quality Criteria, the Member Project Board further determined the Level Two sub-criteria and the weightings as shown below. These sub-criteria are recommended in order to further focus and assist in the evaluation and consideration of the technology options.

Figure 2.3: Level Two Sub-Criterion and weightings



The Level Two Quality sub-criteria were then broken down into a series of indicators as a means of measuring the impact of the individual criteria. As shown below; further research was undertaken and the treatment technology and data was analysed.

Table 2.2: Level Two sub criterion indicators

Level 1	Level 2 Sub-Criteria	Indicators
Environmental	Climate change - energy balance - Emissions of greenhouse gases	CO_2 (carbon dioxide), CH_4 (methane), transport
	Air emissions	SO_2 (sulphur dioxide), NO_x (oxides of nitrogen), PM10 (particulate matter), Dioxins and Furans
	Sustainable Waste Management - Compatibility with waste hierarchy	% recycled, composted, recovered, landfilled
Socio-economic	Impacts on human health/amenity	Deaths brought forward, noise, odour, dust
	Transport	Vehicle movements
	Contribution to self-sufficiency and proximity principles.	Modularity of technology options, reliance on third party facilities
	Planning Risk	Public perception, number of operational facilities
Technical	Technology Risk	Proof of technologies, volume risk, composition risk, operational risk
	LATS risk - Ability and risk of diverting biodegradable municipal solid waste from landfill i.e. will the technologies meet the expectations of the Landfill Allowance Trading Scheme (LATS)	Quantity of biodegradable waste diverted from landfill
	Contributes to recycling and composting performance.	BVPI performance of technology options
	Market/product outlet risk	Risk of securing a market for products, and quality of those products

The breaking down of the evaluation process into Level Zero, One, and Two sub-criterion is considered an essential part of the OA process. This process enables stakeholders to consider which issues are the most important based on relevant local circumstances.

This process is also considered essential in the engagement of stakeholders and allows their considerations to be taken into account. It also allows the stakeholder groups to focus and explore particular areas of concern.

2.4 FINANCIAL SUB-CRITERION

Participants at the Criteria Consultation Day were asked not to consider the financial aspects of the technology options. In previous option appraisal projects, experience has found that including the cost of technology in the options often impairs an objective evaluation against other more qualitative criteria. It was therefore determined by the Member Project Board that the Cost criterion would be considered exclusively by the Member Project Board and after the consideration and evaluation of the Quality criterion. The outcome of the Cost Evaluation is summarised in Section 6 of this document.

The only Level Two sub-criterion taken forward under ‘Cost’ was:

- Financial Cost – cost of delivery of each option.

In selecting the short-list of technology options, a variety of factors were considered, including the market for technology processes, proof of technologies, robustness of suppliers, and commercial track record of suppliers.

3 ENVIRONMENTAL EVALUATION

The Level One environmental evaluation criterion comprises of three Level Two sub-criteria, these are:

- Climate change;
- Air emissions; and
- Sustainable wastes management.

Each of the Level Two sub-criteria were assessed using a number of indicators. The indicators used for each of the Level Two environmental sub-criteria are set out in the table below.

Table 3.1: Environmental Level Two Sub-Criteria and Indicators

Sub-criteria	Indicator
Climate change – energy balance, emissions of greenhouse gases	CO_2 (carbon dioxide), CH_4 (methane), transport
Air emissions	SO_2 (sulphur dioxide), NO_x (oxides of nitrogen), PM10 (particulate matter), Dioxins and Furans
Sustainable wastes management – compatibility with waste hierarchy	% recycled, composted, recovered, landfilled

3.1 CLIMATE CHANGE

The climate change impact is measured through a combination of carbon dioxide and methane emissions in order to identify the global warming potential.

In order to put the calculated emissions into context, data was taken from the National Atmospheric Emissions Inventory for 2004.

For climate change, the following parameters have been considered:

- Carbon dioxide (CO2);
- Methane (CH4); and
- Global warming potential (GWP).

The Global Warming Potential (GWP) is a measure of how much a given mass of greenhouse gas is estimated to contribute to global warming. It is assumed that methane has a GWP of 21 relative to carbon dioxide. This means that the production of 1 tonne of methane will have the same impact as 21 tonnes of carbon dioxide, and is therefore more damaging in respect of global warming.

For each technology option being assessed, the emissions provided within this study refer to the operation of the plant or plants required to process the waste produced within the West of England partnership region for one year (i.e. 2028).

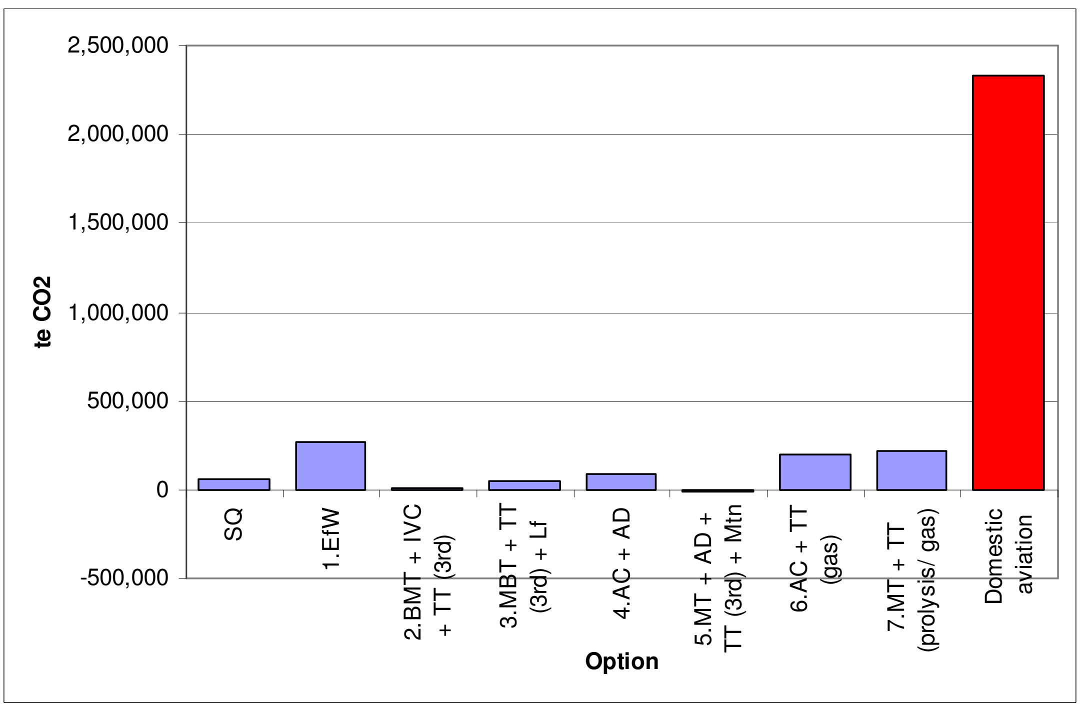
The emissions shown for each technology option do not include those associated with the transportation of waste. Emissions associated with the transportation of waste would be additional to those presented here. It was not possible to estimate the emissions from transportation since the location of potential waste management facilities was unknown during this study. The impact of transport was considered in terms of vehicle movements in the socio-economic evaluation criterion in Section 4 of this document.

In order to assist in the interpretation of the results, they are expressed in conjunction with emissions resulting from road transport and/or domestic aviation for the UK as a whole for one year.

3.2.1 CO_2 EMISSIONS

The carbon dioxide emissions for each waste management option being assessed are shown below.

Figure 3.1: CO_2 Emissions

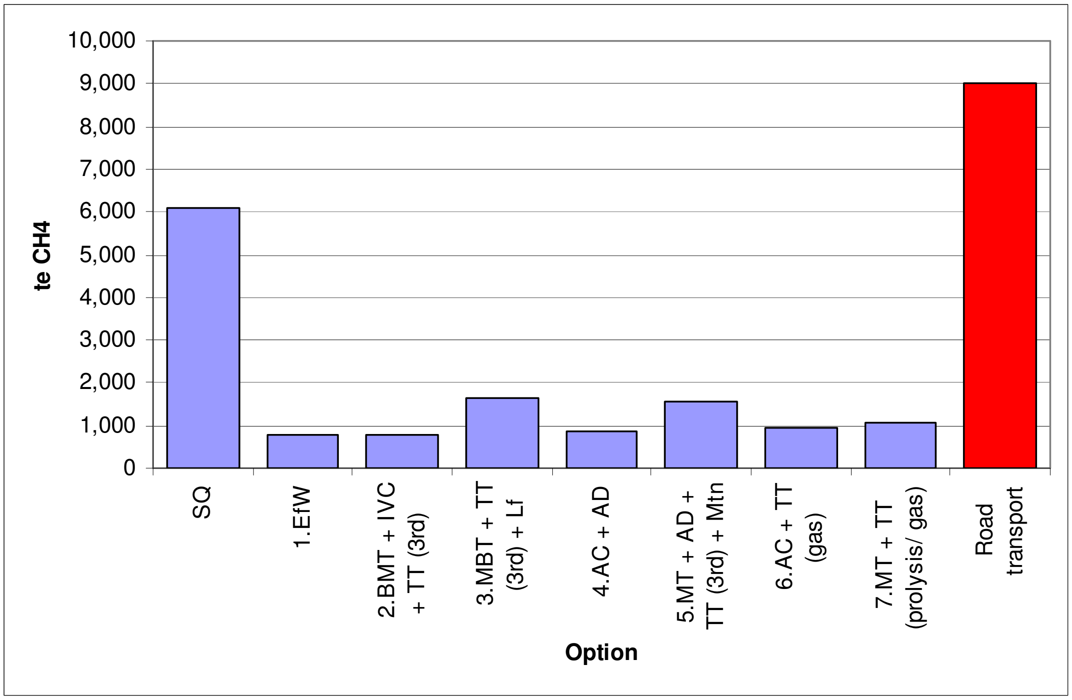


Status Quo, Option 6 and Option 7 have the highest carbon dioxide emissions due to the direct combustion of the waste and the resulting release of carbon. Options 2, 3 and 5 would benefit from reductions in emissions of carbon dioxide if the Solid Recovery Fuel (SRF) were to be burnt in a cement kiln. This SRF is formed when waste is dried through processing. If the SRF was not burnt within a cement kiln then the carbon dioxide emissions from Options 2, 3 and 5 would be significantly higher.

3.1.2 METHANE (CH_4) EMISSIONS

The methane emissions for each waste management option being assessed are shown below.

Figure 3.2: CH_4 Emissions

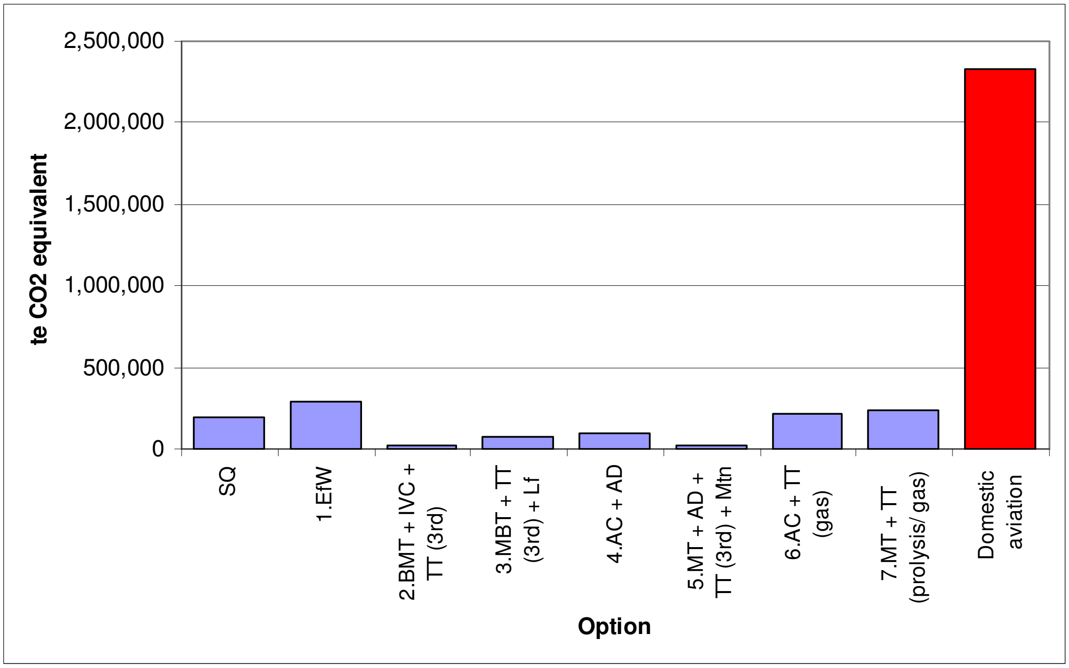


The highest methane emissions come from the landfill element of each option. Options with high landfill components therefore have high methane emissions in comparison to options that use landfill to a lesser extent. Therefore, Status Quo produces the highest amount of methane as the waste would continue to be landfilled with minimal treatment. Option 3 and Option 5 produce high emissions of methane compared to the other technologies.

3.1.3 GLOBAL WARMING POTENTIAL

The global warming potential for each option was calculated from the previous carbon dioxide and methane emissions.

Figure 3.3: Global Warming Potential



Despite methane being more damaging than carbon dioxide, a much greater quantity of carbon dioxide is released per technology option. However, Options 1, 6 & 7 have the highest Global Warming Potential even when methane emissions are taken into account.

3.2 AIR EMISSIONS

In terms of air emissions, the following emissions have been considered from each of the Options:

- Sulphur dioxide (SO_2);
- Oxides of nitrogen (NOx);
- Particulate matter (PM10); and
- Dioxins and furans.

It was assumed that all of the processes will be modern, well run, regulated processes. The comparison between options was therefore based on the mass emissions from each option.

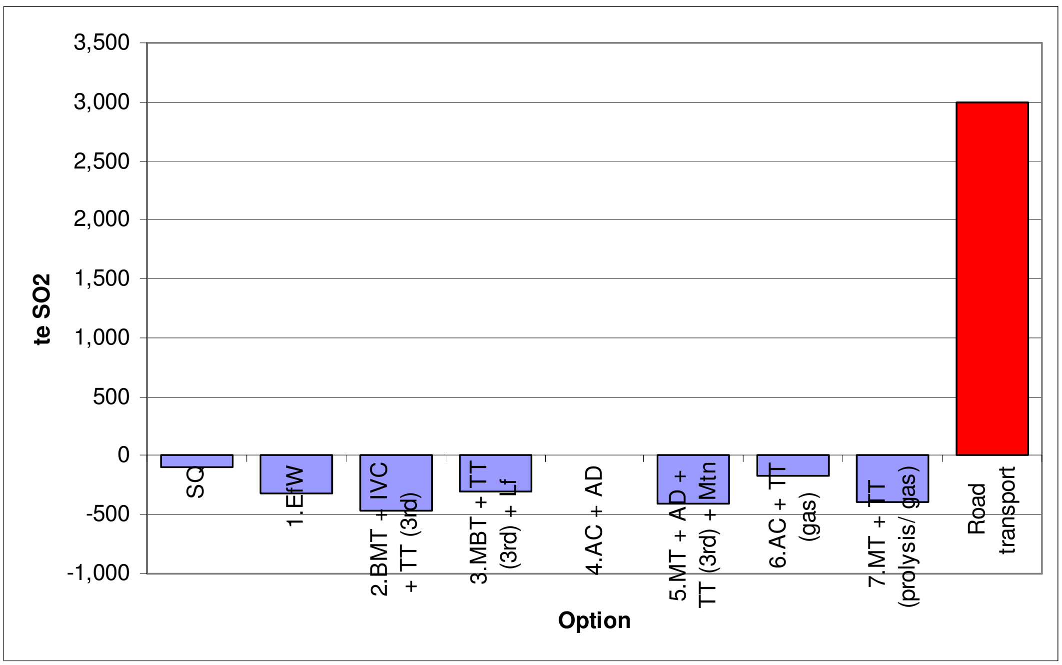
In order to put the calculated emissions into context, data was taken from the National Atmospheric Emissions Inventory for 2004. The context was provided, for

example, by comparison against emissions from road transport or domestic aviation. This was to enable an interpretation of the results.
Using the data and conclusion from the recent Defra1 study into environmental and health effects, this study assumes the processes will all be modern, well run and regulated and that there should be no harm to human health or the environment from the emissions.

3.2.1 SULPHUR DIOXIDE EMISSIONS

The sulphur dioxide emissions resulting from each option are provided below. The emissions for each technology option are presented to show the net amount of emissions i.e. where the technology involves a thermal process, it will displace the use of fossil fuels in producing electricity, steam or to fuel a industrial process for beneficial use. This is therefore shown as an overall benefit. Where a technology option does not displace the use of fossil fuel, it may be shown as a zero net effect.

Figure 3.4: SO_2 Emissions



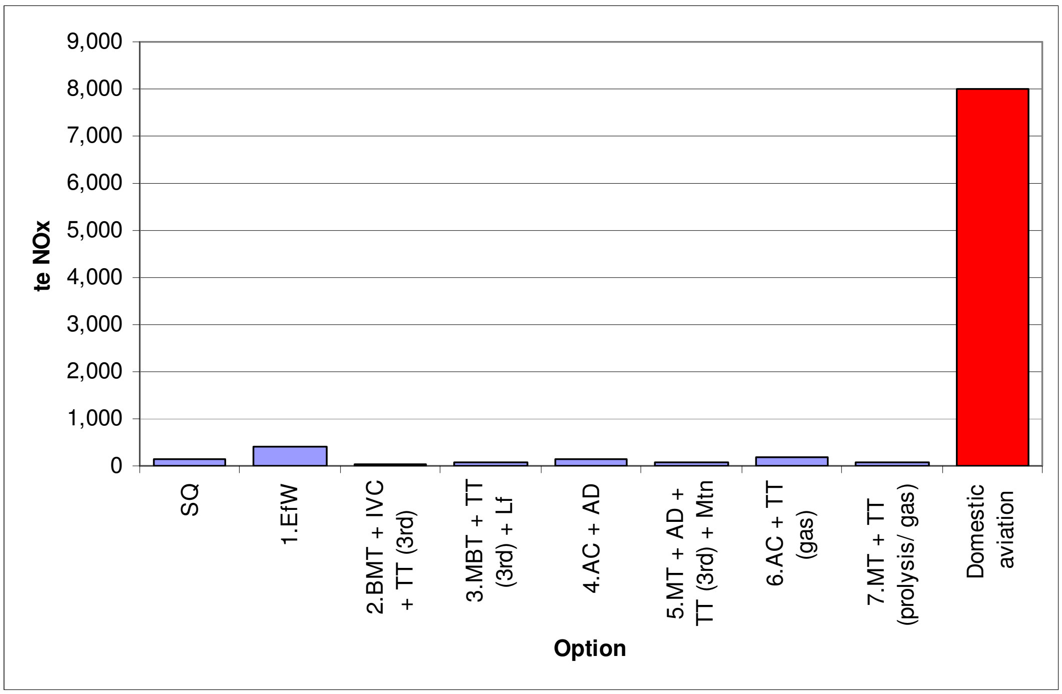
All of the options have approximately zero or a net saving of sulphur dioxide emissions (this is due to the relatively high sulphur emissions from the UK power sector). Options 2, 3 & 5, have the highest net savings (as SRF has a lower sulphur and carbon content than coal) but this depends on the SRF displacing coal and other fossil fuels from cement kilns. However, in the context of UK national emissions, sulphur dioxide emissions from the process are not that significant and should not be viewed as a differentiator between the options

[1] Defra, Review of Environmental and Health Effects of Waste Management: Municipal Solid Wastes and Similar Waste, 2004.

3.2.2 OXIDES OF NITROGEN EMISSIONS

The oxides of nitrogen resulting from each Option are shown in the following diagram. The emissions for each technology option are presented to show the net amount of emissions i.e. where the technology involves a thermal process, it will displace the use of fossil fuels in producing electricity, steam or to fuel a industrial process for beneficial use. This is therefore shown as an overall benefit. Where a technology option does not displace the use of fossil fuel, it may be shown as a zero net effect.

Figure 3-5: Oxides of Nitrogen Emissions

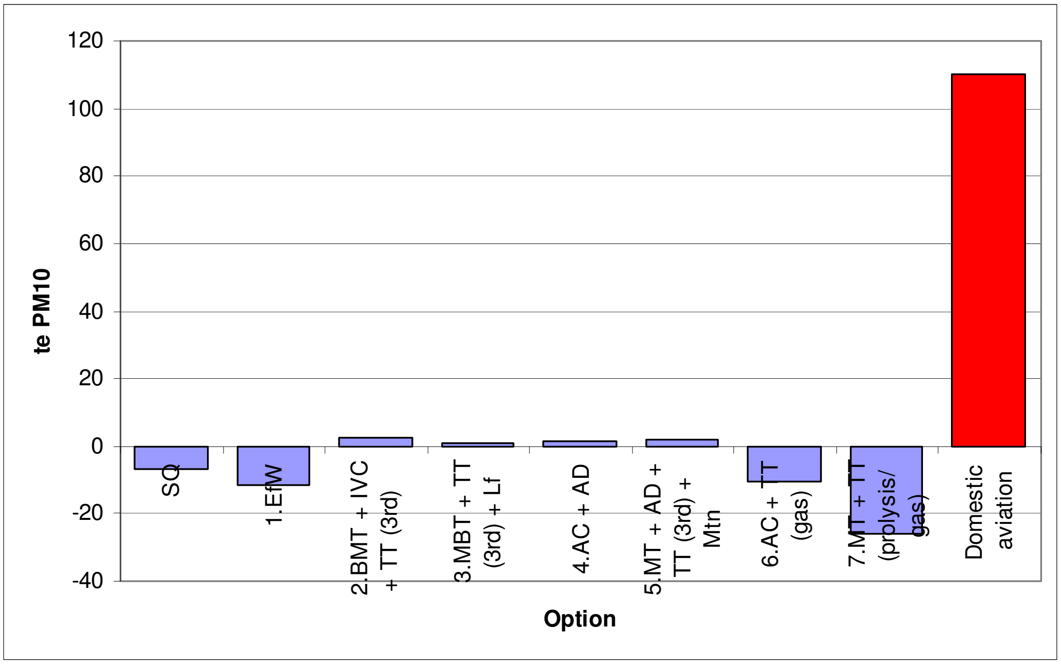


In terms of oxides of nitrogen, Option 1 has the highest emissions, but in relation to UK emissions of 1,320,000te/year, the overall emission quantities are not that significant. However, oxides of nitrogen can be a problem for local air quality due to traffic emissions.

3.2.3 PARTICULATE MATTER (PM10) EMISSIONS

The emissions of particulate matter for each technology option assessed are shown below. The emissions for each technology option are presented to show the net amount of emissions i.e. where the technology involves a thermal process, it will displace the use of fossil fuels in producing electricity, steam or to fuel a industrial process for beneficial use. This is therefore shown as an overall benefit. Where a technology option does not displace the use of fossil fuel, it may be shown as a zero net effect.

Figure 3.6: PM10 Emissions



The options have a mixed performance in terms of PM10 emissions, but all emissions were relatively low. The difference in emissions between the technology options is not significant. In comparing between technologies the quantity of particulate matter emissions should not be the only air emission parameter that is considered.

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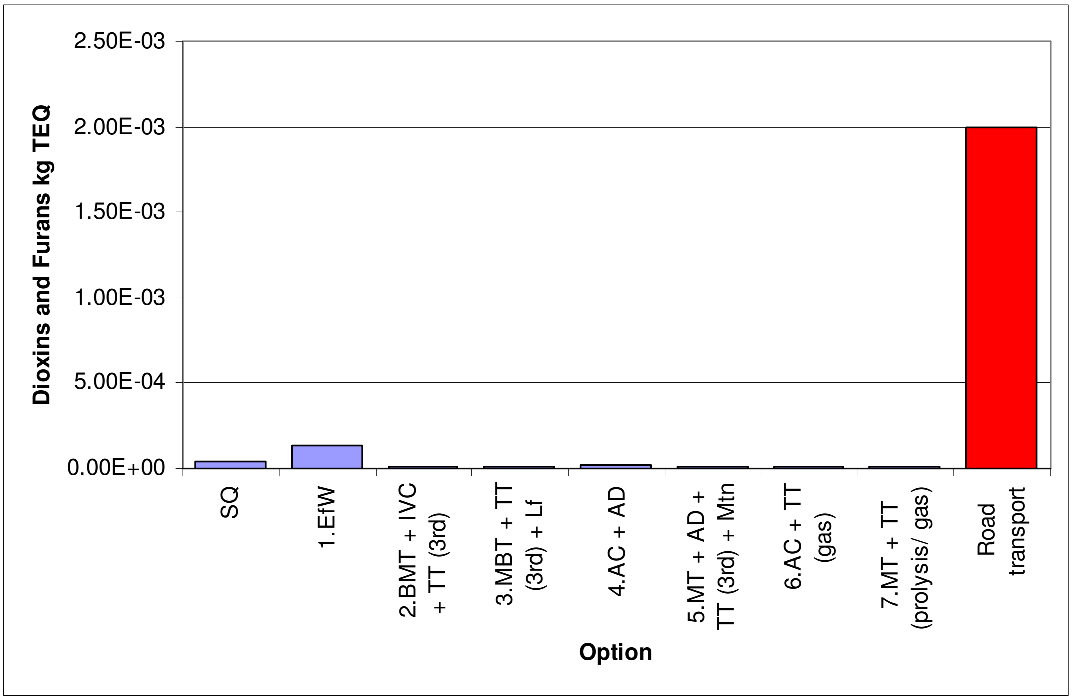
3.2.4 DIOXINS AND FURANS EMISSIONS

The emissions of dioxins and furans for each option being assessed are shown below.

Figure 3.7: Dioxins and Furans Emissions

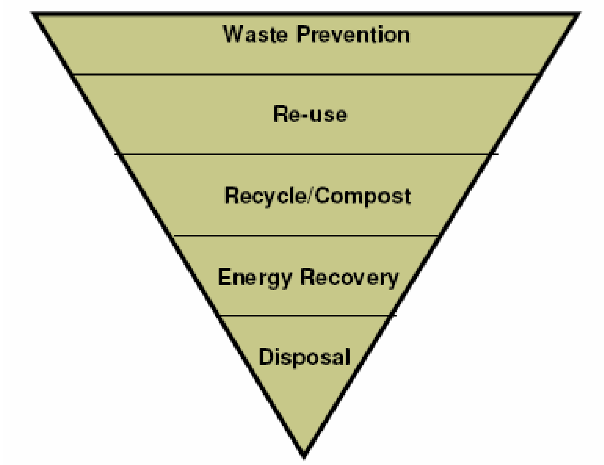


In terms of dioxins and furans, all emissions are low, but Option 1 has (compared to other options) the highest emission by at least a factor of three. Given the nature of the impact of dioxins and furans, these emissions are probably the most significant out of all of the emissions assessed.

3.3 SUSTAINABLE WASTE MANAGEMENT

The Sustainable Waste Management criterion was used to measure the technologies compatibility with the waste hierarchy. The waste hierarchy encourages waste to be managed in the order shown in the diagram below i.e. waste should be prevented or reduced at source as far as possible and only if it cannot be prevented, re-used, recycled/composted or recovered. Disposal to landfill is the final and least environmentally sound option, however if landfill is the only available option it should it be disposed of to landfill in a controlled manner.

Figure 3.8: Waste Hierarchy



In order to consider the sustainability of each technology option the proportion of the input MSW recycled, composted, recovered and landfilled was calculated as shown in the graph and table below. These figures were not based on BVPI (Best Value Performance Indicators)[2] definitions of recycling and composting, but actual tonnages of material physically recycled and composted, recovered and landfilled.

[2] Local Government Performance www.bvpi.gov.uk

Figure 3.9: The proportion of MSW recycled, composted, recovered, and landfilled using each technology option in 2019/20

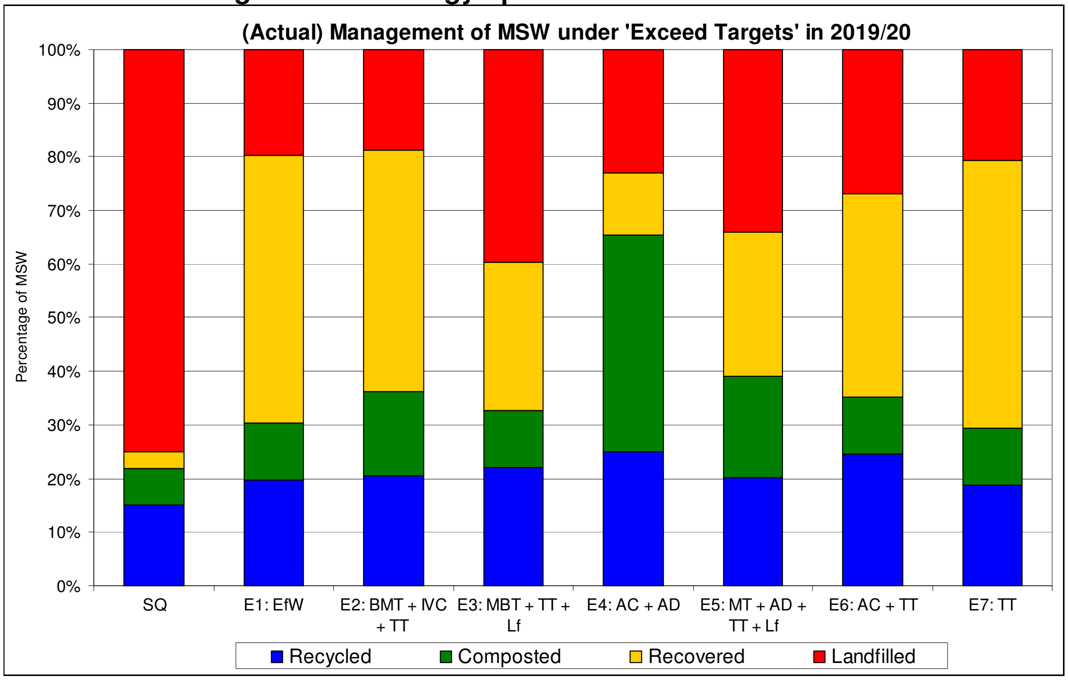


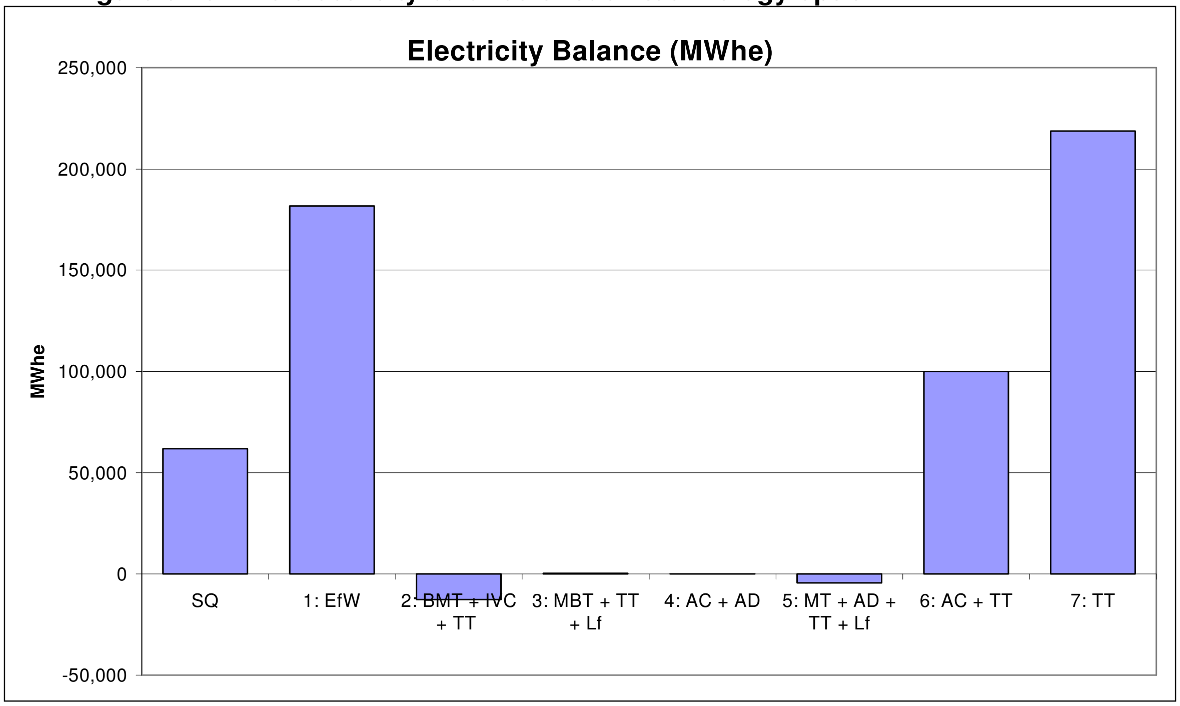
Table 3.2: The percentage of MSW recycled, composted, recovered, and landfilled using each technology option in 2019/20

2019/20	SQ	E1: EfW	E2: BMT + IVC + TT	E3: MBT + TT + Lf	E4: AC + AD	E5: MT + AD + TT + Lf	E6: AC + TT	E7: TT
Recycled	15%	20%	21%	22%	25%	20%	25%	19%
Composted	7%	11%	16%	11%	40%	19%	11%	11%
Recovered	3%	50%	45%	28%	12%	27%	38%	50%
Landfilled	75%	20%	19%	40%	23%	34%	27%	21%

The Status Quo produces the least sustainable option in terms of the waste hierarchy. Options 3 and 5 have a relatively high reliance on landfill compared to the other technologies. Option 4 recycles and composts the largest quantity of waste. Options 1 and 7 recover the largest amount of energy.

In order to include energy production in the assessment of recovery in the waste hierarchy, the electricity balance of each technology was also considered and is shown below for each option.

Figure 3.10: The electricity balance of each technology option



The positive nature of the energy balance under the Status Quo and for Options 1, 3, 6 and 7, indicates the process is a net generator of energy. It is assumed therefore, that there would be a saving in emissions from energy that would not be generated from the UK grid. Conversely, the negative nature of the energy balance for Options 2, 4 and 5 indicates the process is a user of energy and there would be emissions associated with this option from the generation of energy from the UK grid.

4 SOCIO-ECONOMIC EVALUATION

The Level One socio-economic evaluation criterion comprises of four Level Two sub-criteria. These are:

- Transport impacts;
- Contribution to self-sufficiency and proximity principles;
- Planning risk; and
- Impacts on human health/amenity.

Each Level Two sub-criterion was assessed using a number of indicators. The indicators used for each of the Level Two socio-economic sub-criterion are set out in the table below.

Table 4.1: Socio-Economic Level Two sub-criteria and indicators

Sub-criteria	Indicator
Impacts on human health/ amenity	Number of deaths brought forward per year
	Potential noise, odour and dust impact
Contribution to self-sufficiency and proximity principles	Maximum number of sites required.
	Can the technologies and solution deal with all waste streams and outputs within, or close to, the West of England Partnership boundaries?
Transport impacts	The number of HGV movements
Planning risk	The adopted and emerging planning policy framework
	Facilities that have been through the planning process and obtained planning permission
	Public perception

4.1 IMPACTS ON HUMAN HEALTH/AMENITY

This criterion considers the potential risks to human health and amenity deriving from the technology options. This criterion is measured using a number of different indicators including the number of deaths brought forward as a result of emissions by each waste technology per year. This indicator uses data which has been collected on behalf of Defra3. Other areas of waste management which could potentially impact on human health and amenity are noise, odour, and dust. Each of these impacts is also considered and assessments of those technologies which have the potential for greater impact have been identified.

The indicators used to assess this criterion are:

- Deaths brought forward per tonne of waste; and
- Potential for noise, odour and dust impact.

[3] Defra, Review of Environmental and Health Effects of Waste Management: Municipal Solid Wastes and Similar Waste, 2004.

4.1.1 DEATHS BROUGHT FORWARD PER TONNE OF WASTE

The data used to assess the risk of deaths brought forward per tonne of waste processed for technology options is taken from Defra and is shown in the table below. The data shows that 2.9 billion tonnes of residual municipal waste would need to be landfilled for one statistical death to occur. This data is based purely on information gathered on emissions to air. To place this in context, the hypothetical contract for the Partnership will manage approximately 17.9 million tonnes over 28 years.

Table 4.2: Data of deaths brought forward per tonne of waste processed

	Landfill	EfW	Composting	Anaerobic Digestion	Mechanical Biological Treatment	Pyrolysis/ Gasification
Deaths brought forward per tonne of waste processed	$2.9x10^{-9}$	$6.4x10^{-8}$	No data	$1.48x10^{-9}$	$1.82x10^{-8}$	$3.08x10^{-8}$

The assessment of the risk of the potential for deaths brought forward has assumed the following:

- "Facilities are assumed to be modern, well run, well regulated waste management facilities operated in line with current pollution control techniques" (PPS10)4;
- Risks are not site specific; and
- Risks are not specific to the region.

Data was not available for all elements of the technologies modelled. Where data was unavailable, for example, 3rd party thermal treatment, maturation and autoclave, a conservative approach was adopted by selecting appropriate comparative technology data from Defra.

It should be noted that when considering this indicator that the Defra document states that:

"The estimated health consequences information is appropriate to typical facilities which may be operate in the UK. Any assessment of an individual facility would need to take into account of the local circumstances and any known sensitivity to the emission studied in the Defra health and environmental impacts report."

The Defra report further states:

"In view of the margin of uncertainty in these estimates, the presently available data does not allow us to say that one option for managing MSW is better or worse than another in terms of health effects. Although these estimates are of moderate or poor quality they give a scale of health effects

[4] PPS10 Planning for Sustainable Waste Management

likely to be associated with emissions to air from waste management activities."

The risk assessment of deaths brought forward per tonne of waste processed was based on emissions to air. The risk assessment was calculated by:

- Deaths brought forward per tonne of waste x tonnage throughput for each element of the technology options

This gave a cumulative (tonnage throughput normalised) risk score for each technology option. The cumulative (tonnage throughput normalised) risk score does not however relate to number of deaths. The findings of this assessment are set out in the table below.

Table 4.3: Normalised scores for deaths brought forward per tonne of waste

Option		Cumulative (tonnage throughput normalised) risk score
SQ	SQ	14
1	EfW	225
2	BMT + IVC + TT (3rd)	177
3	MBT + TT (3rd) + Lf	140
4	AC + AD	77
5	MT + TT (3rd) + AD + Mtn	165
6	AC + TT (gas)	142
7	MT + TT (pyrolysis/ gas)	103

Based on this data, Option SQ is considered to have the least number of deaths brought forward per tonne of waste processed. Option 1, 2 and 5 are considered to have the most number of deaths brought forward per tonne of waste processed.

4.1.2 POTENTIAL FOR NOISE, ODOUR AND DUST IMPACT

The risk potential for noise, dust and odour problems was assessed using the risk matrix set out below. The risk matrix was used to assess the probability of the risk event against the impact if the event occurred. Each technology within the options was assessed using this risk matrix.

Table 4.4: Risk Matrix

IMPACT	**High**	Significant	Critical	Unacceptable
	Medium	Insignificant	Significant	Critical
	Low	Acceptable	Insignificant	Significant
		Low	**Medium**	**High**
		PROBABILITY		

The risk rating of each element of the technology was assigned a risk rating score which was based on the following scoring and risk definitions taken from the risk matrix.

Table 4.5: Scoring and risk definitions (taken from Defra, 2004)

Risk Rating	Score	Defra Terminology
Acceptable	1	No effect
Insignificant	2	Unlikely to be significant
Significant	3	Potentially significant impact, but could be controlled with mitigation
Critical	4	Impact can normally be controlled, but an issue at sites where design, engineering or operation falls below best practice
Unacceptable	5	An issue at all sites

The cumulative score for each element of the technology options was normalised against waste tonnage throughput per facility in each technology option to give a total risk score. The total risk score for each technology was combined to provide a cumulative (tonnage throughput normalised) risk score for each option. The cumulative normalised risk tonnage scores are presented in the table below.

Table 4.6: Normalised scores for noise dust and odour

	Option	Cumulative (tonnage throughput normalised) risk score
SQ	SQ	5,922,000
1	EfW	3,456,000
2	BMT + IVC + TT (3rd)	7,022,000
3	MBT + TT (3rd) + Lf	7,536,000
4	AC + AD	9,661,000
5	MT + TT (3rd) + AD + Mtn	8,822,000
6	AC + TT (gas)	7,002,000
7	MT + TT (pyrolysis/ gas)	4,133,000

Options 1 and 7 scored highest and were considered to be the options which were least likely to give rise to adverse dust, odour and noise impacts. These two options are both largely contained within a building which significantly reduces dust, odour and noise potential. Options 4 and 5 scored lowest, these options both involve composting which may take place outdoors which reduces the ability to minimise adverse dust, odour and noise impacts.

SUMMARY HUMAN HEALTH/AMENITY

The deaths brought forward per tonne of waste processed is not considered to be an accurate tool for assessing impact on human health, especially in light of the cautions included in the Defra report that the information was taken from.

The risk potential for noise, dust and odour problems is primarily related to the ability to contain the technology within a building. If the technology is housed then appropriate mitigation measures can be applied to reduce noise, dust and odour impacts. The only technology that could not be reasonably contained within a building would be landfill.

4.2 CONTRIBUTION TO SELF-SUFFICIENCY AND PROXIMITY PRINCIPLES

This criterion considers the contribution that each option would make to the self sufficiency and proximity principles.

The two indicators used to assess this criterion are:

- Maximum number of locations required; and
- Can the technologies and solution deal with all waste streams and outputs within, or close to, the Partnership boundaries?

This indicator assumes that options which include facilities that operate in modules provide greater opportunity to have sites in several locations. This should reduce the distance the waste would need to be transported and would help meet the proximity principle.

The two most significant elements of the residual waste disposal options which are likely to impact on self sufficiency and proximity principle are third party disposal of SRF and disposal to landfill. The key reasons for using these are: the limited landfill capacity within partnership boundaries; and, the existing location of potential 3rd party treatment of SRF through cement kilns.

Table 4.7: Scoring for fulfilling the proximity principle

	Option	Likelihood of fulfilling proximity principle	Maximum number of locations required	Reliance on 3rd party treatment of SRF?	Total SRF from 3rd party treatment (tones per year)
SQ	SQ	Low	1	No	n/a
1	EfW	Low	1	No	n/a
2	BMT + IVC + TT (3rd)	High	8	Yes	165,000
3	MBT + TT (3rd) + Lf	Med	3	Yes	103,000
4	AC + AD	High	8	No	n/a
5	MT + TT (3rd) + AD + Mtn	High	8	Yes	141,000
6	AC + TT (gas)	High	7	No	n/a
7	MT + TT (pyrolysis/ gas)	Med	4	No	n/a

It is worth noting that the maximum number of facilities is for residual waste only (i.e. dry-recyclables are not considered here). The Status Quo and Option 1 would require 1 facility for the management of residual waste and is therefore less likely to fulfil the proximity principle, because with a single facility waste is likely to have to be transported further from the point of arisings. In comparison, Options 2, 4, 5, and 6 would require a maximum of 7 or 8 facilities, and this has the potential to reduce transport cost and fulfil the proximity principle.

Options 2, 3 and 5 all rely on 3rd party treatment of SRF, and are therefore unlikely to fulfil the regional self-sufficiency principle, as facilities for the treatment of SRF are not likely to be within the Partnership boundary.

SUMMARY – SELF-SUFFICIENCY AND PROXIMITY PRINCIPLE

Overall the options which involve a high potential for facilities in a number of locations and do not involve 3rd party treatment of SRF or high reliance on landfill are likely to fulfil the self-sufficiency and proximity principles. Based on the findings of this assessment, Options 4 and 6 are most likely to fulfil the self-sufficiency and proximity principles.

4.3 TRANSPORT IMPACTS

The indicator used to consider transport impacts is the number of vehicle movements per year into and out of each of the residual waste treatment facilities for each of the technology options. This indicator was included because it provides an indication of the impacts each technology will have on congestion, road safety, noise and vibration, air quality and amenities. Emissions from transport have been considered under the climate change and air quality sub-criteria.

The number of HGV movements per year and per week is shown below. These movements are taken from contract year 28 when the technology option would be operating at its maximum proposed capacity.

Table 4.8: HGV movements in Contract Year 28 (2036/37) (rounded)

Option	SQ	1	2	3	4	5	6	7
HGV movements per year	26,000	30,000	41,000	45,000	50,000	39,000	49,000	31,000
HGV movements per week	500	580	790	870	960	750	940	600

It is shown that the SQ would give rise to the least number of vehicle movements because there are very limited additional movements of recyclates or residues from final disposal location. Whereas, Options 4 and 6, involve several different treatment operations resulting in the production of a number of different recyclates/residual wastes requiring transportation to different locations for further recycling or end use.

4.4 PLANNING RISK

The planning risk criterion considers the likelihood of obtaining planning permission for each of the technology options being considered. There are many factors which influence planning risk, many of which are site specific. At this stage, it has not been possible to consider these factors because the sites are not yet known. However, work is currently taking place as part of the preparation of the Joint Waste Development Plan Document to identify potential locations for waste management facilities within the Partnership. In addition many of the indicators that have been considered under the other socio-economic and environmental sub-criteria influence the planning process, including impacts on amenity and transport movements.

Planning risk considers the likelihood of obtaining planning permission for the technology option being considered. The indicators that have been used to present information on planning risk are:

- The adopted and emerging waste planning policy framework;
- Facilities that have been through the planning process and obtained planning permission; and
- Public perception.

The review of the planning policies of the Partnership revealed that there were no technology options being considered which have explicit policy opposition, or that do not meet general waste management facility policy. All technology options either had specific policy support for technology option or no explicit opposition.

The number of applications successfully processed within the UK for the past 5 years were assessed.

Table 4.9: Perceived Planning risk

	Option	No of facilities with planning permission in UK	Level of risk	Perceived level of concern
SQ	SQ	>1	Low	High
1	EfW	>1	Low	High
2	BMT + IVC + TT (3rd)	>1	Low	Med
3	MBT + TT (3rd) + Lf	>1	Low	Med
4	AC + AD	>1	Low	Med
5	MT + TT (3rd) + AD + Mtn	1	Med	Med
6	AC + TT (gas)	0	High	Med
7	MT + TT (pyrolysis/ gas)	1	Med	Med

SUMMARY – PLANNING RISK

There is considered to be limited distinction between options in terms of the local and regional waste planning policy framework.

As shown in the table, the Status Quo, and Options 1, 2, 3, and 4 have had more than one application approved and are therefore considered as being low risk options in terms of gaining planning permission. In comparison, Option 6 has had no applications for full scale plants successfully processed within the past five years and is therefore considered as high risk.

Pyrolysis/Gasification are not operating in the UK on a commercial scale for treating MSW, but pilot trials on MSW have been conducted on very small tonnage throughputs. A larger pilot plant to handle up to 30,000 tonnes per annum is due to commence operation by approximately 2008. There is a medium risk associated with the implementation of Options 5 and 7 since only one planning application has been successfully processed within the past five years.

The public perception indicator was evaluated through a literature review and by using professional judgement. Planning risk in terms of public perception was assessed by considering whether the option involved energy from waste (EfW) or thermal treatment (TT) and its reliance on landfill. Generally, all major waste management facilities give rise to an element of public concern. Status Quo and Option 1 were considered to have the highest planning risk in terms of public perception due to the reliance on landfill and due to the involvement of EfW, which is subject to greater national focus from national pressure groups. All the other options were considered to have a medium perceived level of concern.

5 TECHNICAL EVALUATION

The Level One Technical evaluation criterion comprises of four Level Two sub-criteria, these are:

- Technology risk;
- LATS[5] risk;
- Contributes to recycling and composting performance; and
- Market/product outlet risk.

Each Level Two sub-criterion was assessed using a number of indicators. The indicators used for each of the Level Two Technical sub-criteria are set out in the table below.

Table 5.1: Technical Level Two sub-criteria and indicators

Sub-criterion	Indicator
Technology Risk	Proof of technologies, volume risk, composition risk, operational risk, performance risk
LATS risk - Ability and risk of diverting biodegradable municipal solid waste from landfill i.e. will the technologies meet the expectations of the Landfill Allowance Trading Scheme (LATS)	Quantity of biodegradable waste diverted from landfill
Contributes to recycling and composting performance.	BVPI[6] performance of technology options
Market/Product Outlet Risk	Risk of securing a market for products, and quality of those products

5.1 TECHNOLOGY RISK

Assuming a satisfactory balance between cost and performance can be established, there are a series of additional risks that should be considered which apply to each facility of each technology option. This outline technology risk assessment considers risks that impact upon deliverability. This is in order to inform the evaluation of the technology options.

The risks that each technology was assessed against are as follows:

[5] Landfill Allowance Trading Scheme http://www.defra.gov.uk/environment/waste/localauth/lats/index.htm
[6] Local Government Performance www.bvpi.gov.uk

- Proof of Technology – number of other plants operating, performance of existing plants, references from other Authorities using the technology, supplier robustness;
- Volume risk – Flexibility of technology to changes in waste volumes;
- Composition risk – Flexibility of technology to changes in waste composition;
- Operational risk – Maintenance, plant utilisation, plant failure, operating costs will vary, durability of technology; and
- Performance risk – Ability of technology to divert biodegradable municipal waste from landfill i.e. will the technologies meet the expectations of the Landfill Allowance Trading Scheme (LATS).

These technology risks were all assessed in isolation, i.e.

- Risks are not site specific purely with the technology; and
- Risks not specific to the region.

For each of these technology risk parameters, the scoring for each technology option was carried out collectively by members of Jacobs and further presented at the scoring day for consideration by stakeholder members. This was conducted by Jacobs due to the specific technological issues associated with the various waste treatment options.

The technical risks detailed further below all relate to the eight technological solutions modelled.

Proof of technology:
Application of collective professional judgement based on the review of published information, knowledge of and experience with the technologies being evaluated.

Volume risk:
Low probability for volume risk applied to all options and all technologies. Negative volume risk i.e. volume increasing equating to a tonnage increase in line with capture rate modelling

Composition risk:
Low probability of waste composition changing, and this is the same for all options. Assumption on future composition taken into account through the Programmed Service Improvement (PSI) modelling option, which models the planned improvements in the future for source segregation performance of the Partnership above and beyond the SQ baseline).

Operational risk:
Probability of technologies failing to operate and the impact of this in terms of rectifying the defect or unplanned maintenance.

Performance risk:
Assessment based on risk of achieving specified LATS diversion.

Each technology option is considered and assigned a risk rating based on a simple three by three risk matrix (as shown in Section 4.1.2) that has been applied for this Options Appraisal (OA).

The cumulative score for each element of the technology options was normalised against tonnage throughput to give a cumulative (tonnage throughput normalised) risk score. The risk score for each technology within each technology option was combined to give the sum risk score per technology option. The results can be seen in the table below.

Table 5.2: Cumulative Normalised Risk based on tonnage score

	Option	Cumulative normalised risk tonnage score
SQ	SQ	3,455,000
1	EfW	4,804,000
2	BMT + IVC + TT (3rd)	5,945,000
3	MBT + TT (3rd) + Lf	5,945,000
4	AC + AD	7,549,000
5	MT + TT (3rd) + AD + Mtn	10,298,000
6	AC + TT (gas)	7,503,000
7	MT + TT (pyrolysis/ gas)	6,218,000

SUMMARY – TECHNOLOGY RISK

The higher the normalised score, the more undesirable the option is in terms of technology risk. Those options that are considered to be most ‘established’ within the UK (i.e. EfW and landfill) had a relatively low score in comparison to the other options.

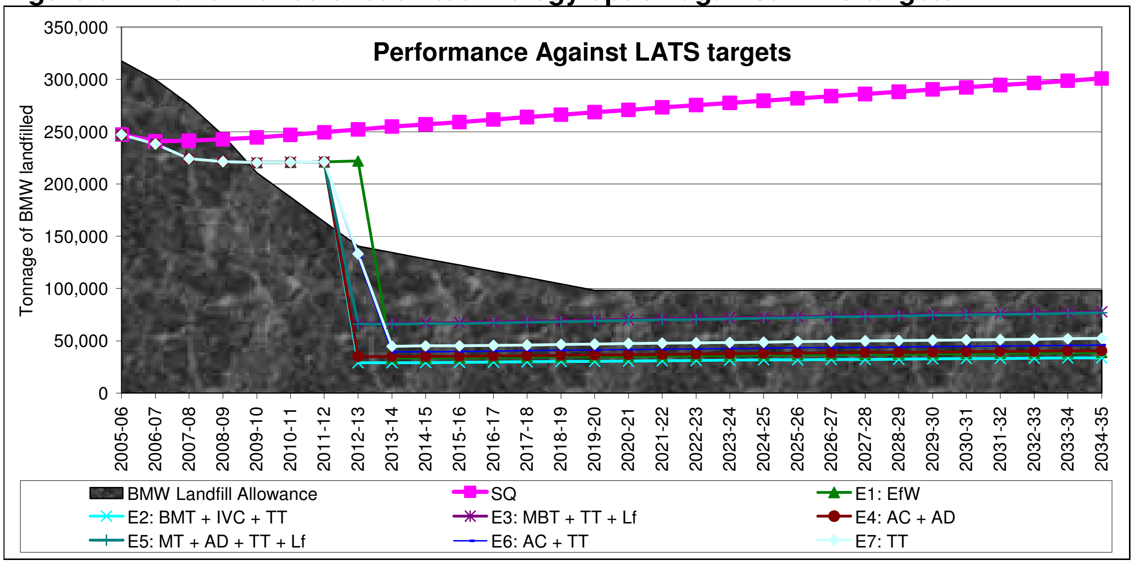
Option 5 was the least desirable option in respect of technology risk. This was made increasingly undesirable by the use of mechanical treatment, particularly in terms of operational risk and performance risk, both of which were evaluated as critical. In addition, proof of technology and volume risk was considered as significant for mechanical separation. Third party thermal treatment of SRF in Option 5 was also viewed as significant, therefore further reducing the desirability of this option. This also impacted upon the other options, but was less significant overall as the other risks associated with the different options were not as high.

In contrast, excluding the Status Quo, Option 1 was the most preferential option in terms of minimising technology risk. It was only the production of hazardous landfill material that was considered as a critical operational risk. The remaining technology risks were evaluated as either significant or acceptable for Option 1. The Status Quo option was the most desirable of all scenarios assessed in terms of technology risk. Excluding the three options identified above, all options were considered to have a medium technology risk associated with them.

5.2 LATS RISK

One of the primary outputs from the Technology Model is the performance of each technology option against the Landfill Allowance Trading Scheme (LATS) targets. These targets provide each local authority with a maximum tonnage of biodegradable waste allowable to landfill. If the authority landfills less than their prescribed quota they can sell there spare quota to other authorities and *vice versa*. This section presents the performance of the options in diverting biodegradable municipal waste (BMW) from landfill in order to meet LATS targets. It is assumed that LATS targets would maintain at the same level from 2019/20 onwards. The results can be seen in the figure below.

Figure 5-1: Performance of each technology option against LATS targets



The black marble area in the figure represents the maximum allowable quantity of BMW that can be landfilled in any one year. The coloured lines represent the quantity of BMW landfilled under the various technology options. The SQ scenario has been shown for comparison purposes.

All the technology options meet the LATS targets from 2012/13 onwards, however, there are slight differences in performance between all the options, with Option 2 modelled as landfilling the least amount of BMW and Option 3 landfilling the most. The table below shows these tonnages in greater detail.

It should be noted that none of the technology options meet the LATS targets for 2012/13. This is due to the time required to procure contracts and construct waste management facilities. With the exception of the SQ option, the shortfall subsides once these facilities become fully operational.

Table 5.3: Tonnage shortfall or excess against LATS targets (figures rounded)

	Option	Tonnage Shortfall or excess of BMW landfilled against 2019/20 LATS target (98,223t)	Total tonnes of BMW Landfilled
SQ	SQ	-169,200	267,400
1	EfW	63,400	34,900
2	BMT + IVC + TT (3rd)	67,900	30,400
3	MBT + TT (3rd) + Lf	28,600	69,700
4	AC + AD	61,800	36,400
5	MT + TT (3rd) + AD + Mtn	29,500	68,700
6	AC + TT (gas)	57,000	41,200
7	MT + TT (pyrolysis/ gas)	51,400	46,800

SUMMARY – LATS RISK

None of the options meet the LATS targets for the year 2012/13, however, this is due to the time required to procure contracts and construct the waste management facilities. Once the infrastructure has been constructed, all of the options, with the exception of the Status Quo, would exceed the LATS targets set for the Partnership from 2012/13 onwards.

While each of the technology options exceed the LATS targets from 2012/13 onwards, there are some variations between the options in the quantities of residual BMW sent to landfill. These variations should be taken into account as the smaller the quantity of BMW sent to landfill, the more excess LATS permits will be available to the Partnership, which could be traded with other authorities (that are not meeting their targets).

Based on the findings of this assessment Options 2 and 3 are estimated to landfill the least quantity of BMW and therefore could provide the Partnership with a greater quantity of tradable permits. The Status Quo option is estimated to perform poorest against the LATS targets.

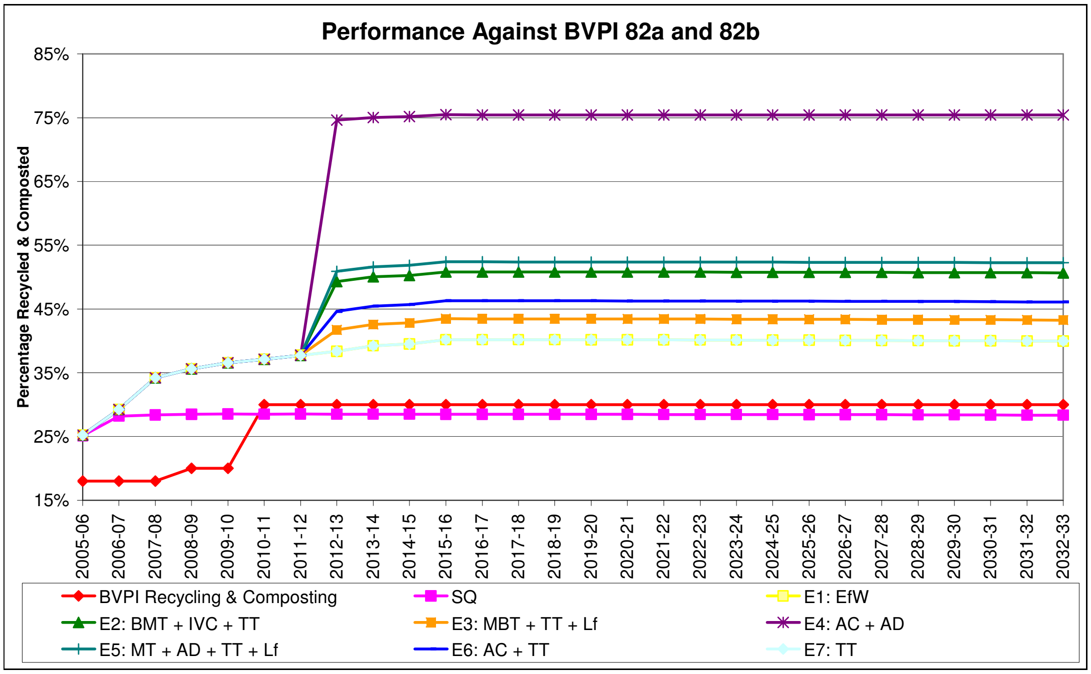
5.3 CONTRIBUTION TO BVPI RECYCLING AND COMPOSTING TARGETS

In terms of the quantity of materials recovered for recycling and composting (and therein performance against BVPI 82a (% recycled) and 82b (% composted)), five of the seven technology options provide additional BVPI performance (above and beyond the PSI baseline of 40.2%[7]). Options 2 and 7 do not provide any additional BVPI performance as it is assumed that metals would be recovered post thermal treatment, which does not meet the criteria laid down in the BVPI definitions of contributing to BVPI performance. Option 4 provides significant additional BVPI performance. This is because the total input to the AD facility is counted towards

[7] This figure represents The Programmed Service Improvements (PSI) scenario model which incorporates any planned improvements in future source segregation performance of the Partnership above the SQ baseline.

BVPI i.e. the 70% fibre output from the AC. The BVPI performance figures can be seen in the graph below.

Figure 5-2: Performances against BVPI 82a and 82b under Exceed Targets Scenario



Tonnages associated with BVPI targets

The percentages recycled and composed illustrated in the figure above are described in the table below.

Table 5.4: Tonnages associated with BVPI targets

	Option	BVPI Tonnage baseline	BVPI Tonnage added	Total BVPI %
SQ	SQ	161,900	0	28.3
1	EfW	228,400	0	40.2[8]
2	BMT + IVC + TT (3rd)	228,400	60,600	50.8
3	MBT + TT (3rd) + Lf	228,400	18,700	43.4
4	AC + AD	228,400	200,600	75.4
5	MT + TT (3rd) + AD + Mtn	228,400	69,500	52.4
6	AC + TT (gas)	228,400	34,700	46.3
7	MT + TT (pyrolysis/ gas)	228,400	0	40.2[9]

SUMMARY - CONTRIBUTION TO BVPI RECYCLING AND COMPOSTING TARGETS

Five of the options produce outputs that add to recycling and composting tonnages resulting in an increase in BVPI 82a and 82b performances. Option 4 was the most desirable option, primarily due the output material from AC being input into AD and therefore counting towards the BVPI.

The Status Quo option did not meet the BVPI targets, with a shortfall of approximately 66,500 tonnes per annum. This was due to a large proportion of the material being landfilled, and therefore not increasing recycling or composting.

5.4 MARKET/PRODUCT OUTLET RISK

In addition to the assessment of technology risks, the Partnership recommended a specific evaluation of market and product outlet risks. As previously discussed in the technology risk section, the market/product risks for each of the technologies was assessed using the same technique as for technology risk i.e. applying collective professional judgement based on the review of published information, knowledge of and experience with the technologies being evaluated. The same three-by-three risk matrix and risk ratings were applied.

The risk rating score for each facility of each technology option was normalised against tonnage throughput and combined under each technology option to give a cumulative (tonnage throughput normalised) risk score for each technology options . The results can be seen in the table below.

[8] Programmed Service Improvements (PSI) baseline
[9] Programmed Service Improvements (PSI) baseline

Table 5.5: Cumulative Market Risk Scores

Option		Cumulative (tonnage throughput normalised) risk score
SQ	SQ	494,000
1	EfW	450,000
2	BMT + IVC + TT (3rd)	1,788,000
3	MBT + TT (3rd) + Lf	1,788,000
4	AC + AD	1,329,000
5	MT + TT (3rd) + AD + Mtn	1,728,000
6	AC + TT (gas)	1,078,000
7	MT + TT (pyrolysis/ gas)	425,000

SUMMARY - MARKET AND PRODUCT OUTLET RISKS

All options that used third party thermal treatment (Options 2, 3, and 5) had a high market risk associated with their implementation. This is due to the uncertainty regarding markets for the use of SRF within cement kilns.

In contrast, those options that produced energy which would be made available for use in the national grid had a low market risk associated with them. This was due to energy markets being established, and an increasing demand for cheap energy sources within the UK.

6 COST EVALUATION

The cost of each technology option was modelled in an **indicative** Cost Model. This Cost Model used outputs from the Technology Model, in terms of projected facility throughputs.

Against a series of cost modelling assumptions, the CAPEX (capital expenditure), the OPEX (operational expenditure) and the potential revenues (sale of electricity produced, sale of spare processing capacity in the facilities) for each technology option was projected over the 28 year hypothetical contract to determine an indicative service cost for managing all municipal waste in terms of a Net Present Value (£)[10].

NPV is used to allow comparison of different expenditure profits on a common base time. This service cost included the costs for managing source segregated materials i.e. at kerbside, at household waste recycling centres (HWRCs) and at bring banks. Although, it excludes capital expenditure on infrastructure associated with managing these source segregated materials.

The NPV as currently calculated will not represent the actual cost to the authority of procuring that technology scenario, nor will it indicate the gate fee or unitary charge that may result from procuring that technology mix.

The Cost criterion 'costs of delivery of each option' was considered at a Member Project Board. The indicative Net Present Value (£) for each technology option is presented in the table below.

Table 6.1: Indicative Net Present Values of technology options

Option	Technology	NPV £ (rounded)	NPV £ per household (rounded)	NPV £ per tonne (rounded)
SQ	SQ: Status Quo	£939,316,000	£65.00	£52.00
E1	E1: EfW	£658,827,000	£46.00	£37.00
E2	E2: BMT + IVC + TT	£798,050,000	£56.00	£44.00
E3	E3: MBT + TT + Lf	£841,133,000	£59.00	£47.00
E4	E4: AC + AD	£781,237,000	£54.00	£44.00
E5	E5: MT + AD + TT + Lf	£852,881,000	£59.00	£48.00
E6	E6: AC + TT	£742,480,000	£52.00	£41.00
E7	E7: TT	£632,382,000	£44.00	£35.00

[10] NPV is an accounting method to represent the current value of future expenditure and income

The Member Project Board Members scored the technology options in the same way that scoring was undertaken at Scoring Consultation Day.

The NPV £ per household represents the indicative cost to manage municipal waste for each household in the Partnership averaged over 28 years.

Each household in the Partnership produces approximately 0.78 tonnes per year, or 780kg of waste per year, which is equal to 123 stone in weight!

The NPV £ per tonne represents the cost on a per tonne basis, averaged over the 28 years. During the 28 years approximately 17.9 million tonnes of municipal waste is estimated to have to be managed.