ENVIRONMENT DEPARTMENT

WASTE DISPOSAL

Appendix 4 Enviros Report – Modelling of Selected Waste Treatment and Disposal Scenarios

Appendix 5 Enviros Report – New Technologies for the Treatment of Residual Waste

Appendix 4

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STATES OF GUERNSEY – ENVIRONMENT DEPARTMENT

MODELLING OF SELECTED WASTE TREATMENT AND DISPOSAL SCENARIOS

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APPENDICES

EXECUTIVE SUMMARY

This report describes the modelling undertaken to assess the effects of a range of different waste management scenarios on extending the life of the existing Mont Cuet landfill site, which has been the main driver for work to date. Discussion is provided on the potential impacts on the timescales required for constructing and operating the different technologies. The modelling provides a means of comparing the effects of different waste treatment and disposal technologies and recycling scenarios. The aims of this modelling exercise are:

- An assessment of each scenario's effect on extending the life of Mont Cuet landfill site;
- The comparison of the different technologies and recycling scenarios;
- An understanding of the critical issues of timing and the influence on time scales for the different scenarios;
- The identification of total waste tonnages for treatment and disposal, to be dealt with by the States of Guernsey; and
- The comparison of indicative costs of each scenario

These aims are achieved through modelling a series of agreed scenarios, combining source segregation or co-mingled recycling and recovery with the selected generic treatment and disposal technologies, which are described in detail.

The main sources and quantities of wastes arising on Guernsey have been identified and data have been validated previously. The appropriate disposal routes for these wastes can be broken into two types, that which is diverted from disposal to some alternative use and that which requires disposal via landfill or treatment. Four potential destinations for the wastes that requires disposal are the existing Mont Cuet landfill site; facilities for Mechanical Biological Treatment (MBT); Advanced Thermal Treatment (ATT) and Energy from Waste (EfW).

The three treatment options (MBT, ATT and EfW) will create outputs that require disposal either at Longue Hougue or Mont Cuet landfill site.

The modelling shows that the various scenarios have the effect of filling the Mont Cuet landfill site to capacity in periods ranging from 2014 to beyond 2031 (the extent of the 25 year period covered by the model). The scenarios which show greatest effect on extending the life expectancy of the landfill are those with the greatest potential to divert

waste from landfill i.e. EfW with or without high levels of recycling and recovery. All other facility types generate significant amounts of material to be landfilled, with the result that the Mont Cuet landfill site will reach capacity significantly earlier.

Scenarios (Technology Comparison) Summary

Scenario	Recycling	Facility & Size	Life Expectancy of Mont Cuet landfill site	Waste diverted by facility
Baseline	Current	None	2014	0%
2	High	MBT 71,000 EfW 41,000	2029	79%
3a	Current	MBT 98,000 EfW 58,000	2023	83%
3b	None	MBT 114,000 EfW 68,000	2023	85%
4	High	EfW 71,000	Beyond 2031	100%
5	Current	EfW 98,000	Beyond 2031	100%
6	High	ATT 71,000	2024	67%
7	Current	ATT 98,000	2018	67%

Indicative, comparative costs for the various scenarios (year on year and total project costs) are expressed as both nominal costs (non-discounted costs with present day costs with inflation rate applied) and Net Present Value (NPV), the present value of the expected future cash flows, by using a discount rate of 5% on the nominal value.

The "Do Nothing" Option or Baseline Scenario will result in no active landfill sites being available on Guernsey within 10 years. Increasing recycling and diverting green waste will extend the life expectancy of Mont Cuet landfill site. However these schemes need to be introduced as soon as possible to increase the life expectancy of Mont Cuet landfill site. The modelled recycling scenarios are based on best practice examples in the UK and extend the life expectancy only when there is a facility operating to divert the waste. Increasing recycling and diverting green waste will also decrease the required capacity of any disposal facility. Using best practice for recycling and composting the smallest facility capacity is modelled to be 71,000tpa over the modelling period (starting with an input tonnage of 44,000tpa in 2012). The size of a disposal facility will increase if no recycling or diversion of green waste is carried out before wastes reach the facility. If this “no recycling before treatment” scenario is selected the facility capacity will be 114,000tpa over the modelling period (starting with input tonnage of 72,000tpa in 2012).

High Recycling with an EfW facility (Scenario 4) represent the cheapest residual waste treatment scenario when considering total costs. The total nominal cost is £219 million less and NPV is £87 million less than the Baseline Scenario. Current Recycling with an EfW facility (Scenario 5) represents the cheapest and most cost efficient of residual waste treatment scenarios when looking at cost per tonne. The nominal cost, for Scenario 5, is £68 per tonne, and NPV is £43. Scenarios 4 and 5 are the best performing in terms of extending the life of Mont Cuet landfill site. They are also the cheapest because some of the costs are offset by the revenue gained from the sale of energy from the EfW facility at £22 per tonne.

High Recycling with MBT and a small capacity EfW (Scenario 2) extends the life expectancy of Mont Cuet landfill site to 2029. This is a significant extension and Scenario 2 may be a viable option which should be investigated further. High or current levels of recycling with ATT (Scenarios 6 and 7) would be viable facility options if their outputs (char) were further treated, classified as inerts and could therefore be deposited at Longue Hogue. In that case Scenarios 6 and 7 would be more comparable with the EfW scenarios (Scenarios 4 and 5.)

However a number of caveats or provisos are necessary. These include: the limited availability of markets for recyclates; the uncertainties over track record of some technologies to deal with Guernsey’s waste; the additional costs of construction and operation on Guernsey; the market appetite for or interest in providing Guernsey with an appropriate; long-term waste management solution and the nature and extent of the comparative cost analysis carried out here. It is recommended that an outline business case and a “soft market testing” exercise are completed, to gather more reliable information. The procurement process is being investigated and much of the work for an outline business case and soft testing of the market has already been carried out, by the States of Guernsey and their consultants. The conclusions from the various reports and work streams should be drawn together and summarised in a formal report, taking account of all the factors which influence the decision on the future waste management strategy for Guernsey, and making a recommendation on the way forward.

ABBREVIATIONS

Listed below are frequently used abbreviations within this report:

Abbreviation	
AD	Anaerobic Digestion
A & H	Agriculture and Horticulture
ATT	Advanced Thermal Treatment
BVPI	Best Value Performance Indicators
C & D	Construction and Demolition
C & I	Commercial and Industrial
CA	Civic Amenity
EfW	Energy from Waste
ELV	End of Life Vehicles
ISL	Integrated Skills Limited
MBT	Mechanical Biological Treatment
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
NPV	Net Present Value
RDF	Refuse Derived Fuel
tpa	tonnes per annum
WEEE	Waste Electrical and Electronic Equipment
WIP	Waste Implementation Programme
WWTP	Waste Water Treatment Plant

1. INTRODUCTION

The States of Guernsey and its advisors have been actively considering the issues of the management and disposal of wastes, over a period of at least ten years. As part of this process, the design and the construction of the supporting infrastructure for a 50,000 to 70,000 tonnes per annum (tpa) mass-burn energy from waste (EfW) facility at Longue Hogue had been completed by May 2004.

However, the decision was taken, by means of a Requête or formal request dated 28 May 2004, to defer the contract for the construction and operation of the EfW facility pending review by an independent panel of experts (which became known as the Dadd Panel). Following the publication and review of the Panel's report the Environment Department recommended that the States should conduct further investigations on a number of points [Enviros 2006b & Dadd et al. 2005].

Enviros Consulting Ltd was appointed by the Environmental Department to review the current waste strategies which have been developed for the Island and to provide independent information regarding new technologies and procurement issues. Options for alternative methods for the management, treatment and disposal of parish or household waste, Commercial and Industrial (C&I) and Construction and Demolition (C&D) wastes which are currently or would otherwise be landfilled were to be identified.

Enviros was instructed to challenge the assumptions made during the process of selecting EfW facility as the preferred waste treatment and disposal option for Guernsey and to question the outcomes of any related decision-making procedures. A series of actions for Enviros to undertake (as part of Report 1) were identified these included:

1. Data acquisition including wastes composition. This should identify the nature and types of materials arising, allow direct comparison with the results of studies elsewhere and identify what could be achieved, indicating likely areas of uncertainty regarding current waste arisings;

2. Meeting with the States of Guernsey's Commerce and Employment Department to discuss economic issues and background. This should verify population and gross domestic product (GDP) data, grounds for growth predictions and associated sensitivities;

3. Market development for recyclates. Opportunities for the processing and reuse of recyclates on Guernsey or neighbouring

islands, to benefit from greater economies of scale should be evaluated.

Report 1 questioned the assumptions in the adopted Waste Management Plan, which was prepared by the States of Guernsey using Integrated Skills Limited (ISL) consultants from 1999 to 2004. Report 1 confirmed that the base waste data, assumptions and composition used in the compilation of the Waste Management Plan are justified and well documented [Enviros 2006b]. Changes which might occur when varying these base assumptions or compositions may have an impact on the waste flows. However they do not produce a significant impact on the tonnage input to the facility proposed in the Waste Management Plan.

Having established the overall validity of the base data for wastes, the assumptions were identified for predicting waste arisings in Guernsey until 2026 as part of the development of the Waste Management Plan [ISL, 2002b]. These assumptions and the resulting predictions, made using the ISL model [ISL, 2004], and the overall interpretation of the results contained in the Plan have been shown to be valid. The potential markets for organic wastes on the Island were also investigated.

Report 1 also describes the modelling undertaken to assess the effect of different waste management scenarios on extending the life of Mont Cuet landfill site and assesses the potential impacts of the timescales required for constructing and operating the different technologies. The modelling provides a means of comparing the effect of different technologies and recycling scenarios and the output of the total waste tonnage for disposal to be dealt with by the States of Guernsey.

1.1 Aims

The aims of this modelling exercise are:

- An assessment of each scenario's effect on extending the life of Mont Cuet landfill site;
- The comparison of the different technologies and recycling scenarios;
- An understanding of the critical issues of timing and the influence on time scales for the different scenarios;
- The identification of total waste tonnages for disposal (after treatment) to be dealt with by the States of Guernsey; and
- The comparison of indicative costs of the facilities for each scenario

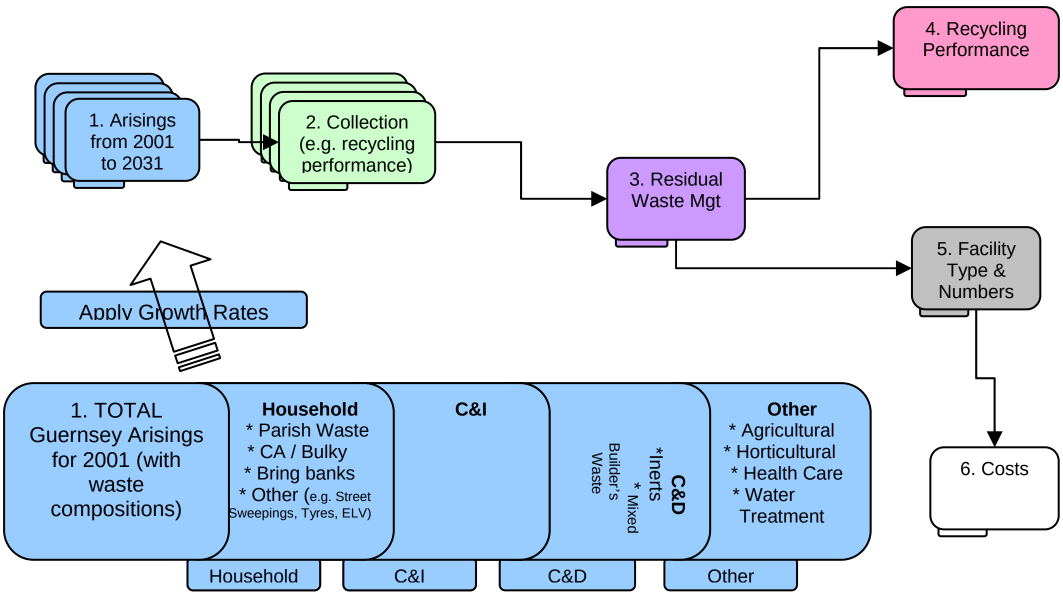
These aims are achieved through modelling a series of agreed scenarios, combining source segregation or co-mingled recycling and recovery with the selected generic treatment and disposal technologies, which are described in more detail in Section 2.3.

1.2 Methodology

Enviros has developed a materials flow model to aid waste management decisions by allowing the user to predict future waste arisings, flows and destinations of waste. The model, which has been adapted specifically for Guernsey, uses a range of base data including: waste arisings from 2001 (known as the base year); waste compositions; recycling levels; and growth rates. The model was also calibrated using information for 2004 on waste arisings, recycling levels and inputs to Mont Cuet. These data are used to predict the flows of waste (including the tonnage of waste disposed of to landfill) up to 2031.

A flow chart of the methodology is shown schematically in Figure 1 .

Figure 1 Flow Chart of Methodology



1.2.1 Inputs

The waste growth rates and compositions are applied to Guernsey's waste arisings for 2001 to estimate future total waste arisings. The requirements of selected material collections, treatment and disposal facilities are applied to the model to demonstrate possible courses of action and their impacts on the longevity, capacity or life expectancy of the Mont Cuet landfill site.

1.2.2 Baseline Scenario

The 2001 recycling performance is incorporated into a Baseline Scenario, and calibrated using further actual recycling performance data for 2004. This scenario is used as the basis for the other scenarios and provides a level against which the other scenarios can be compared.

The Baseline Scenario provides a forward prediction of recycling performance as a percentage of total waste (assuming 2001 practices continue) and a residual waste tonnage to landfill. The tonnage predicted to be disposed of to landfill is compared to the remaining available landfill capacity at Mont Cuet landfill site.

1.2.3 Other Scenarios

The other seven scenarios were modelled by making assumptions regarding recycling performance to create a “current recycling”, “high recycling” and “no recycling” situation (see Chapter 2 and Appendix 4). In addition potential residual waste management treatment facilities were selected with estimated values for start year (2012) and operating capacities, taking account of the procurement and build period and the tonnage of waste likely to be available for or requiring treatment.

1.2.4 Outputs

The outputs from the modelling of each scenario are a series of graphs and tables demonstrating total waste arisings and the effects of recycling and composting performance for household[1] and total Guernsey waste[2] arising, waste to landfill and the implications for remaining landfill capacity on Guernsey at Mont Cuet landfill site.

1.2.5 Costs

Following finalisation of the predictions for material flows, the next step is an evaluation of the facility costs for each scenario. The cost modelling considers the capital and operating expenditure associated with each of the residual treatment facilities and landfill. Revenue from recovered energy and sale of recyclates from the facilities for each scenario is also included. The cost modelling allows a comparison of facility costs between the scenarios. Collection and transport costs have

1 Guernsey does not have the same definition of household waste as in the UK. In this report Household waste is as defined in the UK by Best Value Performance Indicators (BVPI) and includes Parish and Civic Amenity Waste (see later discussion) [Enviros 2005].

2 Total Guernsey Waste includes parish, CA waste, C&I, C&D and other non-household wastes. [Enviros 2005]

not been included because they are assumed to be similar for all scenarios. In addition no costs or revenues have been assessed for the separate recyclates, green diversion or inerts that are separated from the residual waste prior to entering a treatment facility. (See Chapter 4)

1.3 Base Data

The base data are crucial to the modelling exercise because they form the basis on which all future predictions are made. Enviros has already confirmed predictions of previous ISL model waste arisings for 2004 by comparison with actual waste arisings [Enviros 2006b] from various sources. The base data for 2001 (see Appendix 1) were used to compile the model and check predictions with the ISL model. The Enviros model was then calibrated using “actual waste arising data for 2004” and updated recycling and recovery rates. The 2004 data are included in Appendix 2.

The model was calibrated so that in 2004 Mont Cuet accepted 57,108 tonnes of waste (see Table 1). The waste arisings information from previous reports was utilised, with additional detail from more recent data (see Appendix 2). All the data on weights for recycled waste for 2004 have been included in the model.

Table 1 Inputs to Mont Cuet Landfill Site in 2004

Categories of Waste in to Mont Cuet	**Tonnes in 2004**
Household waste (parish, bulky and CA)	20,585
Commercial and Industrial waste	24,609
Asbestos and Hazardous	360
Construction and Demolition[3]	8,913
Others non-household	2,641
Total[4]	**57,108**

Site preparation material such as that used for haul road building on the landfill site and daily cover material has not been included within the 57,108 tonnes of waste into Mont Cuet landfill site. An additional 17, 672 tonnes of site preparation material was used at Mont Cuet landfill site in 2004.

1.4 Waste Arisings

Using the base data on waste composition and assumptions on waste growth rates, waste arisings are predicted for a 25 year period[5] from the start date of the modelling exercise (2006). Forecasts are made up to 2031 for:

- Household waste[6];
- Commercial & Industrial waste;
- Construction & Demolition waste; and
- Other non-household waste (this includes agricultural and horticultural, healthcare, end of life vehicles and tyres).

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3 C&D waste is residual material from skips. Iinerts have already been diverted to Longue Houge or Ronez. This is not site preparation material.
4 57,108 tonnes is directly from the weighbridge records and excludes site preparation. Other reported figures vary by around 500 tonnes due to further extraction of metals at the landfill face.
5 The previous waste strategy was for a 25 year period (from 2001 to 2026) [ISL 2002]. However since this exercise was undertaken in 2006, the 25 year duration will continue up to 2031.
6 As discussed in earlier report [Enviros 2006b] Household waste includes parish and CA waste.

In addition to the current waste streams arising, there is a possibility that a new Waste Water Treatment Plant (WWTP) will be commissioned and produce a solid waste stream requiring disposal. Since construction has not yet started on the facility, it is not known if, and when the facility will be operational. However, to address the possible impacts of this waste stream, for the purposes of the modelling exercise, it has been assumed that the WWTP will be operational from 2010 producing a solid organic output of around 1,000 tpa which is to be disposed.

1.5 Waste Composition

The waste composition values used to predict future waste arisings by type are given in Table 2.

Table 2 Waste Compositions[7] (Percentage by weight)

	Household Residual [8]	CA Site[9]	C&I[10]	C&D[11]	Other non-household[12]
Glass	12	1	2	1	0
Paper & card	37	4	15	1	0
Metal	4	9	25	5	15
Plastic	12	1	10	1	2
Textiles	4	2	5	1	0
Green waste	1	46	2	2	34
Other Organics	17	10	15	0	41
Timber	0	8	0	5	0
WEEE[13]	0	0	0	0	0
Potentially hazardous	0	0	0	0	0
Miscellaneous combustibles	4	6	10	0	0
Miscellaneous-non combustibles	2	13	16	85	0
Hazardous waste	0	1	0	0	8
Fines	7	0	0	0	0
Total	100	100	100	100	100

7 Compositions verified by Environmental Department of the States of Guernsey (24/4/06)
8 Source: Average of Guernsey's waste composition [WRC 1996] residual composition adjusted to include collected recyclates
9 Source: CA Residual Waste Composition [Eunomia Research et al. 2001] adjusted to ensure the modelling reflects practices on the Island and green waste collected at Chouet.
10 Source: Guernsey Waste Model [ISL 2004].
11 Source: From Guernsey Waste Model [ISL 2004], adjusted with 50,000 tonnes of inerts (for Ronez) and the bulk analyses results conducted by the States of Guernsey, Department of the Environment Guernsey in 2001 to define the composition of "other" category.
12 Source: Composition calculated by the known composition and items within these waste streams
13 WEEE, Waste Electrical and Electronic Equipment

1.6 Collection Arrangements

The collection component of the model is split into different sections to represent the different collection methods which could be employed on the Island. The various different collection methods modelled that are used or could be used in the future, are:

- Kerbside - dry recyclables and kitchen organics will be collected from the kerbside. (Guernsey does not currently provide this service);
- Bring - bring banks provided across the Island collecting glass, paper, cans and textiles (Guernsey already provides this service);
- Civic Amenity (CA) - green and bulky waste delivered to a site, (similar to a CA site in the UK) for recycling (Guernsey already provides this service);
- Commercial & Industrial - both recyclates and residual waste are collected (Guernsey already has this service – could be expanded);
- Construction & Demolition –
    - inert C&D waste delivered to Longue Hougue for land reclamation
    - mixed C&D wastes disposed of in Mont Cuet landfill site with sorting via Materials Recovery Facilities (Guernsey already provides this facility); and
- Other non-household including agricultural & horticultural; healthcare; ELV; tyres; and water sludge.

1.7 Recycling Performance

The model provides output in terms of predicted recycling and composting performance for each year. Recycling and composting tonnages of waste collected separately are reported independently. Any recycling or composting, which may occur through one of the waste treatment facilities, is reported separately. Inert waste disposed of at the land reclamation site at Longue Hougue is also reported.

1.8 Current Disposal Facilities

In 2001 Guernsey managed approximately 250,000 tonnes of waste arisings via seven different routes:

- Recycled on and off Island;
- Composted;
- Diverted from landfill on Island (e.g. manure used on agricultural land);
- Diverted from landfill but shipped off Island (i.e. hazardous waste exported to licensed facilities in the UK);
- Used as commercial aggregate;
- Used for land reclamation at Longue Hougue; and,
- Landfilled at Mont Cuet.

1.9 Void Capacity at Mont Cuet Landfill Site

Mont Cuet landfill site is currently the only active landfill site on the Island. As part of this modelling exercise, the remaining void capacity of the domed profile and, hence, life expectancy of Mont Cuet landfill site is predicted for each scenario.

In January 2001 the remaining void space was calculated as 927,335 cubic metres and the running average for in-situ density[14] of waste was 0.917 tonnes per cubic metre[15]. Any capacity used by daily cover (top soil) and final cover has already been taken into account.

The total tonnage of wastes which can be deposited in the landfill from 2001 has therefore been calculated to be 850,367 tonnes and this value has been used as the starting point for the capacity available at Mont Cuet landfill site.

However, the Panel Inquiry [Dadd et al, 2005] recommended that Guernsey seeks to retain a minimum 5 year reserve of landfill capacity. Therefore each scenario has been assessed against both the year that Mont Cuet landfill site's remaining capacity is exhausted, and when the 5 year reserve will be reached.

14 Settlement has been taken into account. Density is calculated by the tonnage into Mont Cuet, in 6 months, over the volume filled within the same period. However the volume already filled will decrease through time as settlement occurs and therefore will influence calculated density and will be included in the running average over 14 samples (7 years).

15 Source: Information supplied by the Environment Department of The States of Guernsey via email on 17th May 2006

1.10 Alternative Landfill Capacity on Guernsey

Land is limited on Guernsey and there are often conflicting demands on the same land. It is understood that the search for an alternative landfill site on Guernsey to be used after Mont Cuet has reached capacity will not start until after the waste strategy has been agreed and adopted [Billet D'Etat, 2006].

2. TERMINOLOGY, SCENARIOS AND ASSUMPTIONS

2.1 Overview of Terminology, Scenarios and Assumptions

This section describes the terminology, scenarios and assumptions used in the modelling. Figure 2 shows all the potential scenarios and routes available for waste management on Guernsey.

Figure 2 shows the main sources of waste arisings on Guernsey, and the main sources of waste arisings (i.e. household, commercial and industrial, construction and demolition and other non-household.) The arisings are discussed in more detail in section 1.4. The figure illustrates the different routes the various waste arisings can take. These routes can be broken into two types:

- Diverted waste (i.e. via recycling, composting, commercial aggregates, inerts, slurry applied to land, hazardous export); and
- Waste that requires disposal via landfill or treatment.

There are four potential destinations for the waste that requires disposal via landfill or treatment:

- Mont Cuet landfill site;
- Mechanical Biological Treatment (MBT);
- Advanced Thermal Treatment (ATT); and
- Energy from Waste (EfW).

The three treatment options (MBT, ATT and EfW) will create outputs that require disposal either at Longue Hougue or Mont Cuet landfill site. Figure 2 illustrates the main routes of these outputs.

Earlier work has shown limited markets for certain recyclables, aggregates and organic outputs on Guernsey [Enviros 2006b]. Therefore the modelling of any scenario which produces these outputs needs to consider these limited markets and the provision to store the recyclates.

The assumed MBT facility (that is appropriate for Guernsey and used for modelling) produces a refuse derived fuel (RDF) which will in turn be fed into an EfW facility. Rejects from the MBT facility will need to be landfilled at Mont Cuet landfill site.

The EfW facility will produce an inert waste – bottom ash - that can be used as an aggregate or used in Longue Hougue, and an air pollution control (APC) residue - fly ash - that is consider to be hazardous and therefore will require disposal via export.

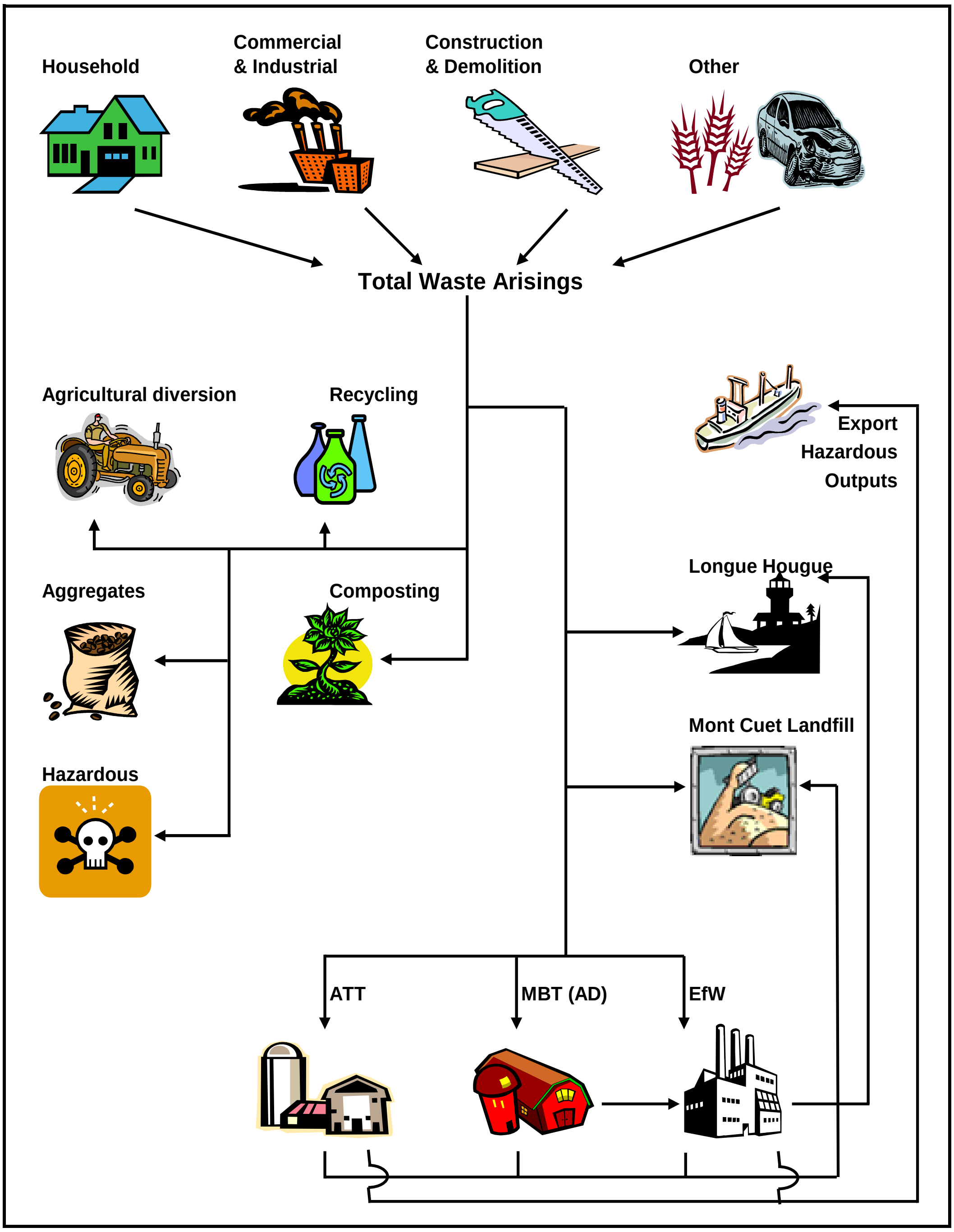
The ATT facility reduces the quantity of waste which will require disposal but will also produce rejects and residuals (called Char) that will need to be disposed at Mont Cuet landfill site. The ATT facility also produces a fly ash that is consider to be hazardous and therefore will require disposal via export.

Further details on the technologies and scenarios are outlined in the following section and discussion of the applicability of the scenarios for the Island is provided in Chapter 5.

A full description of technologies and their applicability for Guernsey is provided in [Enviros 2006c].

Figure 2 provides a template for mapping the materials flows for all the scenarios. As each scenario is discussed in more detail (Chapter 3), the flow chart has been modified to describe the specific scenario under discussion. Facilities and flows not included in the specific scenario have not been shown. Any changes to household recycling and composting are illustrated by an increase or decrease in the relative size of respective symbols and by the thickness of the adjoining lines.

Figure 2 Flow Chart of All Potential Scenarios Available to Guernsey



2.2 Definition of Terms

To clarify what is implied by each scenario, this section provides a definition of terms:

Baseline Scenario: This scenario describes the effects of the continuation of existing methods of collection and disposal without any further investment in the waste management infrastructure on the Island.

High recycling: This Scenario focuses on UK best practice, which demonstrates high recycling rates. Household recycling rates were based on those reported for St. Edmunsbury Borough Council, C&I, and C&D recycling rates were based on information from the Environment Agency. For the purpose of this exercise these recycling rates have been applied to the Guernsey's waste. To achieve this, a combination of methods and processes that typically involve the source separation of recyclable materials (e.g. metals, glass, and paper from household waste sources is required. This may be achieved through a combination of kerbside collection of recyclates, civic amenity sites and bring sites. Other complementary facilities include MRFs (materials recovery facilities), with associated bulking and baling facilities; together with facilities for the onward dispatch of the baled materials. Therefore high recycling would require extensive infrastructure to achieve the required diversion from landfill. Scenarios would be heavily dependent upon the existence of appropriate markets for the recyclate materials (either on the Island or overseas). It should be emphasised that the application of current best practice recycling rates for MSW to all Guernsey's waste represents an extreme step and a significant change in recycling performance for the island.

High green waste diversion: This scenario is based on UK best practice and is a combination of methods and processes that typically involve the separate collection of green waste. Green waste may be specified to include all types of organic wastes including garden waste and kitchen waste, as well as agricultural and horticultural waste. Green waste may be treated using a number of processes to produce compost or a soil conditioner. At its simplest, green waste may be composted using outdoor windrows. However, best practice with respect to the management of green waste that includes kitchen waste, dictates the use of in-vessel composting facilities. Green waste and / or kitchen waste can also be treated through anaerobic digestion of mechanically segregated or source separated waste. The separate collection of green waste from domestic premises may be achieved through, for example fortnightly collections or in some circumstances the adoption of alternate weekly collections, coupled with the collection of residual waste.

Mechanical Biological Treatment (MBT): A generic term for mechanical sorting / separation technologies used in conjunction with biological processes such as composting or AD. MBT is usually applied to residual waste streams, after any kerbside or source separation has taken place. MBT may be applied in situations where the facility is expected to handle several different wastes streams (such as domestic and commercial wastes). The facility may be used for one or more of the following:

- To extract materials that may be recycled (usually metals, potentially also glass and plastics);
- To separate / prepare a combustible fraction for use as a fuel (often known as Refuse Derived Fuel (RDF), see below);
- To separate / prepare the organic component for use as a type of soil conditioner (after composting / biological treatment); and,
- To treat the biodegradable element to render it more 'stable' for deposit into landfill (for example by composting it).

Anaerobic Digestion (AD): A process whereby biodegradable material is broken down in the absence of oxygen. Material is placed into an enclosed vessel and in controlled conditions the waste degrades, typically into a digestate (slurry or sludge), liquor and biogas. The digestate may be further processed to produce a compost or soil conditioner, or in some circumstances, may be combined with other combustible wastes to produce a refuse derived fuel (RDF). The liquor may be re-circulated within the reactor system, or may be discharged to an appropriate effluent treatment plant. The biogas may be used (after cleaning) in a gas engine, or other appropriate energy recovery plant / process to produce electricity and / or heat.

Refuse Derived Fuel (RDF): A fuel produced from combustible waste that can be stored and transported, or combusted directly on site to produce heat and / or power. RDF may be burnt in a traditional incinerator / combustion plant, relevant industrial processes, or may be used as a source of fuel in an advanced thermal treatment plant (e.g. a gasifier or pyrolysis plant).

Energy from Waste (EfW): A process whereby the energy content of waste is released and captured. This may be through a traditional mass burn incineration process coupled with energy and / or heat recovery. Where both heat and power are recovered, the process is significantly more efficient in energy recovery terms. EfW facilities may incorporate district heating systems, particularly for industrial parks or nearby residential areas.

Export of residuals: The transportation of residues from the waste treatment facilities to offshore locations either for further processing or final disposal.

Advanced Thermal Treatment (ATT): The processing of waste using gasification or pyrolysis technologies. ***Gasification*** is the process whereby carbon based waste is heated in the presence of some air / oxidant or steam to produce a combustible synthetic gas, known as syngas. The process is based on the reforming process used to produce town gas from coal. ***Pyrolysis*** involves the heating of organic wastes in the absence of oxygen at lower temperature than gasification, to produce a mixture of gaseous and in some instances liquid fuels. Both processes generate a solid residue. The solid residue (a char or slag) from certain ATT processes may be appropriate for recycling applications as a low grade aggregate, after further treatment. Gasification and pyrolysis technologies may be combined in a single facility (for example the solid residue from a pyrolysis process being fed into a gasification process). The fuel-rich products may be burned in a gas engine or traditional combustion plant to produce energy, or may be used as a feedstock for chemical processes. Both Gasification and Pyrolysis require a pre-sort to ensure only conforming waste enters the process. Non-conforming waste will be sent direct to landfill.

2.3 Scenarios

Enviros has modelled a series of agreed scenarios[16], combining source segregation or co-mingled recycling (except 3b) and recovery with the selected generic treatment and disposal technologies. The scenarios are:

1. Baseline Scenario, (i.e. continuing with current recycling, treatment and disposal);

2. High recycling, high green waste diversion levels followed by MBT feeding AD with RDF to EfW;

3. (a) Current recycling and green waste diversion levels followed by MBT feeding AD, with RDF to EfW;

3. (b) No recycling, no bring banks or green waste diversion, with all Parish waste to MBT feeding AD, with RDF to EfW;

4. High recycling, high green waste diversion levels followed by EfW;

5. Current recycling and green waste diversion levels followed EfW;

6. High recycling, high green waste diversion levels followed by advanced thermal treatment option; and,

7. Current recycling and green waste diversion levels followed by advanced thermal treatment option.

Table 3 provides a summary all the scenarios modelled.

16 The generic scenarios were devised from the responses to the Global search conducted by the States of Guernsey in 2006.

Table 3 Summary of Scenarios Modelled

Scenario	Recycling Options			Facility Options			
	No Recycling	Current Recycling	High Recycling	Landfill Only	MBT with AD and RDF	ATT	EfW
1		✓		✓			
2			✓		✓		
3a		✓			✓		
3b	✓				✓		
4			✓				✓
5		✓					✓
6			✓			✓	
7		✓				✓	

2.4 Assumptions

This section provides an overview of each of the scenarios and describes the potential infrastructure requirements. An assessment of the track record of the technology combinations is presented along with the assumptions made to model the scenario. This section also outlines assumptions about waste characteristics defined in validated work [ISL 2002b & Enviros 2006b], including waste growths and general waste categories.

Details of generic assumptions that are specific for the Enviros model are provided in Appendix 3. Further details of the individual material recycling rate assumptions are provided in Appendix 4.

2.4.1 Generic Assumptions

The following waste growth rates[17] have been assumed in each of the modelling exercises following validation by previous work [Enviros 2006b]. (See Appendix 1)

17 Medium waste growths used.

Table 4 Waste Growth Rates

	Years	
Waste source	**2001-2011**	**2012 onwards**
Household	2.25%	2.75%
Commercial and Industrial	1.65%	2.75%
Construction and Demolition	-3.0%	0.0%
Other non-household	-0.78%	0.04%

The growth rates for other non-household waste, including End-of-Life vehicles, tyres and water treatment sludge and agriculture and horticulture have been combined, in order to simplify the projections. This has limited impact on the final results since the tonnages concerned are small.

Previous work suggests that agricultural and horticultural wastes will reduce by 1% year on year until 2011 and remain static thereafter [ISL 2002]. Other non-household waste is predicted to increase by 0.2% year on year for the period of the modelling. The growth rate given in Table 4 for other non-household combines the two separate growth rates (of agriculture and horticulture and other wastes), so that the final waste tonnage predictions will be the same as if they had been predicted separately.

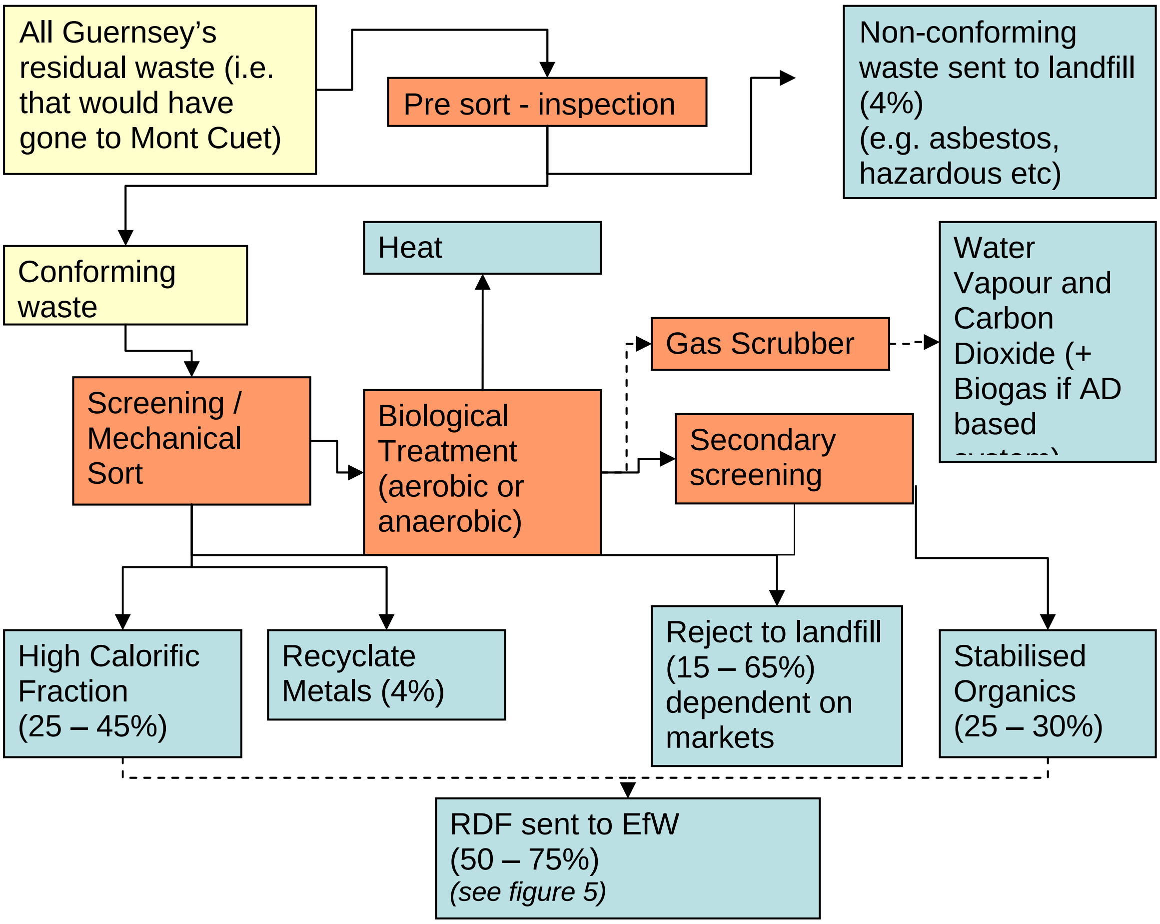
2.4.2 Facility Assumptions

This section provides materials flow diagrams [Enviros & Defra 2005] which form the basis of the different facilities modelled. Further details on how the flow diagrams have been applied within the models are found in Appendix 5.

MBT

Figure 3 shows the process for an MBT (AD) facility. All the waste that would go to Mont Cuet is sent to the MBT facility – an initial sort will send non-conforming waste (e.g. asbestos, hazardous or fragmentised waste from recycling cars) directly to Mont Cuet landfill site. The conforming waste is screened to pull out recyclates such as metal. The screening also separates a high calorific value fraction of the waste (i.e. paper and plastics) which becomes an RDF. The organic fraction of the waste is fed to an AD facility which produces a Biogas (which can be converted and utilised as an energy source) and a stabilised organic fraction, known as digestate. This digestate will be converted to an RDF because there is a small market for soil conditioner in Guernsey [Enviros 2006b]. Finally there will also be rejects that will be disposed of to landfill (Mont Cuet landfill site).

Figure 3 MBT facility Feeding AD Assumptions (Scenarios 2, 3a & 3b)

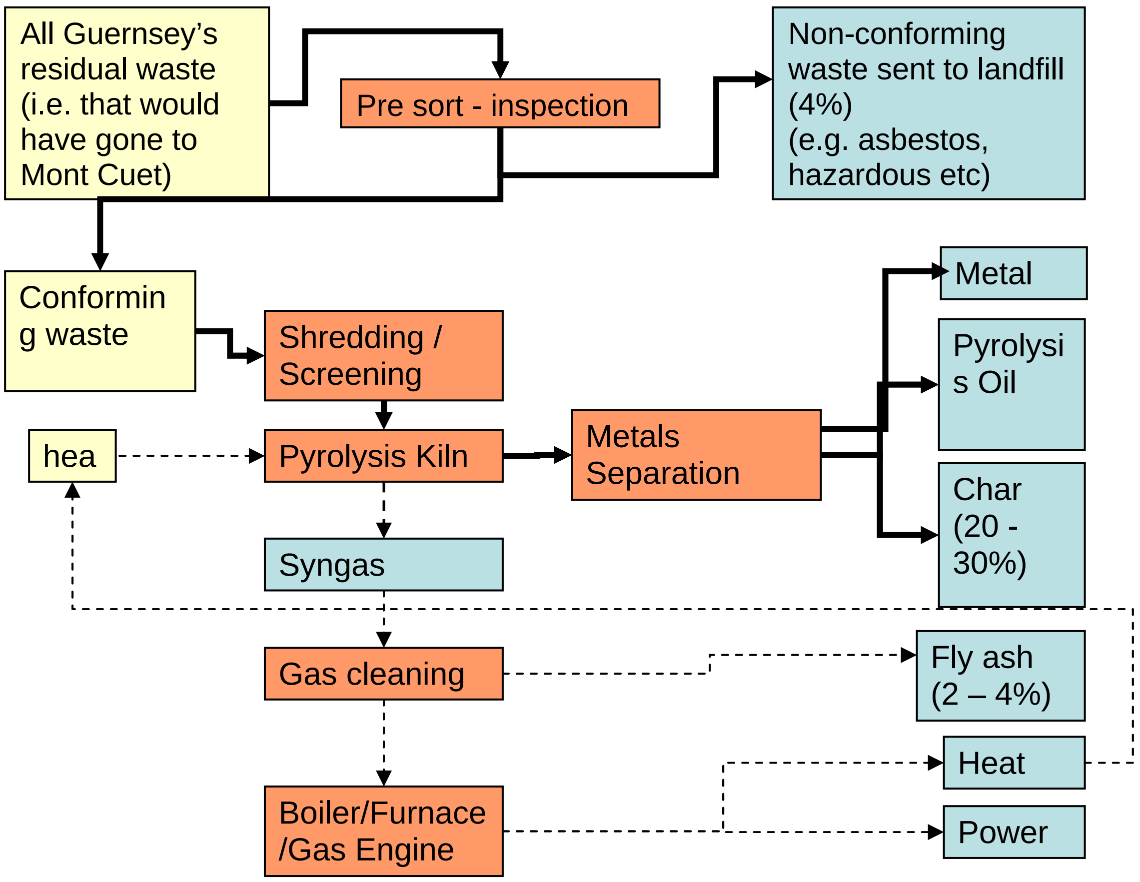


ATT

Figure 4 demonstrates the ATT process, which also accepts conforming waste after the initial sort and inspection. The main outputs are metals as a recyclate, heat and power which will be utilised on Island. Pyrolysis oil is the other output, which has no current market on island. Either a market will need to be developed or alternatively it will need to be exported for markets or disposal. The fly ash (also known as air pollution residues) is considered hazardous and will be exported. The char will be disposed of to landfill.

The char could be processed further through a gasification facility to stabilise the char as an inert output. However this has not been modelled in this scenario, as it would require a second facility.

Figure 4 ATT facility Assumptions[18] (Scenarios 6 & 7)

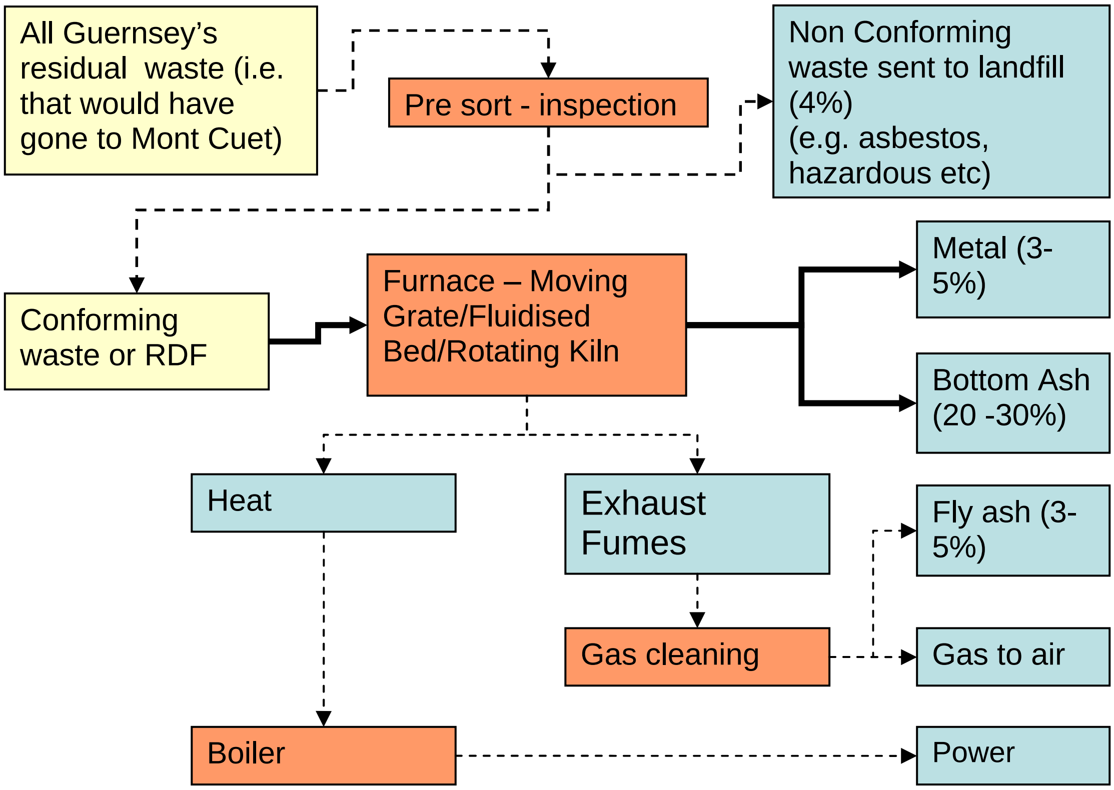


EfW

Figure 5 shows the Energy from Waste (EfW) facility. It accepts conforming waste, which is all of Guernsey's waste e.g. that would have gone to Mont Cuet excluding any asbestos, hazardous waste etc. The EfW facility produces power, which will be utilised on the Island. Metal recyclates are also be extracted. The bottom ash is an inert material and will be used as aggregate in the construction of roads and the land reclamation site at Longue Hougue. Under EC legislation the fly ash (also known as air pollution residues) is deemed hazardous and will exported and disposed of in an appropriate landfill site in the UK.

18 This is the flow diagram for a pyrolysis facility.

Figure 5 EfW facility Assumptions (Scenarios 4 & 5 and second facility for Scenarios 2, 3a & 3b)



2.4.3 Scenario-Specific Assumptions

Table 5 Scenario 1 - Baseline Scenario

Scenario 1: Baseline Scenario – continuing with current recycling, treatment and disposal	
Collection infrastructure considerations	No additional investment in collection infrastructure required. ***Using the Baseline Recycling Assumptions (see Appendix 4)***
Treatment facility	Use existing civic amenity site and landfill site. 2 Materials Recovery Facilities (MRFs) are modelled as operational. Introduction of WWTP in 2010.
Track record of technology combination	Civic amenity site, MRFs and landfill currently in operation. Robust, established, low technology risks.
Comments	Operation of existing landfill does not represent best environmental practice due to ingress of seawater into facility and capacity of landfill limited. There is currently no other landfill capacity identified on the Island. This is not acceptable as a long-term scenario.

Table 6 Scenario 2 – High Recycling with MBT (AD) and EfW

Scenario 2: High recycling, high green waste diversion levels followed by MBT facility feeding AD with RDF to EfW	
Collection infrastructure considerations	Will require solution of major logistical issues and substantial investment in source separated collection systems and / or bring schemes for recyclables (glass, metals, paper and plastics); and the adoption of new collections for green and kitchen waste from householders. Investment may be required to cover any or all of the following: wheeled bins, boxes, bags, collection vehicles for recyclables / green waste, MRF with bulking / baling capability (may be combined with elements of the MBT facility) and export of recyclates off Island. Collection arrangement may affect select of facility to deal with organic material. ***Using the High Recycling Assumptions (see Appendix 4)***
Start year of new recycling scheme	2008
Treatment facility	Investment may be required in some form of composting facility in the short term. This may be a simple open windrow system or a more complex in-vessel system if best practice for the management of kitchen and catering waste is to be followed MBT facility with appropriate combination of sorting / separation / compaction equipment; anaerobic digestion facility with reactor and gas storage tanks; RDF production plant. An EfW facility would be required for combustion of RDF with steam raising and electricity generating capability.
Start year of facility	2012
Facility capacity modelled at 2031	71,000 tpa (MBT) 44,000 tpa in 2012 to 71,000 tpa in 2031 (see Appendix 6) 41,000 tpa (EfW) 25,000t tpa in 2012 to 41,000tpa in 2031(see Appendix 6)

Scenario 2: High recycling, high green waste diversion levels followed by MBT facility feeding AD with RDF to EfW	
Proportion of waste processed through facility	96% of all Guernsey's residual waste after diversion (i.e. what would have gone to Mont Cuet landfill site excluding hazardous, asbestos etc.)
Track record of technology combination	All the selected technologies have been utilized for the management of MSW with a number of technology providers established within the marketplace. MBT facility has no track record for non MSW. Theoretically it should accept all Guernsey's waste (excluding 4% as hazardous waste), which has been assumed in the modelling. In reality Guernsey may have a greater amount of "non-conforming waste" than 4%.
Comments	Scenario represents an integrated waste management approach with energy production capability. Gate fees for the waste entering the facility are likely to be influenced by the viability of markets for the recyclates and composting. The scenario represents an approach to maximise opportunities for recycling and resource recovery. The scenario also has the potential of utilising the various treatment and recovery processes for the benefit of improving the management of waste from all Guernsey's waste streams. There may also be the opportunity for treating sewage sludge through either AD or combustion processes. The fly ash will require export for disposal. The market value of recyclables from source-separated collection will be higher than those mechanically derived from "black bag" collection systems. This scenario requires the development of a significant amount of collection, treatment and recovery infrastructure with the associated capital and operating costs. There are risks in terms of ensuring outlets for the combustion of RDF and potential exportation of recyclables.

As an indication of achievable high recycling rates, U. K. best practice has been reviewed and applied for all Guernsey's waste (see Appendix 4 for full assumptions). However it must be noted that Guernsey has certain restrictions (e.g. costs of exporting material and collection logistics) that may limit the recycling opportunities, as discussed in previous reports [Enviros 2005]. The logistical and social issues to achieve these high recycling rates will be significant and may prove unattainable.

Table 7 Scenario 3(a) – Current Recycling with MBT (AD) and EfW

Scenario 3(a): Current recycling and green waste diversion levels followed by MBT facility feeding AD, with RDF to EfW facility	
Collection infrastructure considerations	No additional investment in collection infrastructure required. ***Using the Baseline Recycling Assumptions (see Appendix 4)***
Treatment facility	MBT facility with appropriate combination of sorting / separation / compaction equipment; anaerobic digestion facility with reactor and gas storage tanks; RDF production plant. A power plant would be required for combustion of RDF with steam raising and electricity generating capability.
Start year of facility	2012
Facility capacity modelled at 2031	98,000 tpa (MBT) 62,000 tpa in 2012 to 98,000 tpa in 2031 (see Appendix 6) 58,000 tpa (EfW) 25,000 tpa in 2012 to 58,000 tpa in 2031 (see Appendix 6)
Proportion of waste processed through facility	96% of all Guernsey's residual waste after diversion (i.e. what would have gone to Mont Cuet landfill site excluding hazardous, asbestos etc.)
Track record of technology combination	All the selected technologies have been utilized for the management of MSW with a number of technology providers established within the marketplace. MBT facility has no track record for non MSW. Theoretically it should accept all Guernsey's waste (excluding 4% of hazardous waste), which has been assumed in the modelling. In reality Guernsey may have a greater amount of "non-conforming waste" than 4%.
Comments	Scenario represents an integrated waste management approach with energy production capability. Gate fees for the waste entering the facility are likely to be influenced by the viability of markets for the recyclates and composting. Value, range of

Scenario 3(a): Current recycling and green waste diversion levels followed by MBT facility feeding AD, with RDF to EfW facility	
	materials and quantity of recyclates captured through the MBT process will to be less than those achieved through Scenario 2 This scenario is likely to be more cost effective than Scenario 2 as there is no need to invest in additional or enhanced collection systems or additional MRF. The scenario also has the potential of utilising the various treatment and recovery processes for the benefit of improving the management of waste from all Guernsey's waste streams. A larger MBT facility, with associated AD capacity and EfW facility would be required to treat the additional residual waste compared to Scenario 2. The fly ash will require export for disposal. There may also be the opportunity for treating sewage sludge through either AD or combustion processes. There are risks in terms of ensuring outlets for the combustion of RDF and potential export of recyclables.

Table 8 Scenario 3(b) – No Recycling with MBT (AD) and EfW

Scenario 3(b): No recycling, no bring banks or green waste diversion followed by MBT facility feeding AD, with RDF to an EfW facility	
Collection infrastructure considerations	Requires the abandonment of the existing recycling infrastructure (e.g. bring sites, civic amenity sites) and continued operation of the existing system of collecting Parish waste. There will be a corresponding increase in the quantity of residual waste collected. ***Using the No Recycling Assumptions (see Appendix 4)***
Start year of new recycling scheme	2012
Treatment facility	MBT facility with appropriate combination of sorting / separation / compaction equipment; anaerobic digestion facility with reactor and storage tanks; RDF production plant. A power plant would be required for combustion of RDF with steam raising and electricity generating capability
Start year of facility	2012
Facility capacity modelled at 2031	114,000 tpa 72,000 tpa in 2012 to 114,000 tpa in 2031 (see Appendix 6) 68,000 tpa (EfW) 42,000 tpa in 2012 to 68,000 tpa in 2031 (see Appendix 6)
Proportion of waste processed through facility	96% of all Guernsey's residual waste after diversion (i.e. what would have gone to Mont Cuet landfill site excluding hazardous, asbestos etc.)
Track record of technology combination	All the selected technologies have been utilized for the management of MSW with a number of technology providers established within the marketplace. MBT facility has no track record for non MSW. Theoretically it should accept all Guernsey's waste (excluding 4% of hazardous waste), which has been assumed in the modelling. In reality Guernsey may have a greater amount of "non-conforming waste" than 4%.

Scenario 3(b): No recycling, no bring banks or green waste diversion followed by MBT facility feeding AD, with RDF to an EfW facility	
Comments	Scenario represents an integrated waste management approach with energy production capability. Gate fees for the waste entering the facility are likely to be influenced by the viability of markets for the recyclates and composting. Value, range of materials and quantity of recyclates captured through the MBT process will be less than those achieved through Scenario 2 and 3a. This scenario is likely to be more cost effective than Scenario 2 as there is no need to invest in additional or enhanced collection systems or additional MRF. Potential cost savings have been identified (by Guernsey) through the abandonment of existing bring sites and CA site. The scenario also has the potential of utilising the various treatment and recovery processes for the benefit of improving the management of waste from all Guernsey's waste streams. A larger MBT facility, with associated AD capacity and EfW facility would be required to treat the additional residual waste, compared to Scenarios 2 and 3a, and the fly ash will require export for disposal. There may also be the opportunity for treating sewage sludge through either AD or combustion processes. There are risks in terms of ensuring outlets for the combustion of RDF and potential export of recyclables.

Table 9 Scenario 4 – High Recycling with EfW

Scenario 4: High recycling, high green waste diversion levels followed by an EfW facility	
Collection infrastructure considerations	Will require solution of major logistical issues and substantial investment in source separated collection systems and / or bring schemes for recyclables (glass, metals, paper and plastics); and the adoption of new collections for green and kitchen waste from householders. Investment may be required to cover any or all of the following: wheeled bins, boxes, bags, collection vehicles for recyclables / green waste, MRF with bulking / baling capability and export of recyclates off island. . Collection arrangement may affect select of facility to deal with organic material. ***Using the High Recycling Assumptions (see Appendix 4)***
Start year of new recycling scheme	2008
Treatment facility	Investment may be required in some form of composting facility in the short term. This may be a simple open windrow system or a more complex in-vessel system if best practice for the management of kitchen and catering waste is to be followed. Long term investment will include the capital and operating costs of an EfW facility.
Start year of facility	2012
Facility capacity modelled at 2031	71,000 tpa 44,000 tpa in 2012 to 71,000 tpa in 2031 (see Appendix 6)
Proportion of waste processed through facility	96% of all Guernsey's residual waste after diversion (i.e. what would have gone to Mont Cuet landfill site excluding hazardous, asbestos etc.)
Track record of technology combination	This technology is well-established. The EfW facilities have been utilised for the management of MSW and C&I waste with a number of technology providers established within the marketplace.

Comments	Scenario represents an integrated approach with energy production capability. Gate fees for this scenario are likely to be influenced by the viability of markets for the recyclates and the cost of the EfW facility. The scenario represents an approach to maximise opportunities for recycling via collection schemes and resource recovery via the EfW facility. This scenario requires the development of a significant amount of collection, treatment and recovery infrastructure with the associated capital and operating costs. The fly ash will require export for disposal.

As an indication of achievable high recycling rates, U. K. best practice has been reviewed and applied for all Guernsey's waste (see Appendix 4 for full assumptions). However it must be noted that Guernsey has certain restrictions (e.g. costs of exporting material and collection logistics) that may limit the recycling opportunities, as discussed in previous reports [Enviros 2005]. The logistical and social issues to achieve these high recycling rates will be significant and it may prove unobtainable.

Table 10 Scenario 5 –Current Recycling with EfW

Scenario 5: Current recycling and green waste diversion levels followed by EfW facility	
Collection infrastructure considerations	No additional investment in collection infrastructure required. ***Using the Baseline Recycling Assumptions (see Appendix 4)***
Treatment facility	Long term investment will include the capital and operating costs of an EfW facility.
Start year of facility	2012
Facility capacity modelled	98,000 tpa 62,000 tpa in 2012 to 98,000 tpa in 2031 (see Appendix 6*)*
Proportion of waste processed through facility	96% of all Guernsey's residual waste after diversion (i.e. what would have gone to Mont Cuet landfill site excluding hazardous, asbestos etc.)
Track record of technology combination	This technology is well-established. The EfW facilities have been utilised for the management of MSW and C&I waste with a number of technology providers established within the marketplace.
Comments	Scenario represents an integrated approach with energy production capability. Gate fees for this scenario are likely to be influenced by the viability of markets for the recyclates and the cost of the EfW facility. The fly ash will require export for disposal.

Table 11 Scenario 6 – High Recycling with ATT

Scenario 6: High recycling, high green waste diversion levels followed by ATT facility	
Collection infrastructure considerations	Will require solution of major logistical issues and substantial investment in source separated collection systems and / or bring schemes for recyclables (glass, metals, paper and plastics); and the adoption of new collections for green and kitchen waste from householders. Investment may be required to cover any or all of the following: wheeled bins, boxes, bags, collection vehicles for recyclables / green waste, MRF with bulking / baling capability and export of recyclates off island. . Collection arrangement may affect select of facility to deal with organic material. ***Using the High Recycling Assumptions (see Appendix 4)***
Start year of new recycling scheme	2008
Treatment facility	Investment may be required in some form of composting facility in the short term. This may be a simple open windrow system or a more complex in-vessel system if best practice for the management of kitchen and catering waste is to be followed. A gasification or pyrolysis plant (or hybrid) with power generation capability. If the green waste is not diverted through the ATT facility, investment will be required in either an outdoor windrow plant or in-vessel composting plant.
Start Year of Facility	2012
Facility Capacity Modelled	71,000 tpa 44,000 tpa in 2012 to 71,000 tpa in 2031 (see Appendix 6)
Proportion of waste processed through facility	96% of all Guernsey's residual waste after diversion (i.e. what would have gone to Mont Cuet landfill site excluding hazardous, asbestos etc.)

Scenario 6: High recycling, high green waste diversion levels followed by ATT facility	
Track record of technology combination	There is limited operational experience world-wide of full scale advanced thermal treatments. ATT has no track record treating of treating mixed C&I waste. Theoretically it should accept all Guernsey's waste (excluding 4% of hazardous waste), which has been assumed in the modelling. In reality Guernsey may have a greater amount of "non-conforming waste" than 4%. ATT is not yet fully proven in Europe with respect to municipal solid waste or C&I waste; there are a limited number of technology providers offering ATT solutions within the marketplace.
Comments	Scenario represents an integrated approach with energy production capability. Gate fees for the waste entering the facility are likely to be influenced by the viability of markets for the recyclates. The scenario represents an approach to maximise opportunities for recycling via collection schemes and resource recovery via the facility. This scenario requires the development of a significant amount of collection, treatment and recovery infrastructure with the associated capital and operating costs. The fly ash will require export for disposal.

As an indication of achievable high recycling rates, U. K. best practice has been reviewed and applied for all Guernsey's waste (see Appendix 4 for full assumptions). However it must be noted that Guernsey has certain restrictions (e.g. costs of exporting material and collection logistics) that may limit the recycling opportunities, as discussed in previous reports [Enviros 2005]. The logistical and social issues to achieve these high recycling rates will be significant and it may prove unobtainable.

Table 12 Scenario 7 – Current Recycling with ATT

Scenario 7: Current recycling and green waste diversion levels followed by ATT facility	
Collection infrastructure considerations	No additional investment in collection infrastructure required. ***Using the Baseline Recycling Assumptions (see Appendix 4)***
Treatment facility	A gasification or pyrolysis plant (or hybrid) with power generation capability. If the green waste is not diverted through the ATT facility, investment will be required in either an outdoor windrow plant or in-vessel composting plant.
Start year of facility	2012
Facility capacity modelled	98,000 tpa 62,000 tpa in 2012 to 98,000 tpa in 2031 (see Appendix 6)
Proportion of waste processed through facility	96% of all Guernsey's residual waste after diversion (i.e. what would have gone to Mont Cuet landfill site excluding hazardous, asbestos etc.)
Track record of technology combination	There is limited operational experience world-wide of full scale advanced thermal treatments. ATT has no track record treating of treating mixed C&I waste. Theoretically it should accept all Guernsey's waste (excluding 4% of hazardous waste), which has been assumed in the modelling. In reality Guernsey may have a greater amount of "non-conforming waste" than 4%. ATT is not yet fully proven in Europe with respect to municipal solid waste or C&I waste; there are a limited number of technology providers offering ATT solutions within the marketplace.
Comments	Scenario represents an integrated approach with energy production capability. Gate fees for the waste entering the facility are likely to be influenced by the viability of markets for the recyclates. The fly ash will require export for disposal.

2.4.4 Feedstock for Facility

It is assumed in all the scenarios that all of Guernsey's waste currently entering Mont Cuet will be directed to the proposed facilities. The first stage of the facilities will be to separate certain non-conforming wastes prior to processing and remove and divert the waste directly to landfill on the Island.

These wastes are:

- Asbestos;
- Water sludge;
- Hazardous waste;
- Fragmentised waste (from recycled ELVs); and
- Incinerator ash from abattoir & healthcare treatment facilities.

This non-conforming waste is in the region of 2,000 tonnes in 2004, which is approximately 4% of total wastes[19] sent to Mont Cuet landfill site in the Baseline Scenario.

2.5 Discussion of Recycling Scenarios

The modelling allows for three recycling scenarios, which are:

- Current Recycling;
- High Recycling; and
- No Recycling.

Current recycling can easily be continued with the existing infrastructure and markets available. Therefore no additional costs will be associated with this option.

The High Recycling Scenario is based on current best practice in the U.K. for high household recycling and Environment Agency best practice examples for C&I waste. However there are a number of caveats that must be understood in order to achieve the high recycling scenarios in reality. To obtain these high recycling rates there must be:

19 This is modelled by 99.7% of the household waste will processed thorough the facility and 95% of all other wastes (C&I, C&D, and other non-household) combined. In total it is 4% of all the residual waste (i.e. waste that would be disposed of at Mont Cuet.)

- considerable commitment by householders on Guernsey and all on Island businesses (within all the sectors including C&I, C&D, agricultural and horticultural) to ensure sucessful implementation of all the recycling schemes, such as;
    - Householder will be required to have space to store and use at least 3 containers (dry recyclables, organics & green waste and residual); and
    - Businesses will need to increase the number of containers for recyclables (e.g. Hotels to have organics & green waste, increase paper and plastic recycling across all businesses, etc).
- investment from the States of Guernsey or private companies in the infrastructure including;
    - supply of recyclables containers to households;
    - provision of a compost facility;
    - provision of another MRF to sort any mixed recyclates collected via kerbside recycling schemes;
    - provision of larger bulking facilities to store a greater amount of recyclates;
    - provision of modern updated CA sites; and
    - provision of new recyclate collection vehicles.
- available markets within the locality or need to remember the associated export costs); and
- Ongoing publicity campaigns – raising awareness of recycling schemes.

Another issue that is specific to Guernsey is the logistical problem associated withn collecting the recyclables from householders and businesses directly. Large collection vehicles may be required, to collect the recyclates most cost-effectively but these may not be permitted or able to access the participating buildings or adjacent roads.

As discussed in Section 2.2 above, high rates of recycling of household wastes can only be achieved if a high proportion of materials are collected separately at the kerbside. Authorities in the UK and elsewhere in Europe which achieve high recycling have introduced a variety of sophisticated and infrastructure-dependent collection systems which would be difficult and expensive to introduce on Guernsey. The separation of clean high value recyclate materials from mixed black bag wastes, as currently collected on Guernsey, is not cost effective nor efficient. These materials are inevitably contaminated and physically difficult to process, and no markets currently exist on Island for their reuse.

3. RESULTS AND DISCUSSION

This section details the modelling results for each scenario. When evaluating the results it should be borne in mind that all results are based on data provided and assumptions used and changes to either data or assumptions could alter these results. However, the following section provides a comparison of different treatments and disposal options based on Guernsey's waste.

3.1 Model Validation

In order to confirm that the modelling undertaken for Phase 3 is robust, the predictions of both the Enviros and ISL models have been compared against measured data from 2004. Both models incorporate a number of materials flows and assumptions. The ISL model has already been validated by Enviros [Enviros 2004b]. To give the user a high degree of confidence in the results of the Enviros modelling exercise a comparison was undertaken comparing actual measured 2004 waste data with that predicted for 2004 by the ISL model and the Enviros model. The Enviros model was then calibrated using actual waste data for 2004. Table 13 shows the results of the validation exercise, comparing actual tonnages with predicted tonnages for 2004.

Table 13 Comparison of 2004 Data to Predicted Data

Waste Arisings Guernsey	2004 Data[20]	2004 Predicted by ISL	Difference between Actual & ISL	2004 Predicted by Enviros	Difference between Actual & Enviros
Mixed Domestic Refuse	16,437	15,768	669	15,768	669
Paper	2,342	2,031	311	2,031	311
Glass	1,510	1,117	393	1,117	393
Aluminium	27	27	0	134	-46
Steel	61	107	-46		
Textiles	261	241	20	241	20
Garden	1,179	1,069	110	1,069	110
Bulky Refuse	4,147	6,959	-2,813	6,959	-2,813
Total Household	**25,964**	**27,319**	**-1,355**	**27,319**	**-1,355**
Separated Paper For Recycling	2,730	2,783	-53	2,783	-53
Mixed C&I	24,358	30,354	-5,997	30,354	-5,997
Separate Metals	6,000	7,063	-1,063	7,063	-1,063
Electrical And Electronic	1,600	1,681	-81	1,681	-81
Batteries[21]	0	53	-53	842[22]	-842
Oils[21]	0	788	-788		
Fluorescent Tubes[21]	0	2	-2		
Asbestos	304	525	-221	612	-234
Other Hazardous	74	87	-13		

20 Waste data gathered using the same method as ISL consulting in 2001 (see appendix 1, [Enviros 2006b])
21 Information still missing.
22 Includes batteries, oils and fluorescent tubes

Waste Arisings Guernsey	2004 Data[20]	2004 Predicted by ISL	Difference between Actual & ISL	2004 Predicted by Enviros	Difference between Actual & Enviros
Total Commercial & Industrial	**35,066**	**43,336**	**-8,270**	**43,336**	**-8,270**
Hospital	450	302	148	1,074[23]	67
Other Healthcare	116	101	15		
Water Treatment Sludge	275	352	-77		
Abattoir	300	340	-40		
Animal Manure	6,000	5,822	178	5,861	139
Plastics	22	49	-27	342[24]	-20
Tyres	300	302	-2		
Horticultural	5,000	5,822	-822	5,861	-861
End Of Life Vehicles (ELVs)	2,285	2,012	273	1,954	331
Total Other Non-Household	**14,748**	**15,100**	**-352**	**15,091**	**-344**
Inert[25]	189,000	115,909	-73,091	136,901	52,099
Mixed	18,900	37,191	-18,291	16,200	2,700
Total Construction & Demolition	**207,900**	**153,101**	**54,799**	**153,101**	**54,799**
TOTAL	**283,678**	**238,856**	**44,822**	**238,847**	**44,830**

23 Includes healthcare, abattoir and water treatment sludge (ISL model predicted 1095 t)
24 Includes farm plastics and tyres (ISL model predicted 351 t)
25 Additional 35,000t from Ronez to be included as inerts with 154,000t to Longue Hougue. 10,000t inerts included as Mixed C&D based on verbal estimate from Island Waste

3.1.1 Comparison of 2004 Data versus Model Predictions

The main difference between the models' predictions and actual data for 2004 is with regard to the C&I waste. Actual waste arisings are considered to be in the region of 35,000 tonnes in 2004, whereas both the ISL and Enviros models predict this waste arising in the region of 43,000 tonnes. The variation could be due to a number of reasons and as there is a lack of weighbridges on Guernsey there are few records of actual weights or origin of waste. Predictions for "Mixed C&I" and "metals" are the materials showing the greatest variation.

The other large difference is with C&D waste, especially as a further 35,000 tonnes of inerts from Ronez have been sourced and included in the waste arisings. However as this addition tonnage and the majority of the C&D waste arisings does not enter Mont Cuet landfill site, it has little impact on the residual waste treatment facility or inputs to Mont Cuet landfill site.

3.1.2 Comparison of Models

The only significant difference between the ISL and Enviros predictions, as shown in Table 13, is for the subsets of data ("inert" and "mixed") for construction and demolition waste. This occurs due to differences in the method for predicting the arisings of inert waste. In 2004, 37,191 tonnes of C&D wastes are allocated in the ISL model as mixed C&D waste, however Enviros' model predicts 16,200 tonnes as mixed C&D waste. There is a difference of 20,991 tonnes which has been included as inert C&D waste within the Enviros model. However the total predictions for C&D waste for both the ISL and Enviros model are the same at 153,000 tonnes. Using 2001 data (on which all predictions were based prior to calibration), the ISL flows indicate that 150,000 tonnes of inert waste is disposed of at Longue Hougue (100,000 tonnes) and the quarrying company, Ronez (50,000 tonnes). This includes 23,000 tonnes of inert waste which is diverted via unofficial sorting facilities, as shown in Figure 6 . However Enviros modelled the flows as set out in Figure 7 .

Figure 6 ISL Flow of C&D Waste

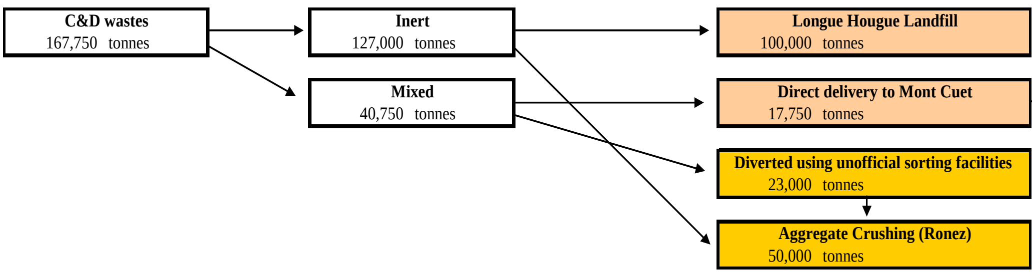
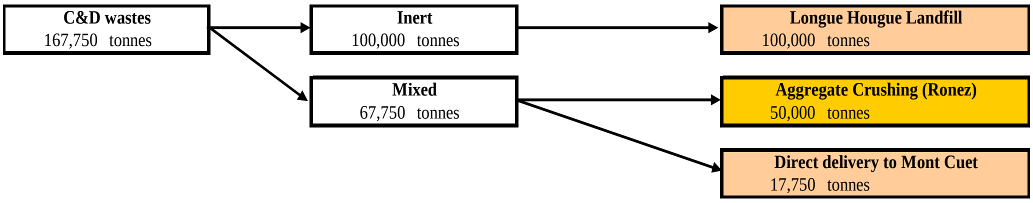


Figure 7 Enviros Flow of C&D Waste



Both model predictions assume a 3% year on year reduction in tonnage, leading to the Enviros projection of 136,901 tonnes of inert waste in 2004. Essentially, the ISL model extracts the 23,000 tonnes of inerts in the mixed waste stream at a later point in comparison to Enviros' method. This does not have significant implications for the model results since this waste does not enter the residual waste stream or Mont Cuet landfill site.

3.1.3 Model Calibration

The Enviros model was calibrated using 2004 waste data.

Slight adjustments to the 2004 waste arisings were made to ensure there was no double counting (e.g. waste from "other non-household"), accommodate any recent changes and ensure the predicted flows into Mont Cuet were correct (see Appendix 2 for calibrating data). For example it was noted [Enviros 2006b] that some waste that would be counted as "other household waste" (e.g. waste from abattoir, hospital, healthcare, agricultural plastics, fragmentised waste from ELVs and farm plastics) had the potential to be double counted, as they were not uniquely labelled as they entered Mont Cuet and were included within the C&I category.

The data for the waste arisings entering Mont Cuet landfill site for 2004 are shown below:

Household waste (entering Mont Cuet)	20,584[26] tonnes
Builders waste (C&D)	8,913 tonnes
Other Non-Household waste	2,641[27] tonnes
Asbestos and Hazardous waste	360 tonnes
C&I waste (i.e. remainder entering Mont Cuet)	24,609 tonnes
Total Input to Mont Cuet landfill site	57,108 tonnes

26 Private household, private and CA sites residual waste (after recyclates have been diverted).
27 Includes healthcare, abattoir outputs from incinerators disposed at Mont Cuet (288t) & fragmentised waste from ELV (820t Source: Guernsey metals verbal estimate Dec 2005) water treatment sludge (275t), farm plastics (22t) and horticultural waste from Chouet (1,236t).

This excludes 17,672 tonnes of site preparation material (used to construct access roads into the landfill site and for daily cover) which was utilised in 2004 at Mont Cuet Landfill site. Site preparation was excluded because the modelling focuses on the residual waste that needs to be treated and disposed of on Island.

3.2 Presentation of Results

The model validation and calibration has confirmed that the Enviros model predictions match those of the ISL model. Years 2001 and 2004 were key years for the validation and calibration process; however they are not required in this presentation. Therefore the model results presented in all subsequent sections of this report are based on 2005.

As identified by the States of Guernsey and previous reports [Enviros 2005], the terminology and management systems for waste are different on Guernsey compared to UK and therefore, England. In England the public sector predominantly collects and manages only municipal and similar wastes. It does not generally collect or manage commercial or industrial wastes. Most of the existing England criteria for Best Value Performance, recycling and diversion targets and arisings data relate to municipal waste.

However, the household recycling and composting rates presented in the following tables have been calculated using the same method used in England to calculate Best Value Performance Indicators (BVPI). Therefore Household Recycling Rate is comparable to BPVI 82a and Household Composting Rate is comparable to BVPI 82b.

The same tables also show non-household recycling and composting rates for Guernsey which includes diversion of waste (e.g. non-household compost includes manure spreading on land) and any diversion of inerts via aggregates or into Longue Hougue.

It should be noted that inputs to Longue Hougue have varied greatly in recent years due to the boom in the construction industry, increasing from 144,000 tonnes in 2001, peaking to 268,000 tonnes in 2003 and decreasing to 124,000 tonnes in 2005. The modelling is unable to predict such large variations in the inputs to Longue Hougue, but focuses on variation in the inputs to Mont Cuet landfill site from C&D waste, in the region of 8,900 tonnes in 2004. Predicted weights of inert material destined for Longue Hougue should be compared with those for similar years for baseline predictions. The key implications of each scenario are described, identifying key points for each scenario arising from the predictions:

- The year Mont Cuet landfill site reaches full capacity (referred to as End Year);
- The year the facility is due to come on line with details of planning, procurement and construction time (known as Time Scales);
- Total waste tonnage to be handled at each facility and disposal point (known as Tonnages)

An Issues section is also provided to highlight any potential problems and to discuss markets for the outputs.

Another of the aims of this exercise is to provide an opportunity to compare the effect of different technologies and recycling options, for this see section 3.10.

Comparative costs for the facilities modelled in each scenario are discussed in Chapter 4.

3.3 Key Assumptions

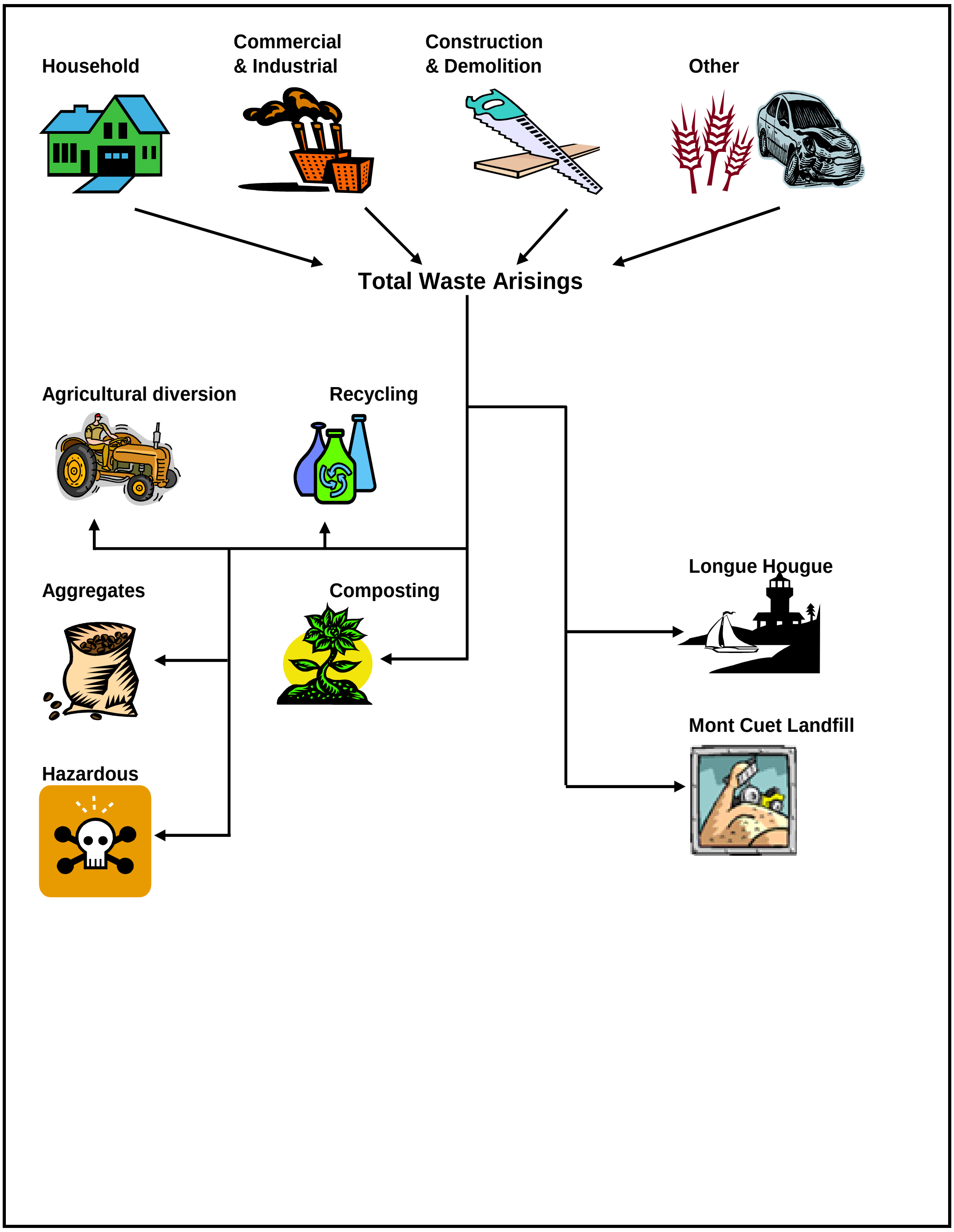
The key assumptions are discussed in detail in Chapter 2 but they are also summarised as follows:

- Facilities are operational in 2012;
- No export of residual waste; and
- Mont Cuet is the only landfill site available to accept residual waste.

3.4 Scenario 1 – Baseline Scenario

The Baseline Scenario provides a benchmark against which the other scenarios can be assessed. In this scenario it is assumed that there is no further investment in collection or disposal infrastructure. The Baseline Scenario waste flows on Guernsey are shown in Figure 8 .

Figure 8 Flow Chart of the Baseline Scenario



Guernsey's total waste arisings are predicted to grow from 280,000 tonnes in 2005 to 306,000 tonnes in 2031 (see Appendix 6 for full details, and also a breakdown of the waste destination year by year).

Key information with regard to recycling and composting rates is recorded in Table 14. This Baseline Scenario shows household recycling and composting rates remain constant at around 16.9% and 4.5% respectively, providing a combined household recycling and composting rate of around 21.4%.[28] However, due to waste growth the tonnage recycled increases from 4,600 tonnes in 2005 to 9,000 tonnes in 2031.

The non-household recycling and composting rate remains relatively constant around 26%. There are small variations in the different growth rates for the various components of the non-household waste (e.g. C&I, C&D and other non-household). It must also be noted that diversion of manure is included within the non-household compost.

The table shows that diversion of inerts to Longue Hougue is a significant method of reducing waste entering Mont Cuet landfill site. This provides the largest diversion of waste from landfill throughout the modelling period, from 53% in 2005 to 40% in 2031, with a respective decrease in tonnage from 149,000 to 124,000 tpa. The model predicts diversion to remain relatively constant from 2012 onwards. Even though the tonnage may remain the same, the proportion this contributes to total waste on Guernsey will decrease due to other waste categories continuing to grow.

28 The States of Guernsey quote a household recycling rate of 20% for 2004, the calculations are different, however the 2 recycling rates are comparable, as they use the same recyclates but exclude any green waste diverted and do not include the bulky residual waste.

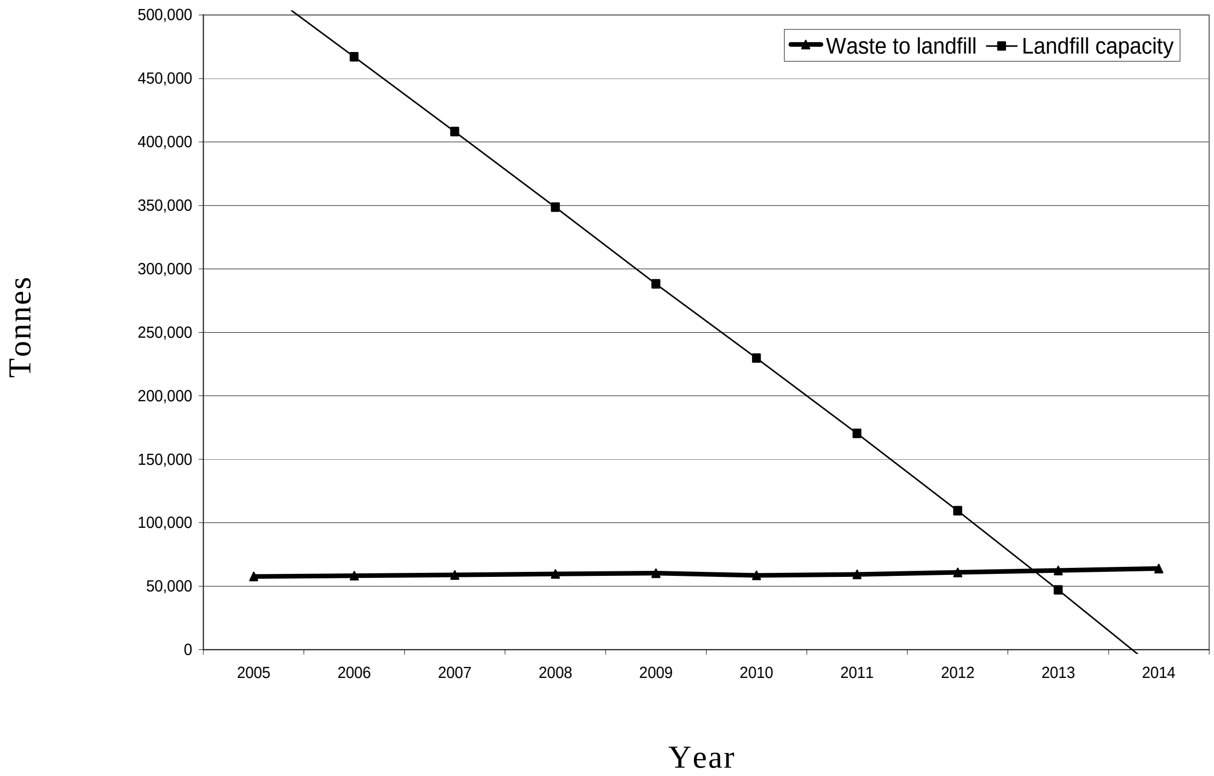
Table 14 Key Information for Baseline Scenario

Model year		Household		Non-Household		Recycled, by Facility	Inerts to Longue Hougue	Total waste diverted via recycling, composting or inerts
		Recycled	Compost	Recycled	Compost			
2005	(t)	4,531	1,206	57,114	9,690	0	149,380	221,920
	(%)	16.9%	4.5%	22.6%	3.8%		53.4%	79.4%
2008	(t)	4,843	1,289	53,809	9,465	0	136,335	205,741
	(%)	16.9%	4.5%	22.7%	4.0%		51.4%	77.5%
2012	(t)	5,320	1,416	51,205	9,249	0	124,429	191,619
	(%)	16.9%	4.5%	22.8%	4.1%		48.6%	74.9%
2020	(t)	6,610	1,759	54,273	9,278	0	124,429	196,349
	(%)	16.9%	4.5%	23.1%	4.0%		45.4%	71.7%
2026	(t)	7,778	2,070	57,052	9,301	0	124,429	200,630
	(%)	16.9%	4.5%	23.4%	3.8%		42.9%	69.1%
2031	(t)	8,908	2,370	59,739	9,319	0	124,429	204,766
	(%)	16.9%	4.5%	23.6%	3.7%		40.7%	66.9%

In summary the diversion of Guernsey's waste arisings in 2005 from landfill is 79% (combined recycling and compost including inerts). As shown in Figure 8 all residual waste is sent to the existing landfill on Guernsey. Figure 9 shows the annual tonnage into Mont Cuet landfill site compared to the remaining landfill capacity at the site. The point where the landfill capacity line crosses the x–axis shows the year when Mont Cuet landfill site capacity runs out (i.e. there is zero capacity remaining). In the Baseline Scenario, landfill capacity is predicted to be exceeded from 2014, if no further waste management infrastructure is introduced to divert additional waste from Mont Cuet landfill site. If this Baseline Scenario is continued, around 1,463,000 cumulative tonnes of residual waste will have been produced on Guernsey (from 2001 to 2031), for which there is currently no capacity on Guernsey. Therefore it will require final disposal or treatment[29], either on or off-Island.

29 Information from Appendix 6

Figure 9 Waste Disposed of to Mont Cuet Landfill Site and Remaining Capacity

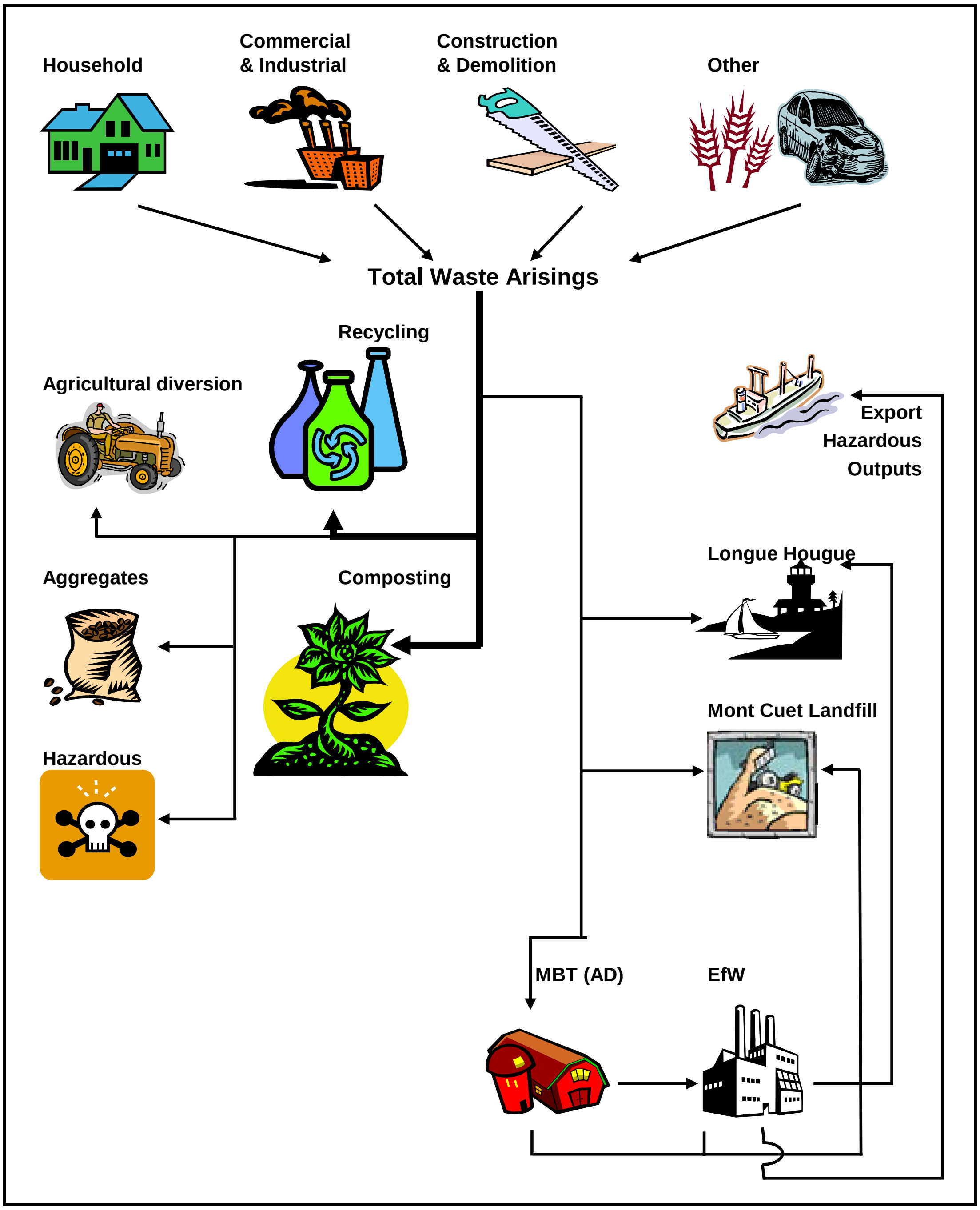


KEY ISSUES:	**Baseline Scenario**
End Year	2014 5 year reserve is reached in 2009
Time Scales	Not applicable for this scenario
Tonnages	**2014:** Mont Cuet landfill site has reached capacity and an additional 34,000t of residual waste will require disposal. **2031**: Cumulative residual waste requiring disposal – 1,463,000t
Issues	From 2014 there will be no planned or existing infrastructure on Guernsey to treat or dispose of residual waste. ***Mont Cuet landfill site will reach capacity in 2014 and as longevity of landfill capacity is a key driver, this scenario is not a viable option for managing Guernsey's waste.***

3.5 Scenario 2 - High Recycling with MBT (AD) and EfW

This scenario considers high recycling, including high green waste diversion followed by MBT facility feeding AD and with RDF to an EfW facility. Figure 10 illustrates the processes modelled, once the facility is built in 2012.

Figure 10 Scenario 2 Flow Chart from 2012



The introduction of an MBT facility in 2012 diverts waste from Mont Cuet landfill site. The MBT facility produces an RDF, which includes the digestate output from the AD facility. The model assumes all the RDF will to be sent to the EfW facility. Figure 10 shows that there is still an output of rejects and residuals from both the MBT facility and the EfW facility. The MBT facility has a final operating capacity of 71,000tpa with a starting input of around 44,000 tonnes in 2012, after hazardous and non-conforming waste is sent directly to Mont Cuet landfill site (3% of the residual waste). The MBT facility diverts 3,500 tonnes of recyclate in 2012 (see Table 15). In total the MBT and EfW facilities divert 79% of the waste which enters them, resulting in 1,300 tonnes of fly ash which would require export to an appropriate landfill site. The remainder would be disposed of at Mont Cuet landfill site.

Table 15 demonstrates the household recycling and composting rate increases in 2008 to 50% as high recycling schemes are brought on line. There is an additional 4,000 tonnes entering Longue Hougue compared to the Baseline Scenario in 2012, which is bottom ash from the EfW facility from 25,000 tonnes of RDF. By 2031 the MBT facility produces 41,000 tonnes of RDF. It has been modelled that there would be an EfW facility with a capacity of 41,000tpa, however in reality the minimum viable capacity of an EfW facility is approximately 50,000tpa.

Table 15 Key Information for Scenario 2

Model year		Household		Non-Household		Recycled, by Facility	Inerts to Longue Hougue	Total waste diverted via recycling, composting or inerts
		Recycled	Compost	Recycled	Compost			
2005	(t)	4,531	1,206	57,114	9,690	0	149,380	221,920
	(%)	16.9%	4.5%	22.6%	3.8%		53.4%	79.4%
2008	(t)	11,209	3,101	61,908	11,044	0	136,335	209,452
	(%)	39.1%	10.8%	26.2%	4.7%		51.4%	78.9%
2012	(t)	12,312	3,407	59,332	10,831	3,398	128,203	203,246
	(%)	39.1%	10.8%	26.4%	4.8%		50.1%	79.4%
2020	(t)	15,297	4,232	63,556	10,965	3,890	129,042	211,785
	(%)	39.1%	10.8%	27.1%	4.7%		47.1%	77.3%
2026	(t)	18,000	4,981	67,382	11,081	4,335	129,803	219,520
	(%)	39.1%	10.8%	27.6%	4.5%		44.7%	75.6%
2031	(t)	20,615	5,704	71,081	11,190	4,765	130,538	227,000
	(%)	39.1%	10.8%	28.1%	4.4%		42.7%	74.2%

In this scenario with an increase in recycling starting from 2008 and an MBT facility starting in 2012, Mont Cuet landfill site is predicted to reach capacity in 2029, as shown in Figure 11 . Therefore the 5 year reserve capacity will be reached in 2024. The effects of the increased levels of recycling and composting in 2008 can be seen in Figure 12 showing a decrease in the annual waste sent to landfill from around 59,000 tonnes in 2007 to 42,000 tonnes in 2008. There is a further decrease in the annual waste to landfill in 2012 when the MBT facility comes on line. By the end of the modelling period (2031) there will be a need for disposal of only a further 36,000 tonnes of residual waste but for which there is no current capacity.

Figure 11 Waste Disposed of to Mont Cuet Landfill Site and Remaining Capacity

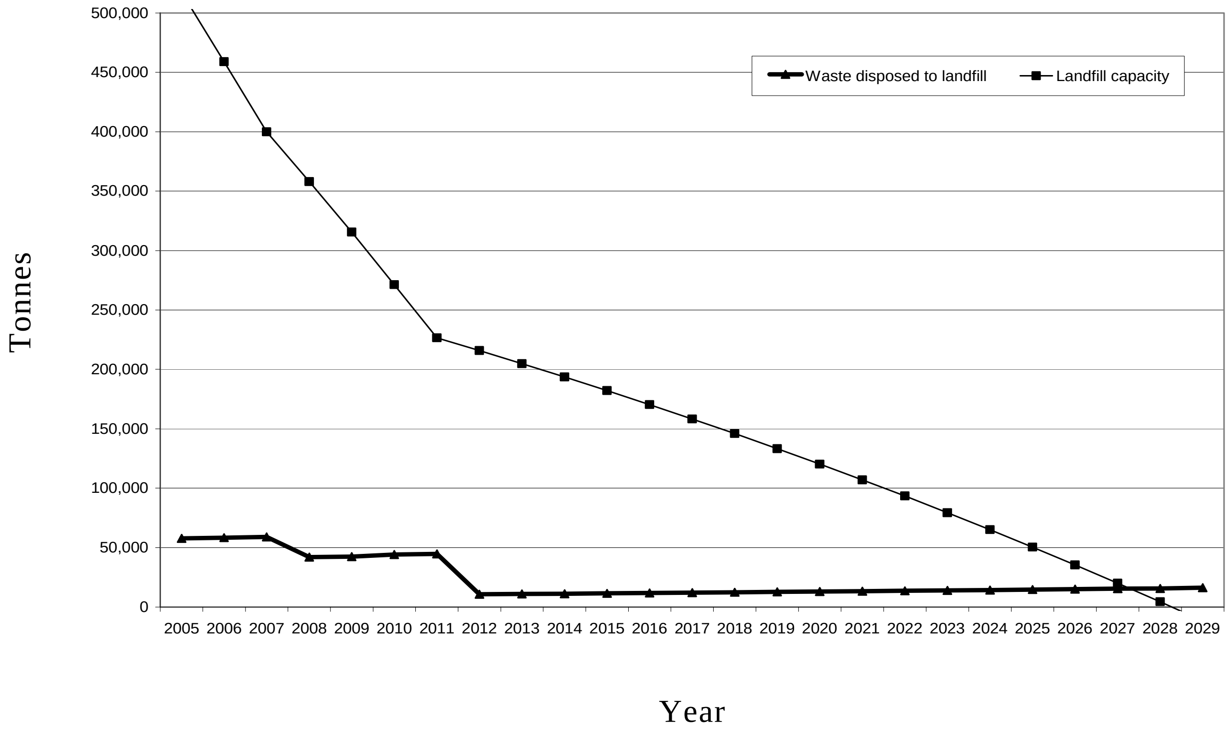
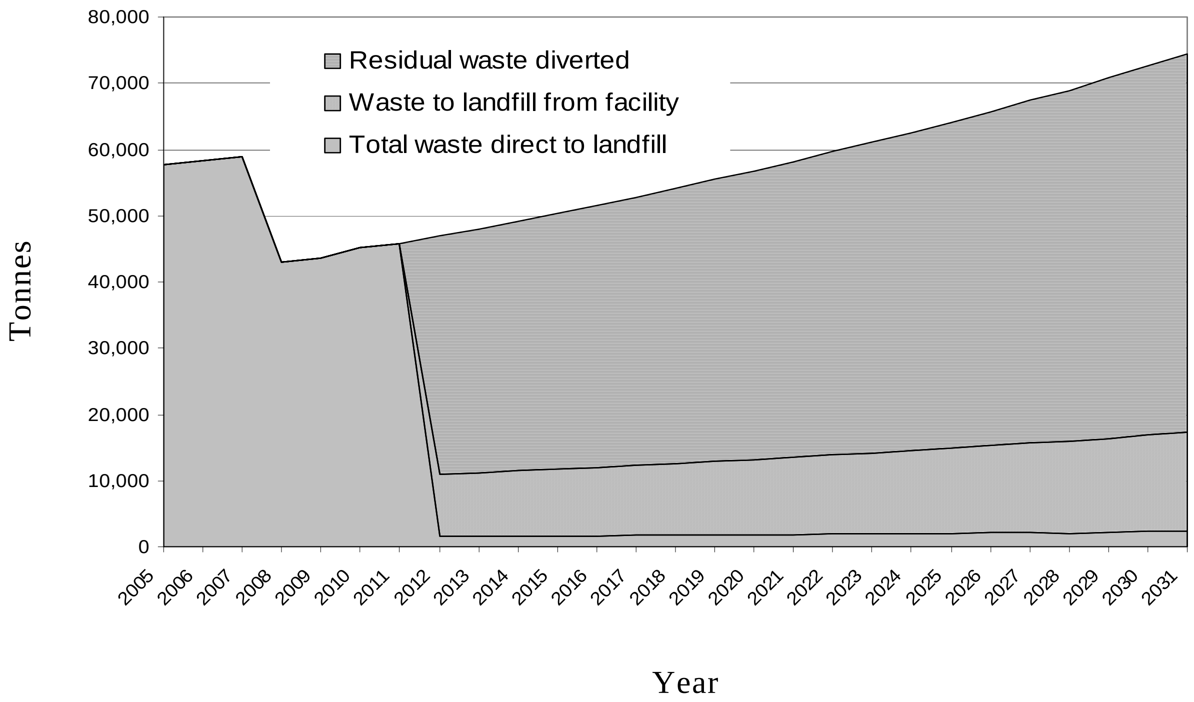


Figure 12 Treatment of Residual Waste



KEY ISSUES:	**Scenario 2 – High Recycling with MBT (AD) and EfW**	
End Year	2029 5 year reserve starts in 2024	
Time Scales	Facilities become operational in 2012 Decision: 2007, Planning: 1-2yrs, Construction: 2-3yrs, Total: 3 – 5 yrs	
Tonnages	MBT capacity: Start throughput in 2012 End throughput in 2031	71,000t 44,000t 71,000t
	EfW capacity: Start throughout in 2012 End throughput in 2031	41,000t 25,000t 41,000t
Issues		
Feedstock	MBT facility does not have a proven track record with variable feedstock of MSW and C&I waste	

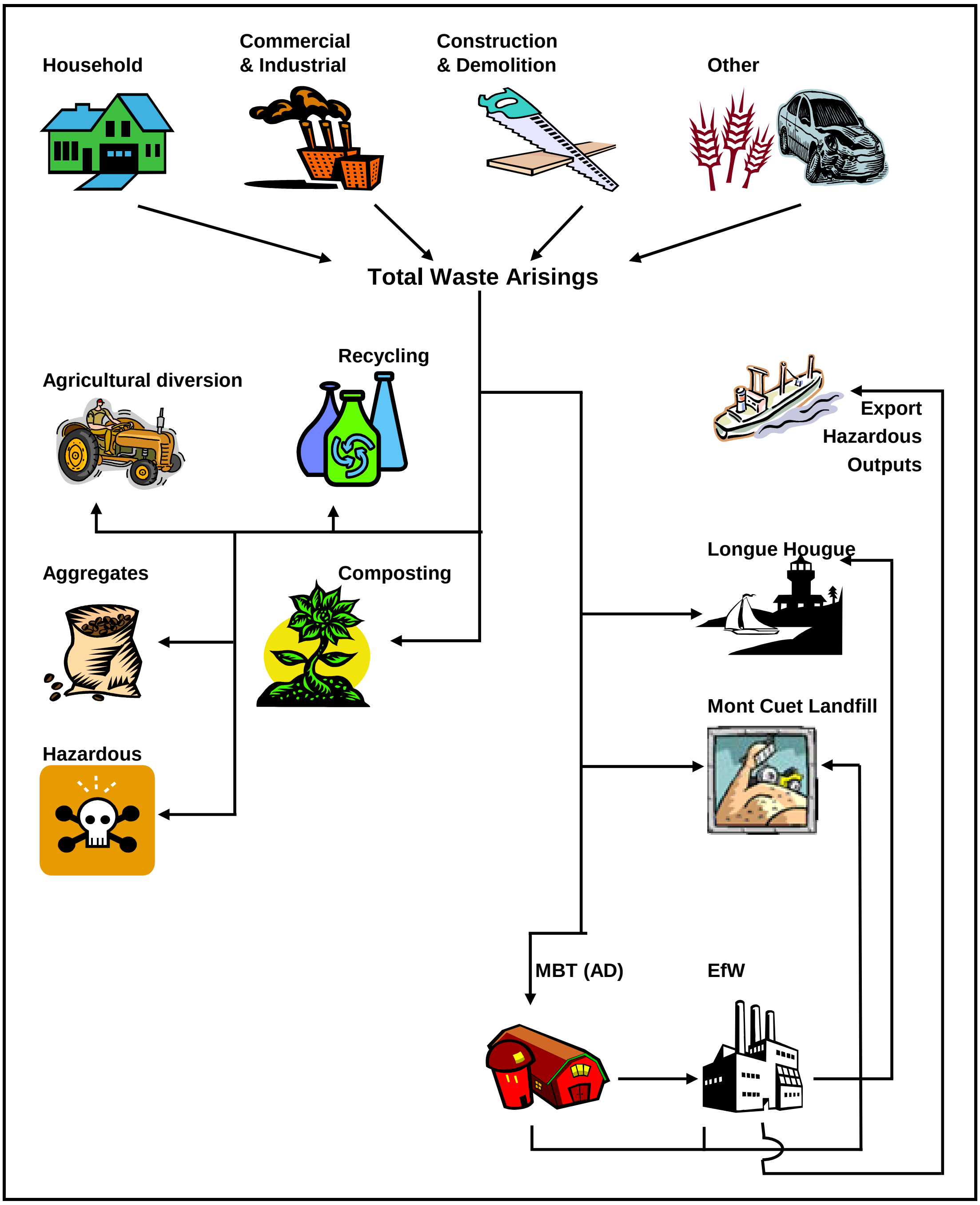
EfW	The size of EfW facility required in this scenario is unlikely to be viable, as it is under the EfW facility threshold. In reality the facility is likely to be a minimum of 50,000tpa. Any delays in building the EfW facility would mean that the RDF would not have an on-Island market. One potential option would be to dispose the RDF to landfill either at Mont Cuet landfill site or overseas. Alternatively, the RDF could be sent to alternative heat and recovery facilities via export but this will have legal and cost implications.
EfW hazardous waste	The Fly Ash from the EfW facility is deemed hazardous and will need to be exported and disposed of in the appropriate manner.
AD Outputs& Power	The AD biogas output could be used as a source of energy on Guernsey. The AD digestate output will be used as part of the RDF and therefore feed the EfW facility, which is turn will generate electricity, which can be utilised by Guernsey.
High Recycling	The high recycling scenario is based on best practice of high recycling rates in the UK. However, it should be noted that the model does not imply that these recycling rates are achievable or practical on Guernsey. With increased recycling, there is an increased need for markets, or storage and export of this material. In addition further infrastructure and investment will be required to support any increased recycling levels.
High Green/ Organic Diversion	A market will be needed for compost arising from green waste and from separately collected kitchen waste. The input compost tonnage will increase by an additional 3,500t in 2012; however potential markets on Island are limited [Enviros 2006b]. ***Mont Cuet landfill site will reach capacity in 2029 and therefore this is a viable option, which merits further evaluation with a more detailed study.***

3.6 Scenario 3 – Current and No Recycling with MBT (AD) and EfW

3.6.1 Scenario 3a - Current Recycling (MBT)

This scenario considers current recycling and green waste diversion levels projected to 2031 and a MBT facility feeding AD, with RDF to an EfW facility. Figure 13 illustrates the processes modelled from 2012.

Figure 13 Scenario 3a Flow Chart



In this scenario the MBT facility in 2012 diverts waste from Mont Cuet landfill site. The MBT facility produces an RDF, which includes the digestate output from the AD facility, which is modelled to be sent to the EfW facility. Figure 13 shows that there is still an output of rejects and residuals from both the MBT and the EfW facilities. In this scenario the waste treatment facilities divert 83% of the waste (that enters the MBT and EfW facilities) away from landfill. An element of the waste diversion results from loss of material from the system during treatment of the waste as combustion losses and moisture loss during the biological stages.

Table 16 demonstrates household recycling and composting levels remain constant at 21.4%. In 2012 the MBT facility becomes operational and increases recycling, composting and diversion via inerts of the residual waste (i.e. the bottom ash of the EfW facility). The MBT facility separates approximately 3,400 tonnes of recyclates in 2012. In addition the bottom ash from the EfW facility can be utilised at Longue Hougue or used as aggregate and therefore inerts to Longue Hougue is greater in 2012 in this scenario compared to the baseline.

Table 16 Key Information for Scenario 3a

Model year		Household		Non-Household		Recycled, by Facility	Inerts to Longue Hougue	Total waste diverted via recycling, composting or inerts
		Recycled	Compost	Recycled	Compost			
2005	(t)	4,531	1,206	57,114	9,690	0	149,380	221,920
	(%)	16.9%	4.5%	22.6%	3.8%		53.4%	79.4%
2008	(t)	4,843	1,289	53,809	9,465	0	136,335	205,741
	(%)	16.9%	4.5%	22.7%	4.0%		51.4%	77.5%
2012	(t)	5,320	1,416	51,205	9,249	7,250	129,803	204,242
	(%)	16.9%	4.5%	22.8%	4.1%		50.7%	79.8%
2020	(t)	6,610	1,759	54,273	9,278	8,320	130,976	211,216
	(%)	16.9%	4.5%	23.1%	4.0%		47.8%	77.1%
2026	(t)	7,778	2,070	57,052	9,301	9,288	132,039	217,527
	(%)	16.9%	4.5%	23.4%	3.8%		45.5%	74.9%
2031	(t)	8,908	2,370	59,739	9,319	10,225	133,067	223,627
	(%)	16.9%	4.5%	23.6%	3.7%		43.5%	73.1%

Figure 14 shows that this scenario predicts Mont Cuet landfill site will reach full capacity in 2023 and therefore the 5 year reserve in 2018. By the end of the modelling period (2031) there will be a need to dispose of further 151,000 tonnes[30] of residual waste.

Figure 15 illustrates the decrease in the annual waste to landfill in 2012 when the facility comes on line and shows all non-conforming waste

30 For further information Appendix 6

(e.g. asbestos) being sent directly to Mont Cuet landfill site along with the rejects from the waste facility.

Figure 14 Waste Disposed of to Mont Cuet Landfill Site and Remaining Capacity

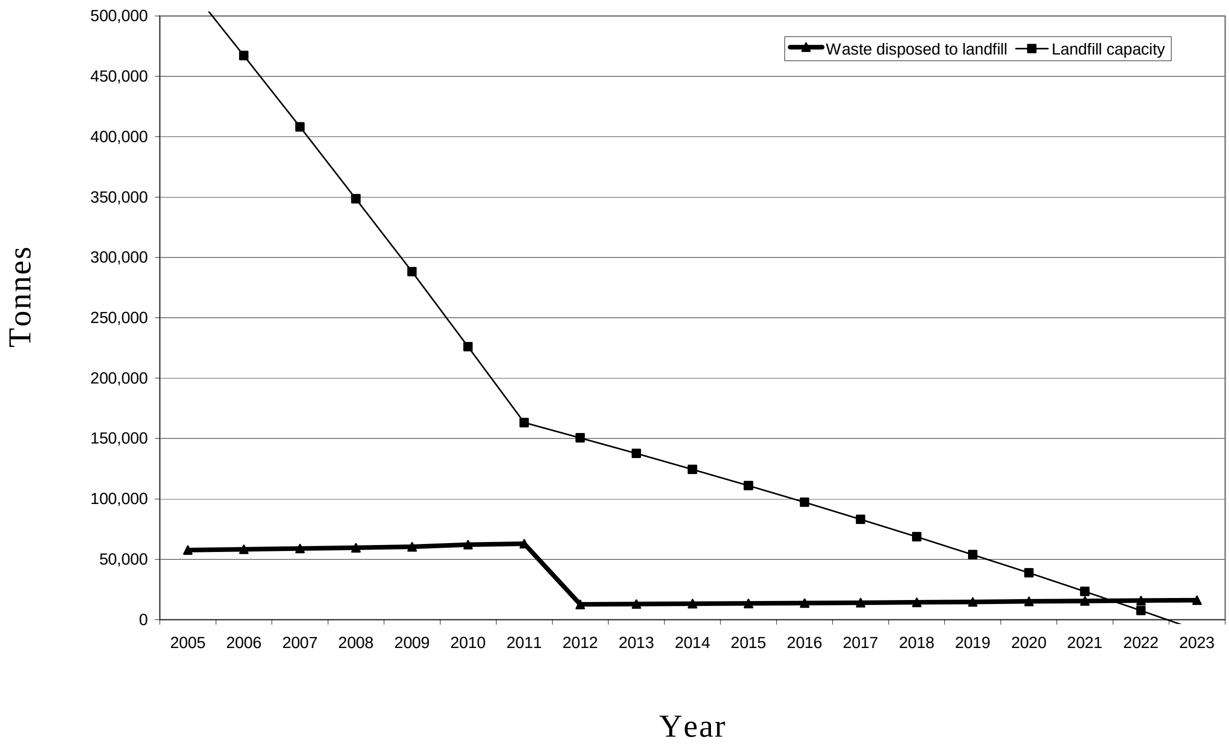
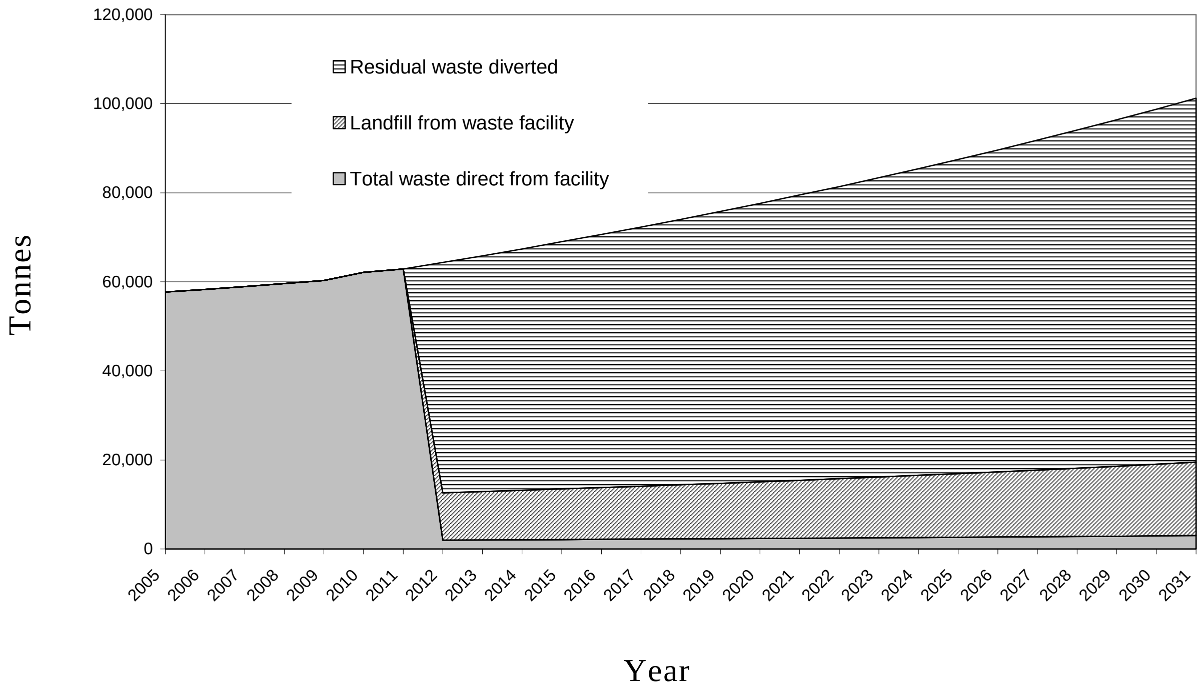


Figure 15 Treatment of Residual Waste



KEY ISSUES:	**Scenario 3a – Current Recycling with MBT (AD) and EfW**	
End Year	2023 5 year reserve starts in 2018	
Time Scales	Facilities on line in 2012 Decision: 2007, Planning: 1-2yrs, Construction: 2-3yrs, Total: 3 – 5 yrs	
Tonnages	MBT capacity: Start throughput in 2012 End throughput in 2031	98,000t 62,000t 98,000t
	EfW capacity Start throughout in 2012 End throughput in 2031	58,000t 36,000t 58,000t

Issues	
Feedstock	MBT facility does not have a proven track record with variable feedstock of MSW and C&I waste
EfW	Any delays in building the EfW facility would mean that the RDF would not have an on-Island market. One potential option would be to dispose the RDF to landfill either at Mont Cuet landfill site or overseas. Alternatively, the RDF could be sent to alternative heat and recovery facilities via export but this will have cost implications.
EfW Hazardous Waste	The Fly Ash from the EfW facility is deemed hazardous and will need to be exported and disposed of in the appropriate manner.
AD outputs & Power	The AD biogas output could be used as a source of energy on Island. The AD digestate output will be used as part of the RDF and therefore feed the EfW facility, which is turn will generate electricity, which can be utilised by Guernsey.
Current Recycling	The current level of recycling should be achievable and maintainable for Guernsey.
	Mont Cuet landfill site will reach capacity in 2023 and as longevity of landfill capacity is a key driver, this scenario is not a viable option for managing Guernsey's waste.

3.6.2 Scenario 3b – No Recycling with MBT (AD) and EfW

This scenario assumes no recycling, no bring banks or green waste diversion, with all Parish waste to MBT facility feeding AD, with RDF to an EfW facility. This assumes recycling activities are stopped in 2012, the year the MBT facility becomes operational. Figure 16 illustrates the waste flows from 2012.

Figure 16 Scenario 3b Flow Chart

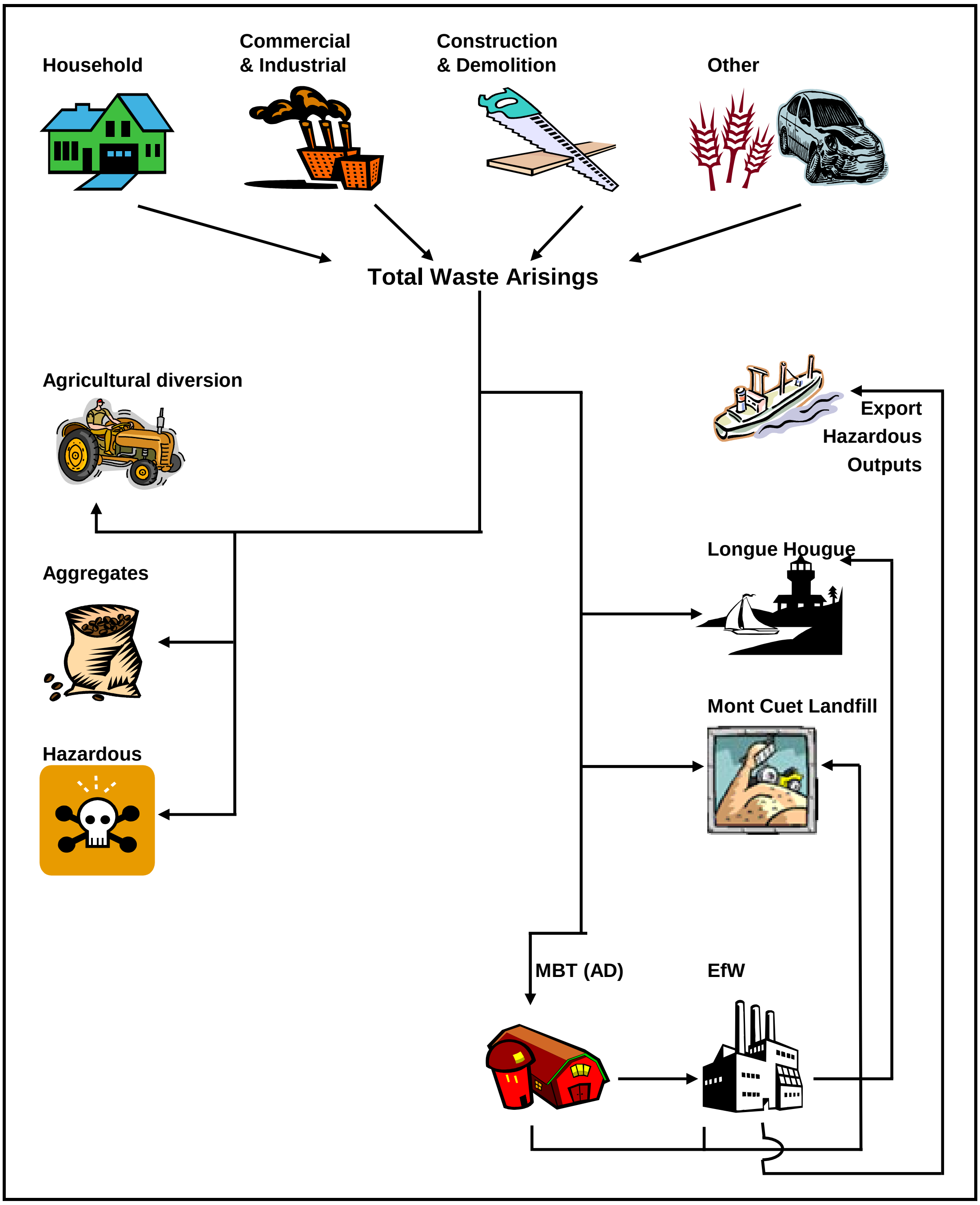


Table 17 shows the decrease in household recycling and composting in 2012 as the rate decreases from 21.4% to 0%. However the MBT facility extracts around 9,300 tonnes of recyclable material (metal, glass and WEEE) in 2012.

Table 17 Key Information for Scenario 3b

Model year		Household Recycled	Household Compost	Non-Household Recycled	Non-Household Compost	Recycled, by Facility	Inerts to Longue Hougue	Total waste diverted via recycling, composting or inerts
2005	(t)	4,531	1,206	57,114	9,690	0	149,380	221,920
	(%)	16.9%	4.5%	22.6%	3.8%		53.4%	79.4%
2008	(t)	4,843	1,289	53,809	9,465	0	136,335	205,741
	(%)	16.9%	4.5%	22.7%	4.0%		51.4%	77.5%
2012	(t)	0	0	48,060	9,249	9,253	130,701	188,009
	(%)	0.0%	0.0%	21.4%	4.1%		51.1%	73.4%
2020	(t)	0	0	50,365	9,278	10,809	132,092	191,736
	(%)	0.0%	0.0%	21.4%	4.0%		48.2%	70.0%
2026	(t)	0	0	52,453	9,301	12,219	133,352	195,106
	(%)	0.0%	0.0%	21.5%	3.8%		45.9%	67.2%
2031	(t)	0	0	54,472	9,319	13,583	134,571	198,362
	(%)	0.0%	0.0%	21.5%	3.7%		44.0%	64.8%

As in Scenarios 2 and 3a, Figure 16 shows that there is still an output of rejects and residuals from both the MBT and the EfW facilities. In this scenario the waste treatment facilities divert 85% of the waste entering the facility from landfill. This is greater than the diversion achieved in Scenarios 2 and 3a. Because there is no other recycling (via kerbside, bring banks, MRFs etc), there is a larger amount of recyclable material in the residual waste, which can be diverted via the MBT facility. For example, metals are not recycled at the kerbside or via bring banks, therefore metals remain within the unsorted material and will be extracted by the MBT facility.

In this scenario Mont Cuet landfill site is predicted to reach full capacity in late 2022 or early 2023 (as shown in Figure 17). The 5 year reserve will be reached in 2018. It also demonstrates that by the end of the modelling period (2031) there will be a need for disposal of a further 167,000 tonnes of residual waste.

Figure 18 illustrates the decrease in the annual waste to landfill in 2012 when the facility comes on line. Figure 18 also shows there is a sharp increase in residual waste (of approximately 10,000 tonnes) in 2012 due to recycling activities finishing this year.

Figure 17 Waste Disposed of to Mont Cuet Landfill Site and Remaining Capacity

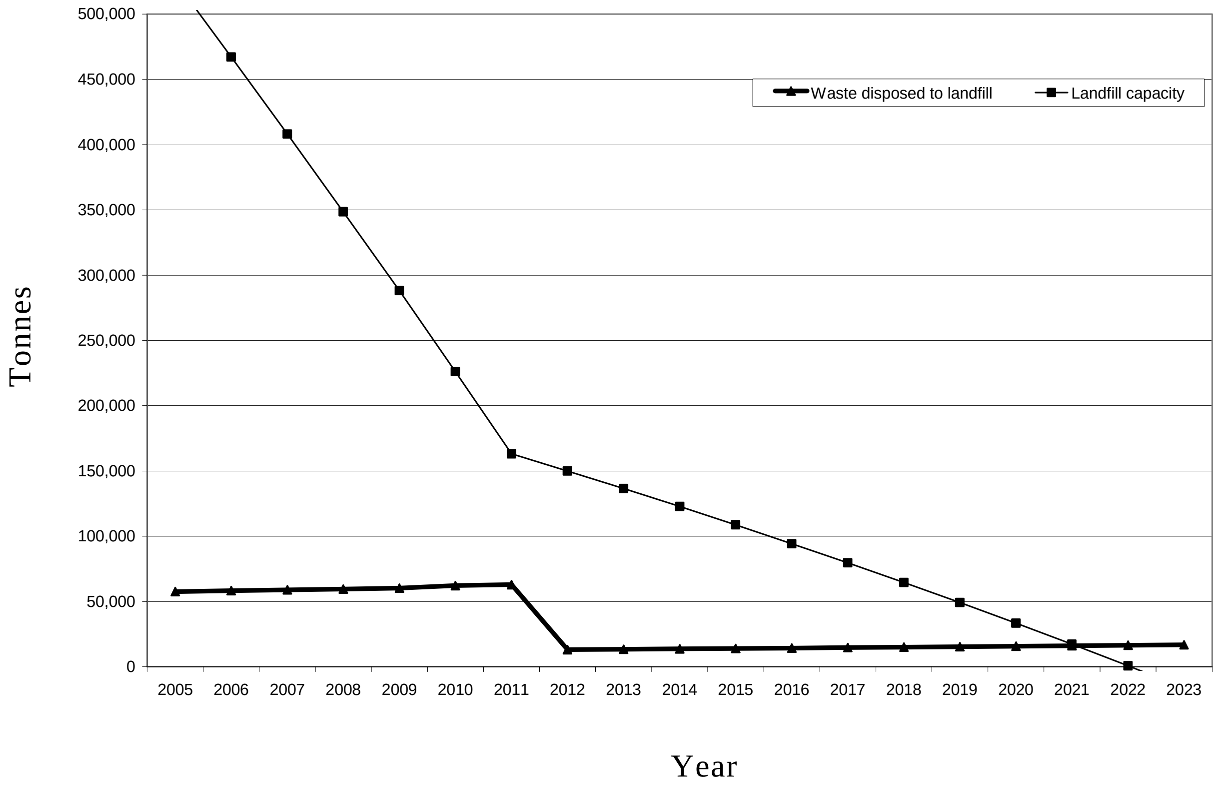
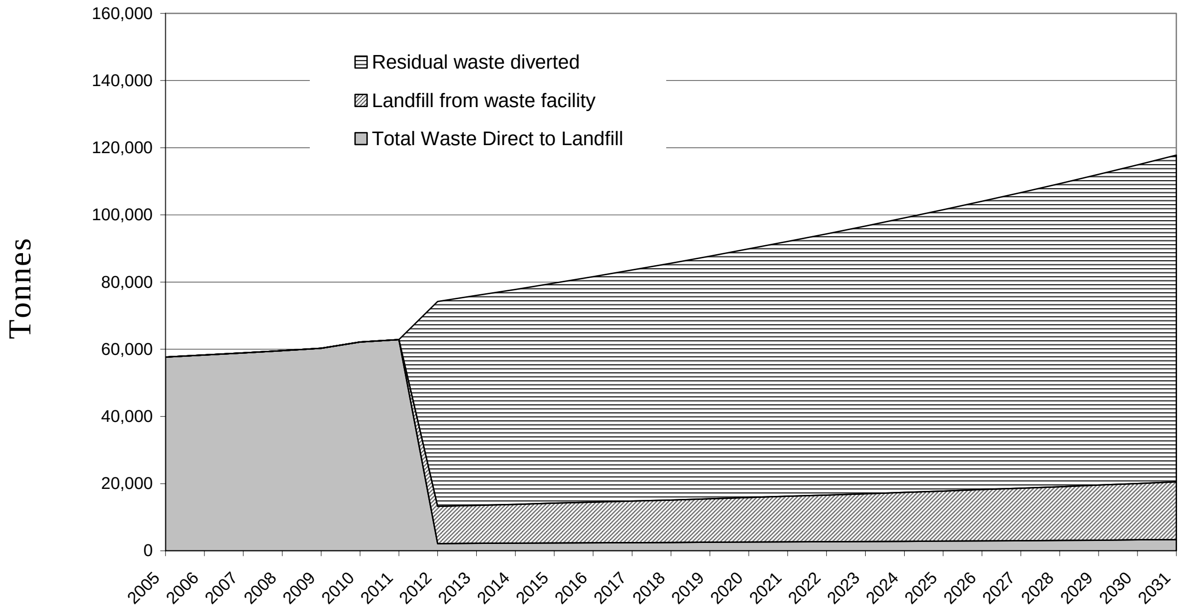


Figure 18 Treatment of Residual Waste

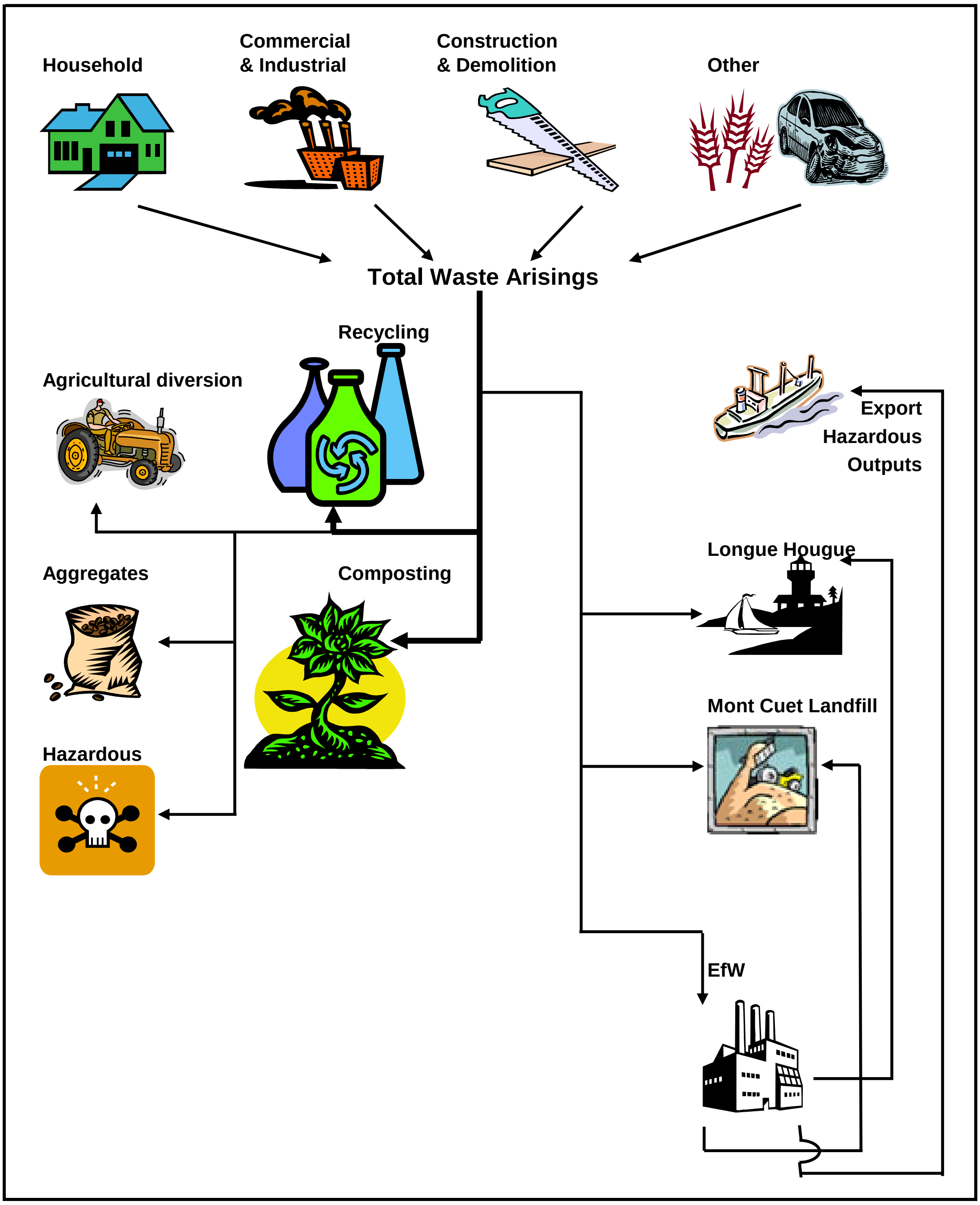


KEY ISSUES:	**Scenario 3b – No Recycling with MBT (AD) and EfW**	
End Year	2023 5 year reserve starts in 2018	
Time Scales	Facilities on line in 2012 Decision: 2007, Planning: 1-2yrs, Construction: 2-3yrs, Total: 3–5yrs	
Tonnages	MBT capacity: Start throughput in 2012 End throughput in 2031	114,000t 72,000t 114,000t
	EfW capacity Start throughout in 2012 End throughput in 2031	68,000t 42,000t 68,000t
Issues		
Feedstock	MBT facility does not have a proven track record with variable feedstock of MSW and C&I waste	
EfW	Any delays in building the EfW facility would mean that the RDF would not have an on-Island market. One potential option would be to dispose the RDF to landfill either at Mont Cuet landfill site or overseas. Alternatively, the RDF could be sent to alternative heat and recovery facilities via export but this will have cost implications.	
EfW Hazardous Waste	The Fly Ash from the EfW facility is deemed hazardous and will need to be exported and disposed of in the appropriate manner.	
AD outputs & Power	The AD biogas output could be used as a source of energy on Island. The AD digestate output will be used as part of the RDF and therefore feed the EfW facility, which is turn will generate electricity, which can be utilised by Guernsey.	
No Recycling	Risk of resistance to apparently decreasing the recycling provision on the Island. Whilst there is no recycling in advance of waste deliveries to the facility, recyclates are extracted as part of the process. Long term – a greater amount of residual waste will require disposal ***Mont Cuet landfill site will reach capacity in 2023 and as longevity of landfill capacity is a key driver, this scenario is not a viable option for managing Guernsey's waste***	

3.7 Scenario 4 - High Recycling with EfW

This scenario considers high recycling, high green waste diversion levels in 2008 followed by an EfW facility in 2012. Figure 19 illustrates the waste flows for this scenario.

Figure 19 Scenario 4 Flow Chart



This scenario focuses on high recycling, which can be seen with the increase in household recycling and compost rate from 21.4% in 2001 to 50% in 2008, as shown in Table 18.

Table 18 Key Information for Scenario 4

Model year		Household		Non-Household		Recycled, by Facility	Inerts to Longue Hougue	Total waste diverted via recycling, composting or inerts
		Recycled	Compost	Recycled	Compost			
2005	(t)	4,531	1,206	57,114	9,690	0	149,380	221,920
	(%)	16.9%	4.5%	22.6%	3.8%		53.4%	79.4%
2008	(t)	11,209	3,101	61,908	11,044	0	136,335	223,598
	(%)	39.1%	10.8%	26.2%	4.7%		51.4%	84.3%
2012	(t)	12,312	3,407	59,332	10,831	2,434	137,574	225,891
	(%)	39.1%	10.8%	26.4%	4.8%		53.7%	88.2%
2020	(t)	15,297	4,232	63,556	10,965	2,763	140,441	237,254
	(%)	39.1%	10.8%	27.1%	4.7%		51.3%	86.6%
2026	(t)	18,000	4,981	67,382	11,081	3,060	143,038	231,481
	(%)	39.1%	10.8%	27.6%	4.5%		49.3%	79.8%
2031	(t)	20,615	5,704	71,081	11,190	3,348	145,551	240,595
	(%)	39.1%	10.8%	28.1%	4.4%		47.6%	78.6%

From 2012 there is an EfW facility which diverts 95% of the waste entering the facility from disposal. Fly ash is required to be exported for disposal, as there no appropriate sites on Guernsey. Therefore 100% of waste entering the EfW facility is diverted from Mont Cuet landfill site. The percentage diversion is so high because the stabilised outputs from the EfW facility can be disposed of as an input to Longue Hougue (this can be seen in the increase in inerts in Table 18 in 2012). The facility sends an additional 13,000 tonnes of inerts in 2012 (compared to the Baseline Scenario) and 22,000 tonnes in 2031.

Figure 20 shows that in this scenario Mont Cuet landfill site is not predicted to achieve full capacity within the modelling period. It also demonstrates that by the end of the modelling period (2031) there will approximately be a further 198,000 tonnes of capacity available at Mont Cuet landfill site.

Figure 21 illustrates a decrease in the annual waste to landfill in 2012 when the facility comes on line. In addition Figure 21 shows a sharp decrease in total residual waste in 2008 due to the “high recycling” scheme starting in this year.

Figure 20 Waste Disposed of to Mont Cuet Landfill Site and Remaining Capacity

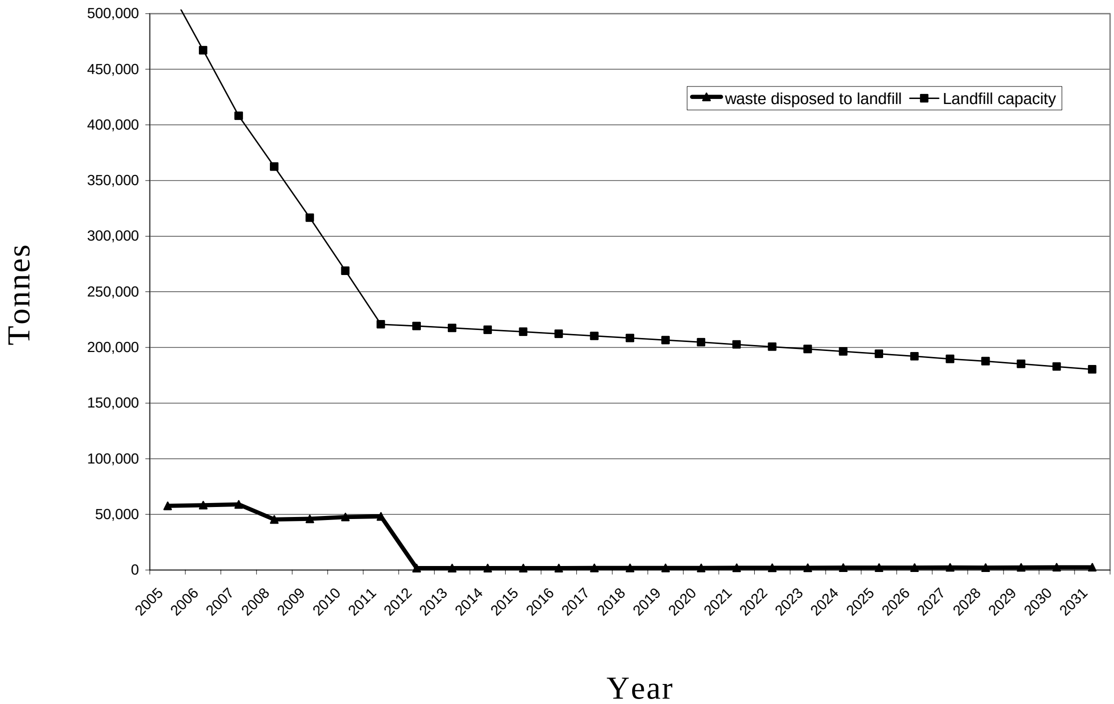
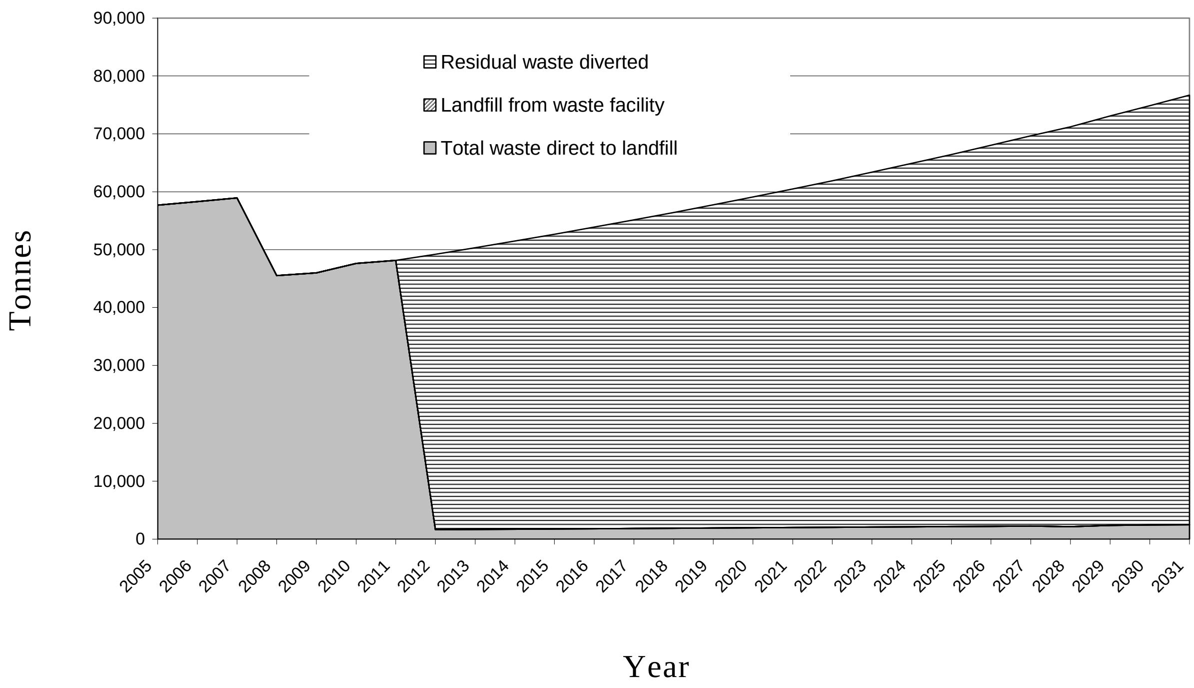


Figure 21 Treatment of Residual Waste



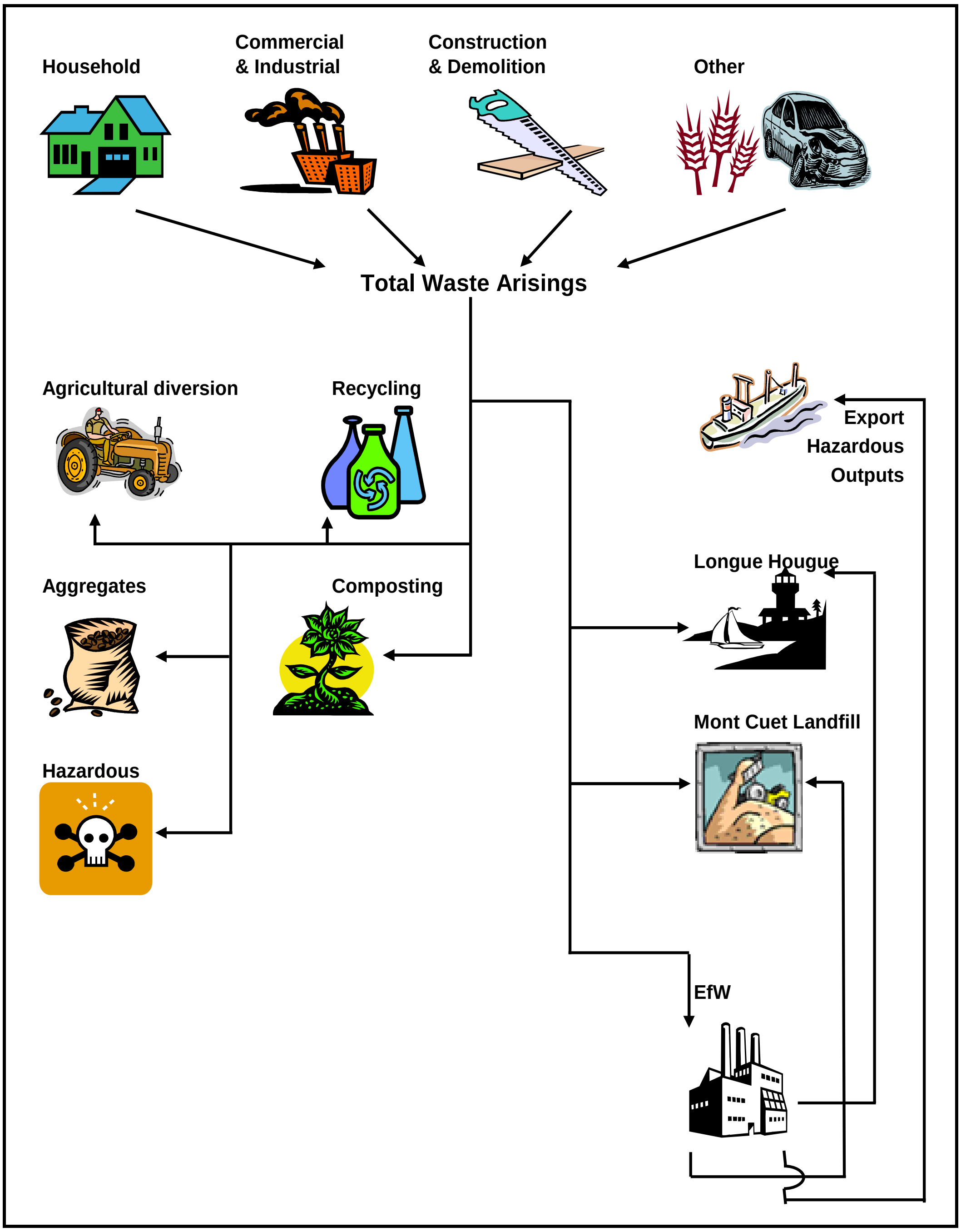
KEY ISSUES:	**Scenario 4 – High Recycling with EfW**	
End Year	Beyond 2031 5 year reserve not reached	
Time Scales	Facilities on line in 2012 Decision:2007, Planning:1-2yrs, Construction:2-3yrs, Total: 3–5yrs	
Tonnages	EfW capacity Start throughout in 2012 End throughput in 2031	71,000t 44,000t 71,000t
Issues		
EfW Hazardous Waste	The Fly Ash from the EfW facility is deemed hazardous and will need to be exported and disposed of in the appropriate manner.	
Power	This scenario generates electricity which can be utilised by Guernsey.	

KEY ISSUES:	**Scenario 4 – High Recycling with EfW**
High Recycling	The high recycling scenario is based on best practice of high recycling rates in the UK. However, it should be noted that the model does not identify these recycling rates are achievable or practical on Guernsey. With increased recycling, there is an increased need for markets, for storage and export of this material. In addition further infrastructure and investment will be required to support any increased recycling levels.
High Green/ Organic Diversion	A market will be needed for compost arising from green waste and from the kitchen waste collected. The input compost tonnage will increase by an additional 3,500t in 2012 however potential markets on Island are limited [Enviros 2006b].
	This scenario enables the existing landfill site to provide sufficient capacity (including a 5 year reserve) for the duration of the strategy period. This achieves the key objective of longevity of landfill capacity and is therefore a viable option.

Scenario 5 – Current Recycling with EfW

This scenario considers current recycling and green waste diversion levels with an EfW facility to be on line in 2012. Figure 22 illustrates the waste flows in this scenario.

Figure 22 Scenario 5 Flow Chart



This scenario focuses on current recycling and produces a consistent household recycling and compost rate of 21.4%, as shown in Table 19.

Table 19 Key Information for Scenario 5

Model year		Household		Non-Household		Recycled, by Facility	Inerts to Longue Hougue	Total waste diverted via recycling, composting or inerts
		Recycled	Compost	Recycled	Compost			
2005	(t)	4,531	1,206	57,114	9,690	0	149,380	221,920
	(%)	16.9%	4.5%	22.6%	3.8%		53.4%	79.4%
2008	(t)	4,843	1,289	53,809	9,465	0	136,335	205,741
	(%)	16.9%	4.5%	22.7%	4.0%		51.4%	77.5%
2012	(t)	5,320	1,416	51,205	9,249	5,130	142,789	215,109
	(%)	16.9%	4.5%	22.8%	4.1%		55.8%	84.0%
2020	(t)	6,610	1,759	54,273	9,278	5,755	146,782	224,457
	(%)	16.9%	4.5%	23.1%	4.0%		53.6%	81.9%
2026	(t)	7,778	2,070	57,052	9,301	6,321	150,399	232,921
	(%)	16.9%	4.5%	23.4%	3.8%		51.8%	80.2%
2031	(t)	8,908	2,370	59,739	9,319	6,868	153,897	241,102
	(%)	16.9%	4.5%	23.6%	3.7%		50.3%	78.8%

From 2012 there is an EfW facility which diverts 95% from disposal; however the remaining 5% is required to be exported for suitable hazardous disposal. Therefore 100% of waste entering the EfW facility is diverted from Mont Cuet landfill site. The percentage of diversion is so high because the stabilised outputs from the EfW facility can be disposed of as an input to Longue Hougue (this can be seen be the increase in inerts in Table 19 in 2012) and in 2031 there will be an additional 30,000 tonnes of inerts compared to the Baseline Scenario.

Figure 23 predicts that in this scenario Mont Cuet landfill site will not achieve full capacity within this modelling period and the 5 year reserve will be maintained throughout. It also demonstrates that by the end of the modelling period (2031) there will be approximately a further 114,000 tonnes of unused capacity at Mont Cuet landfill site.

Figure 24 illustrates a decrease in the annual waste to landfill in 2012 when the facility comes on line.

Figure 23 Waste Disposed of to Mont Cuet Landfill Site and Remaining Capacity

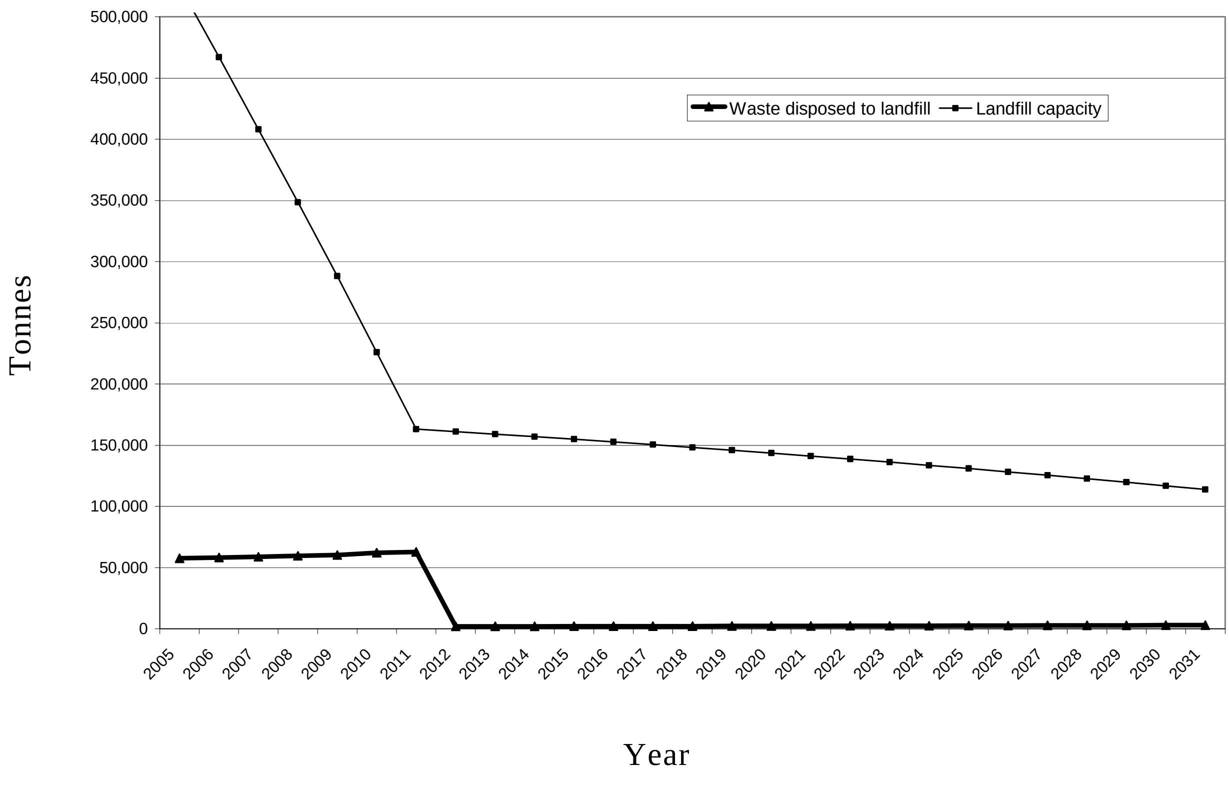
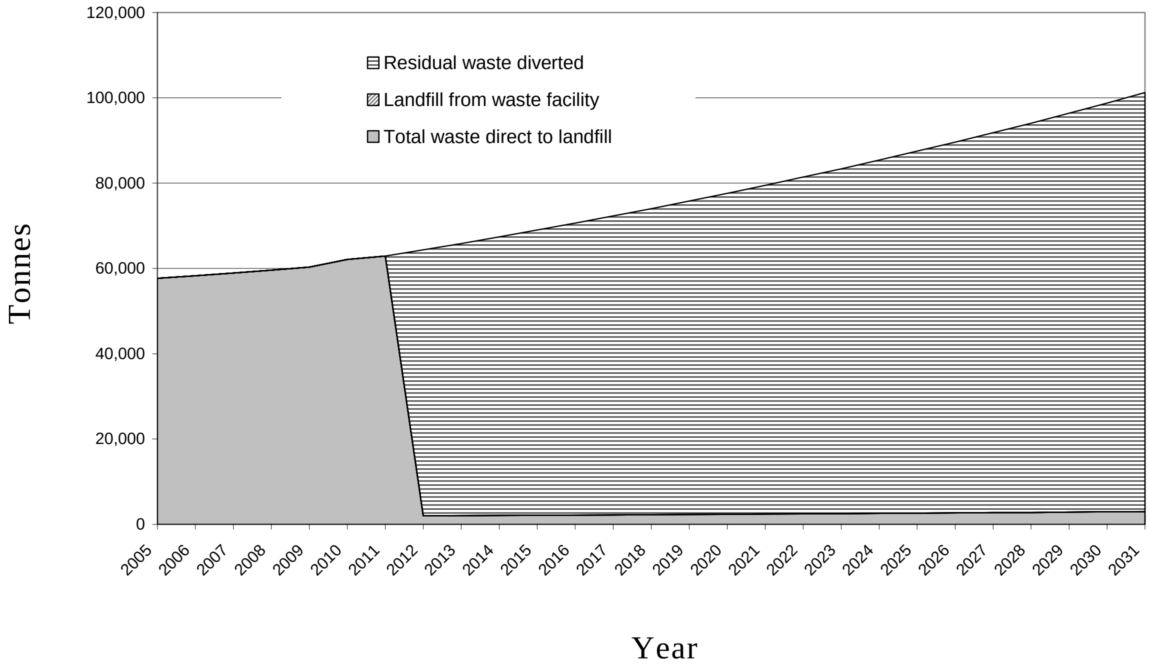


Figure 24 Treatment of Residual Waste



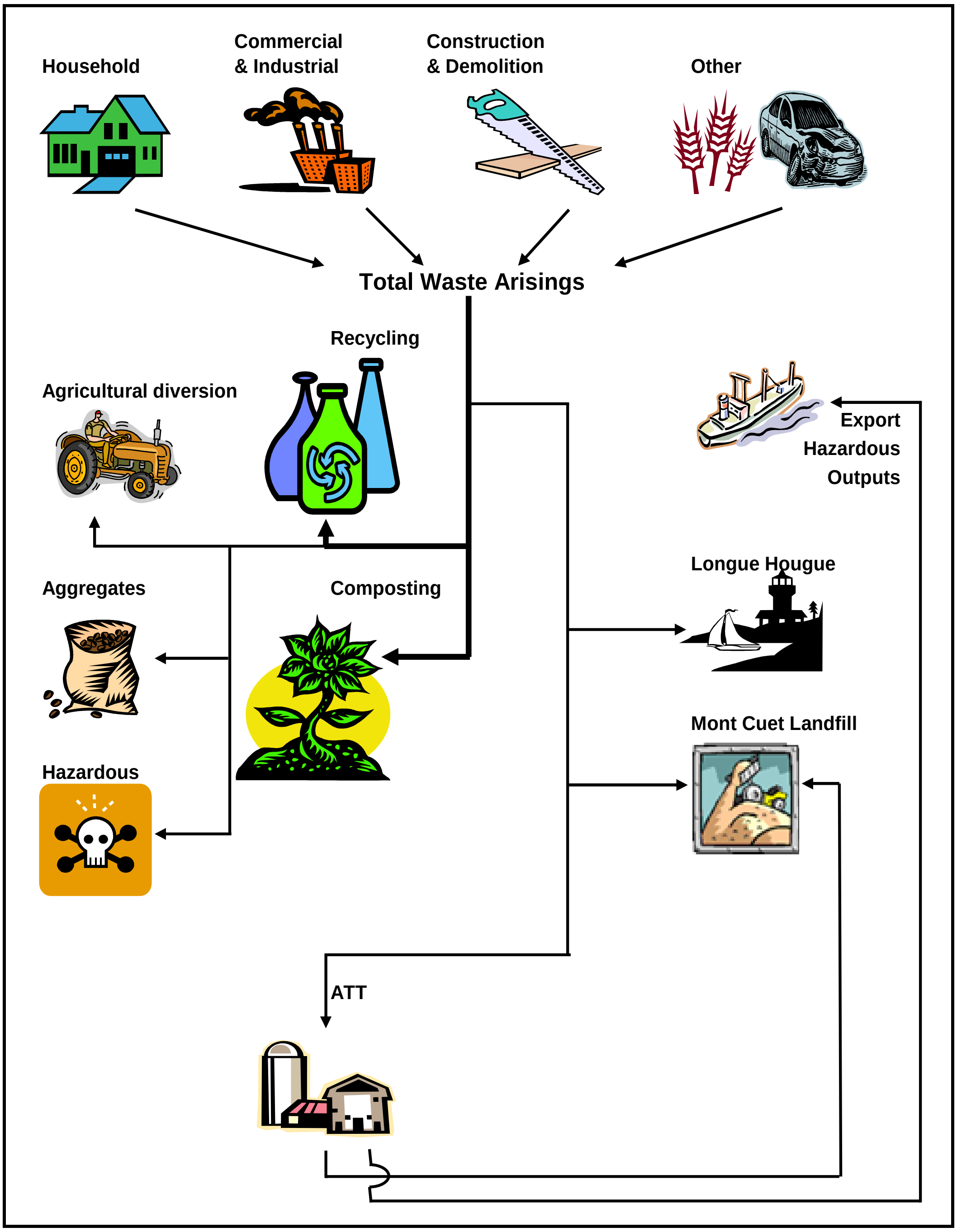
KEY ISSUES:	**Scenario 5 – Current Recycling with EfW**
End Year	Beyond 2031 5 year reserve not reached
Time Scales	Facilities on line in 2012 Decision:2007, Planning:1-2yrs, Construction:2-3yrs, Total: 3–5yrs
Tonnages	EfW capacity 98,000t Start throughout in 2012 62,000t End throughput in 2031 98,000t
Issues	
EfW Hazardous Waste	The Fly Ash from the EfW facility is deemed hazardous and will need to be exported and disposed of in the appropriate manner.
Power	This scenario will also generate electricity which can be utilised by Guernsey.

KEY ISSUES:	**Scenario 5 – Current Recycling with EfW**
Current Recycling	The current level of recycling should be achievable and easy for Guernsey to maintain ***This scenario enables the existing landfill site to provide sufficient capacity (including a 5 year reserve) for the duration of the strategy period. This achieves the key objective of longevity of landfill capacity and is therefore a viable option.***

3.8 Scenario 6 - High Recycling with ATT

This scenario considers high recycling, high green waste diversion levels followed by advanced thermal treatment as shown in Figure 25 .

Figure 25 Scenario 6 Flow Chart from 2012



Scenario 6 focuses on high recycling, which can be seen with the increase in household recycling and compost rate from 21.4% in 2001 to 50% in 2008, as shown in Table 20. Figure 25 demonstrates the increased levels of recycling and the effect of the introduction of the ATT facility in 2012.

Table 20 Key Information for Scenario 6

Model year		Household		Non-Household		Recycled, by Facility	Inerts to Longue Hougue	Total waste diverted via recycling, composting or inerts
		Recycled	Compost	Recycled	Compost			
2005	(t)	4,531	1,206	57,114	9,690	0	149,380	221,920
	(%)	16.9%	4.5%	22.6%	3.8%		53.4%	79.4%
2008	(t)	11,209	3,101	61,908	11,044	0	136,335	223,598
	(%)	39.1%	10.8%	26.2%	4.7%		51.4%	84.3%
2012	(t)	12,312	3,407	59,332	10,831	4,384	124,429	214,696
	(%)	39.1%	10.8%	26.4%	4.8%		48.6%	83.9%
2020	(t)	15,297	4,232	63,556	10,965	5,181	124,429	223,661
	(%)	39.1%	10.8%	27.1%	4.7%		45.4%	81.6%
2026	(t)	18,000	4,981	67,382	11,081	5,903	124,429	231,777
	(%)	39.1%	10.8%	27.6%	4.5%		42.9%	79.9%
2031	(t)	20,615	5,704	71,081	11,190	6,601	124,429	239,622
	(%)	39.1%	10.8%	28.1%	4.4%		40.7%	78.3%

The increase in recycling in 2008 causes a decrease in the waste sent to landfill, as can be seen in Figure 27 , with a step decrease in annual residual tonnage.

From 2012 there is an ATT facility which diverts 67% of waste from landfill due to mass reduction. The diversion from landfill can be seen in Figure 26 with another decrease in annual waste to landfill in 2012.

In this scenario Mont Cuet landfill site is predicted to reach full capacity in 2024 (Figure 26 The 5 year reserve will be reached in 2019. It also demonstrates that by the end of the modelling period (2031) there will be a further need for the disposal of a further 175,000 tonnes of residual waste for which there is currently no capacity on Guernsey.

However if the char, underwent further processes and was oxygenated or passed through a gasification plant, the output may be considered inert and therefore there would be less residual waste to dispose of at Mont Cuet landfill site.

Figure 26 Waste Disposed of to Mont Cuet Landfill Site and Remaining Capacity

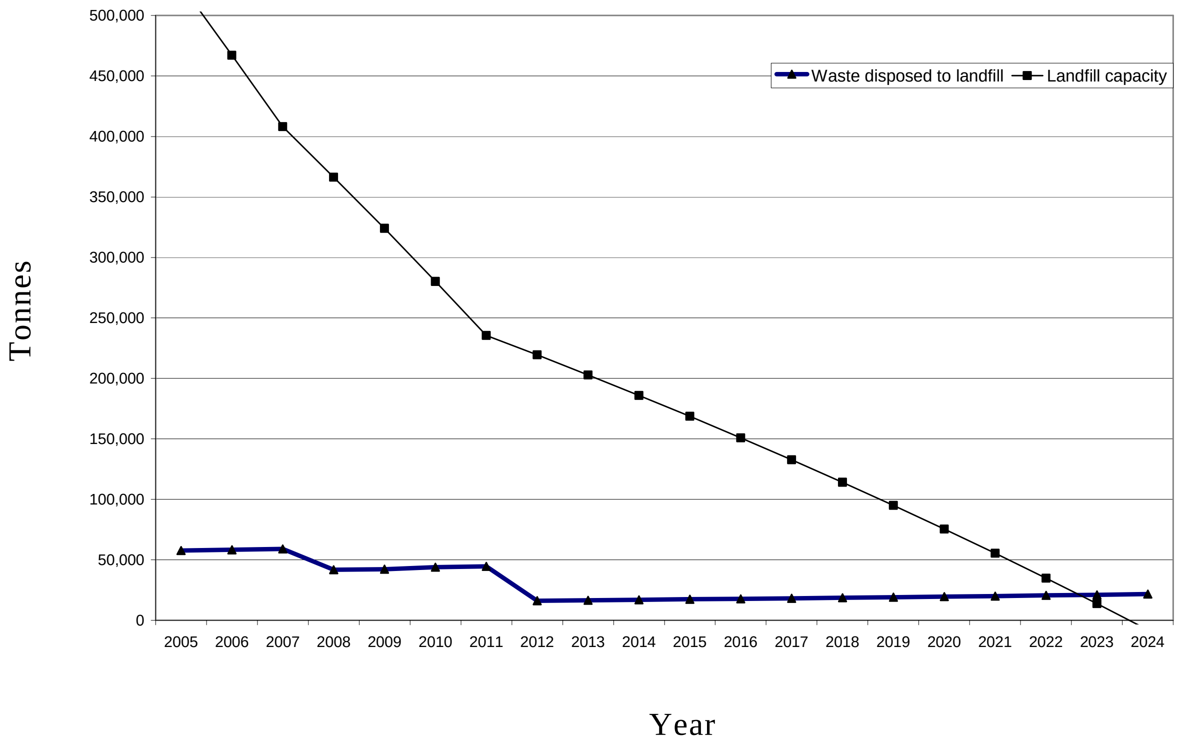
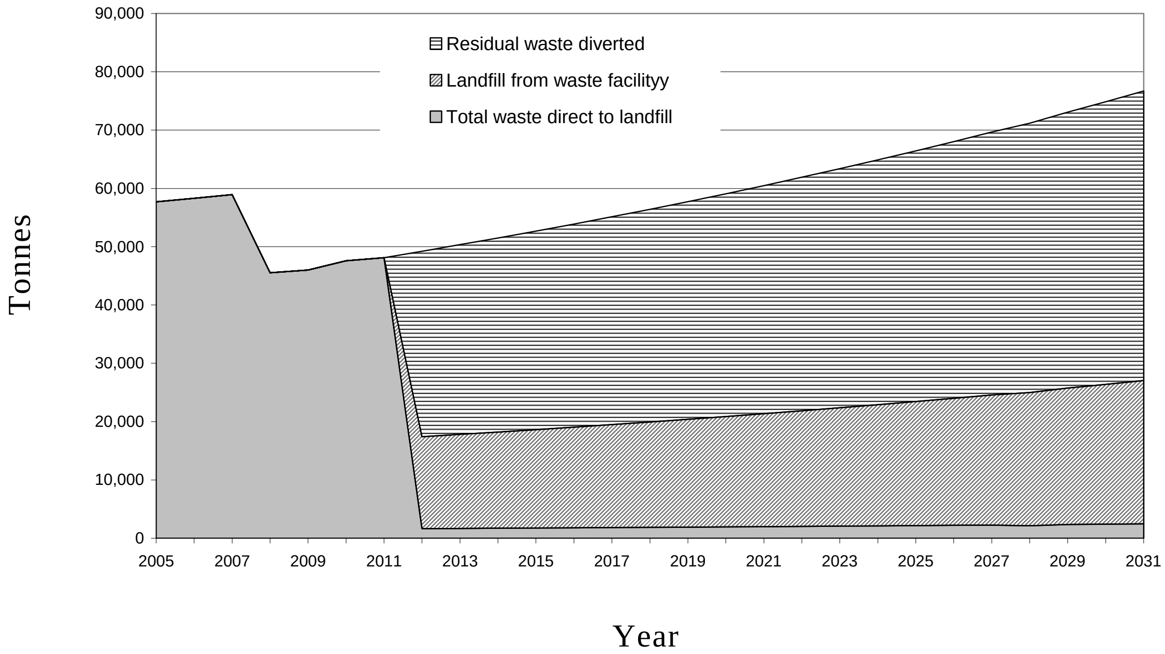


Figure 27 Treatment of Residual Waste



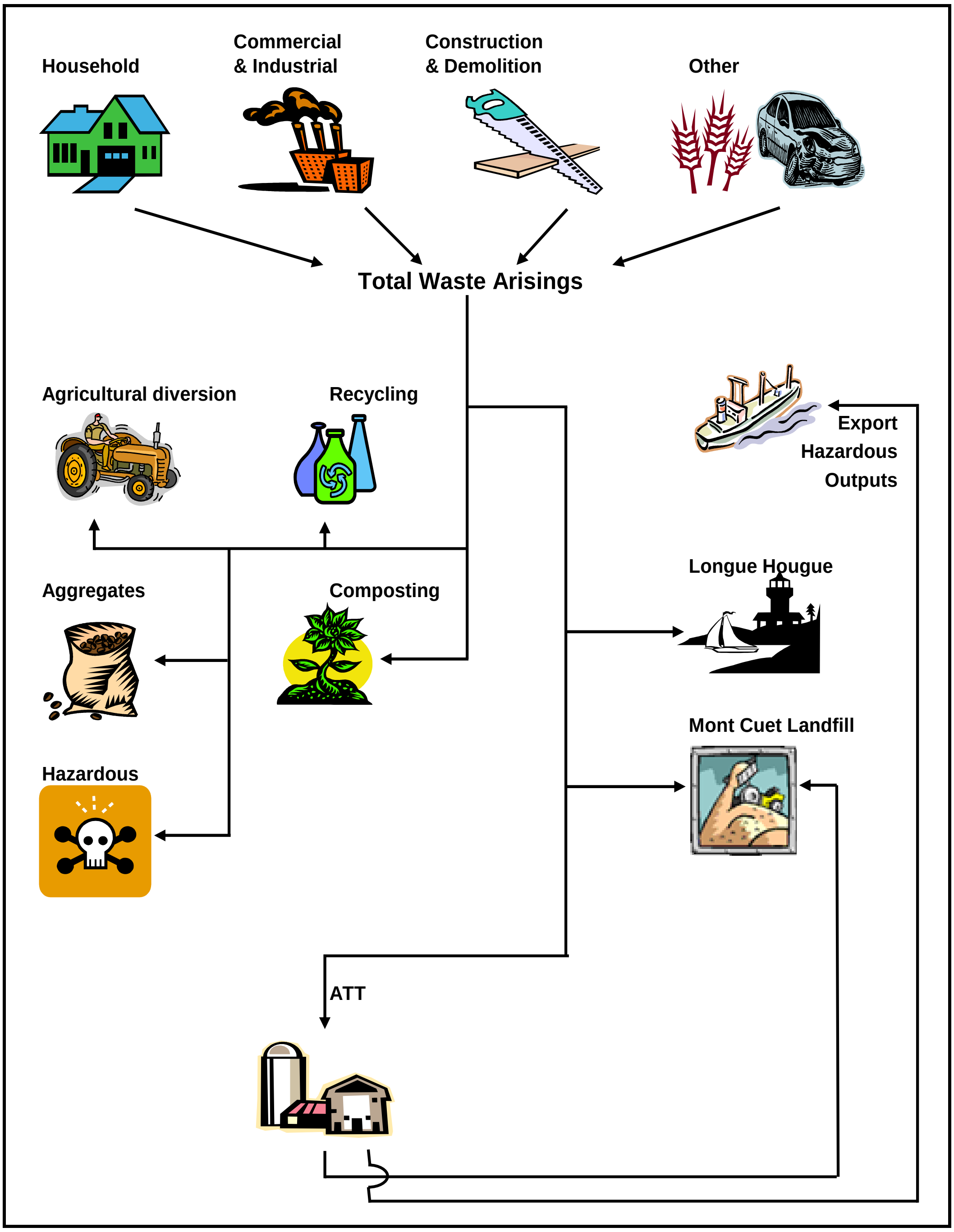
KEY ISSUES:	**Scenario 6 – High Recycling with ATT**	
End Year	2024 5 year reserve starts in 2019	
Time Scales	Facilities on line in 2012 Decision: 2007, Planning: 1-2yrs, Construction: 2-3yrs, Total: 3 – 5 yrs	
Tonnages	ATT facility capacity Start throughout in 2012 End throughput in 2031	71,000t 44,000t 71,000t
Issues		
Feedstocks	ATT does not have a proven track record with variable feedstock of MSW and C&I waste	
Char	The Char output from the ATT facility is not considered to be inert and therefore could not be disposed at Longue Hougue. This material would therefore be disposed of via landfill,	

KEY ISSUES:	**Scenario 6 – High Recycling with ATT**
	however if a different outlet could be sourced for this material it would lengthen the life of Mont Cuet landfill site, as a smaller tonnage would need to be disposed via landfill. An alternative option would be to send the Char via a gasification facility to ensure the output was inert, however this would have further high capital cost implications.
ATT Hazardous waste	The Fly Ash from the ATT is deemed hazardous and will need to be exported and disposed of in the appropriate manner.
Power	This scenario will also generate electricity which can be utilised by Guernsey.
Syngas	The Syngas output would either require a market on island The high recycling scenario is based on best practice of high recycling rates in the UK. However, it should be noted that the model does not imply these recycling rates are achievable or practical on Guernsey.
High Recycling	With increased recycling, there is an increased need for markets, for storage and exportation of this material. In addition further infrastructure and investment will be required to support any increased recycling levels.
High Green/ Organic Diversion	A market will be needed for compost arising from green waste and from the kitchen waste collected. The input compost tonnage will increase by an additional 3,500t in 2012, however potential markets on Island are limited [Enviros 2006b].
	Mont Cuet landfill site will reach capacity in 2024. Whilst landfill capacity is not extended as long as the other scenarios, if the Char (bottom ash of ATT) were further treated and thus classified as iner, it would be a comparable to the conventional EfW.

3.9 Scenario 7 – Current Recycling with ATT

This scenario considers current recycling and green waste diversion levels followed by advanced thermal treatment, as shown in Figure 28 .

Figure 28 Scenario 7 Flow Chart from 2012



Scenario 7 has a consistent household recycling and composting rate of 21.4%, as shown in Table 21. This table also shows the ATT facility increases recycling, as it segregates the metal from residual waste. However the main process of diversion using an ATT facility is due to mass reduction. Therefore diversion of waste will increase but recycling and composting will remain relatively constant.

Table 21 Key Information for Scenario 7

Model year		Household		Non-Household		Recycled, by Facility	Inerts to Longue Hougue	Total waste diverted via recycling, composting or inerts
		Recycled	Compost	Recycled	Compost			
2005	(t)	4,531	1,206	57,114	9,690	0	149,380	221,920
	(%)	16.9%	4.5%	22.6%	3.8%		53.4%	79.4%
2008	(t)	4,843	1,289	53,809	9,465	0	136,335	205,741
	(%)	16.9%	4.5%	22.7%	4.0%		51.4%	77.5%
2012	(t)	5,320	1,416	51,205	9,249	7,767	124,429	199,386
	(%)	16.9%	4.5%	22.8%	4.1%		48.6%	77.9%
2020	(t)	6,610	1,759	54,273	9,278	9,107	124,429	205,457
	(%)	16.9%	4.5%	23.1%	4.0%		45.4%	75.0%
2026	(t)	7,778	2,070	57,052	9,301	10,322	124,429	210,951
	(%)	16.9%	4.5%	23.4%	3.8%		42.9%	72.7%
2031	(t)	8,908	2,370	59,739	9,319	11,496	124,429	216,261
	(%)	16.9%	4.5%	23.6%	3.7%		40.7%	70.7%

From 2012 there is an ATT facility which diverts 67% from landfill, as the residual waste is converted to char. The diversion from landfill can be seen in Figure 30 with the decrease in waste to landfill starting in 2012.

Figure 29 shows Mont Cuet landfill site will reach capacity in 2018 and therefore the 5 year reserve will be reached in 2013. It also demonstrates that by the end of the modelling period (2031) there will be a need for the disposal of approximately a further 408,000 tonnes of residual waste but for which there is currently no capacity on Guernsey.

However if the char underwent further processes and was oxygenated or passed through a gasification plant, the output may be considered inert and therefore there would be less residual waste to dispose of at Mont Cuet landfill site.

Figure 29 Waste Disposed of to Mont Cuet Landfill Site and Remaining Capacity

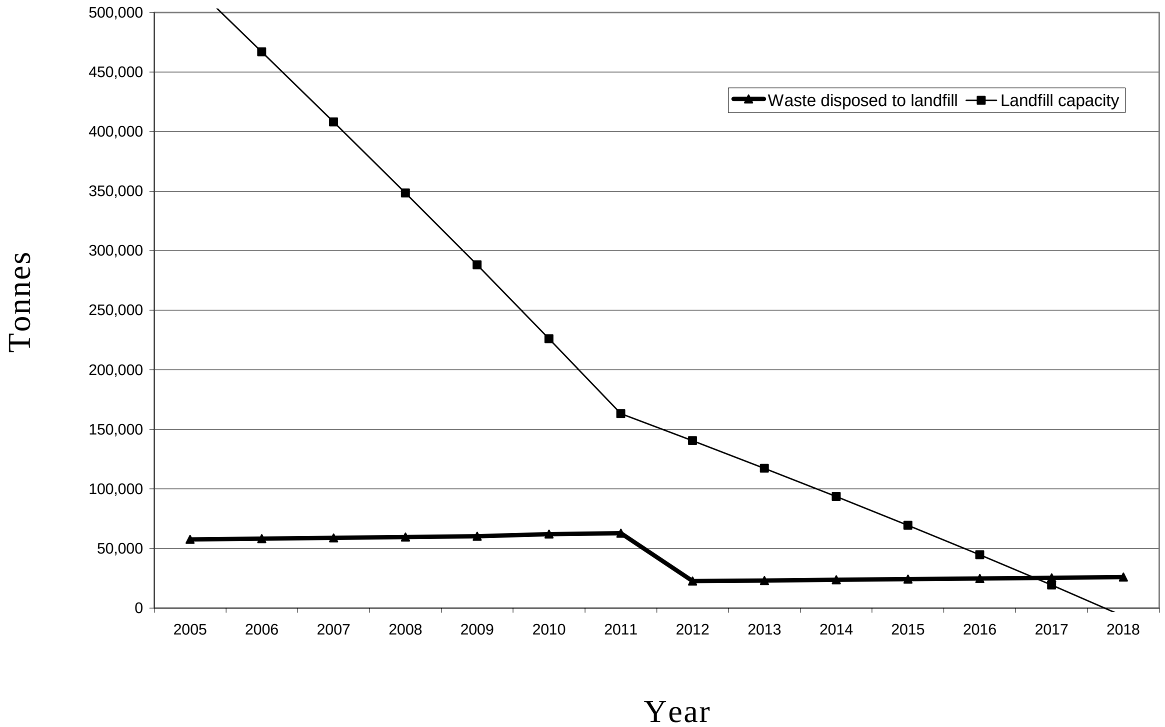
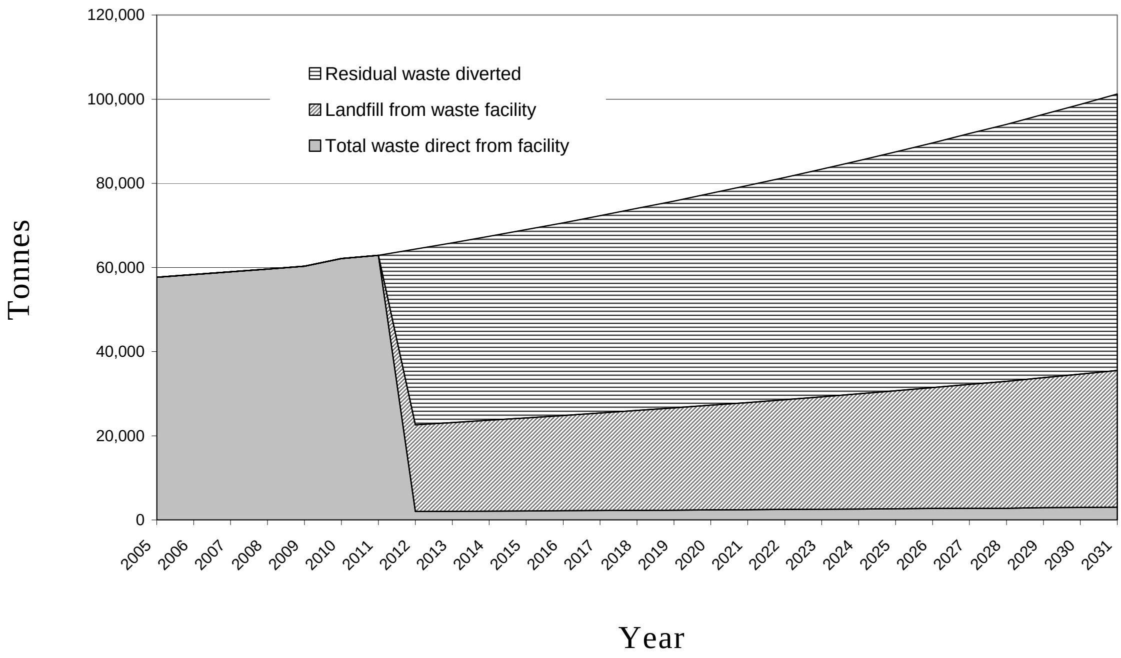


Figure 30 Treatment of Residual Waste



KEY ISSUES:	**Scenario 7 – Current Recycling with ATT**	
End Year	2018 5 year reserve starts in 2013	
Time Scales	Facilities on line in 2012 Decision: 2007, Planning: 1-2yrs, Construction: 2-3yrs, Total: 3 – 5 yrs	
Tonnages	ATT facility capacity Start throughout in 2012 End throughput in 2031	98,000t 62,000t 98,000t
Issues		
Feedstocks	ATT does not have a proven track record with variable feedstock of MSW and C&I waste	
Char	The Char output from the ATT facility is not considered to be inert and therefore could not be disposed at Longue Hougue. This material would therefore be disposed of via landfill, however if a different outlet could be sourced for this material it	

KEY ISSUES:	**Scenario 7 – Current Recycling with ATT**
	would lengthen the life of Mont Cuet landfill site, as a smaller tonnage would need to be disposed via landfill. An alternative option would be to send the Char via a gasification facility to ensure the output was inert, however this would have further high capital cost implications.
ATT Hazardous waste	The Fly Ash from the ATT is deemed hazardous and will need to be exported and disposed of in the appropriate manner.
Power	This scenario will also generate electricity which can be utilised by Guernsey.
Syngas	The Syngas output would either require a market on island
Current Recycling	The current level of recycling should be achievable and maintainable for Guernsey
	Mont Cuet landfill site will reach capacity in 2018. Whilst landfill capacity is not extended as long as the other scenarios, if the Char (bottom ash of ATT) were further treated and thus classified as inert, it would be a comparable to the conventional EfW.

3.10 Comparison of Results

This section compares the main results of the modelling of mass flow of waste on Guernsey. It provides a summary table presenting key results of:

- Capacity of the facilities modelled;
- Start year of the facilities (2012);
- Annual tonnage processed through the facility for its start year;
- The percentage of waste processed through the facility that is diverted from landfill;
- The year that Mont Cuet landfill site is predicted to reach full capacity;
- Remaining landfill capacity at Mont Cuet in 2031

This information is set out in Table 22. Figure 31 shows the predicted residual waste needing final disposal until 2031 and Figure 32 shows the predicted capacity for Mont Cuet landfill site for each scenario.

Table 22 Summary of the scenarios and the tonnage capacity of the facilities and Mont Cuet landfill site

Scenario and Description	Year Mont Cuet landfill site reaches capacity	Capacity of Facility Modelled (based on capacity in 2031)	Start year of Facility	Start Capacity Required (t)	Percentage of input to facility sent to Mont Cuet landfill site	Remaining landfill capacity (t) at Mont Cuet landfill site in 2031
1 – Baseline	2014	N/A	N/A	N/A	100%	-1,463,000
2- High recycling with MBT (AD) & EfW	2029	MBT – 71,000 EfW – 41,000	2012	44,000 25,000	21% total	-44,000
3a - Current recycling with MBT (AD) & EfW	2023	MBT – 98,000 EfW – 58,000	2012	62,000 36,000	17% total as EfW 0%	-151,000
3b - No recycling with MBT (AD) & EfW	2023	MBT – 114,000 EfW – 68,000	2012	72,000 42,000	15% as EfW 0%	-167,000
4 – High recycling with EfW	Beyond 2031	71,000	2012	44,000	0%	198,000
5 – Current recycling with EfW	Beyond 2031	98,000	2012	62,000	0%	114,000
6 – High recycling with ATT	2024	71,000	2012	44,000	33%	-175,000
7 - Current recycling with ATT	2018	98,000	2012	62,000	33%	-408,000

Figure 31 Predicted Annual Tonnage of Residual Waste to Landfill for Each Scenario

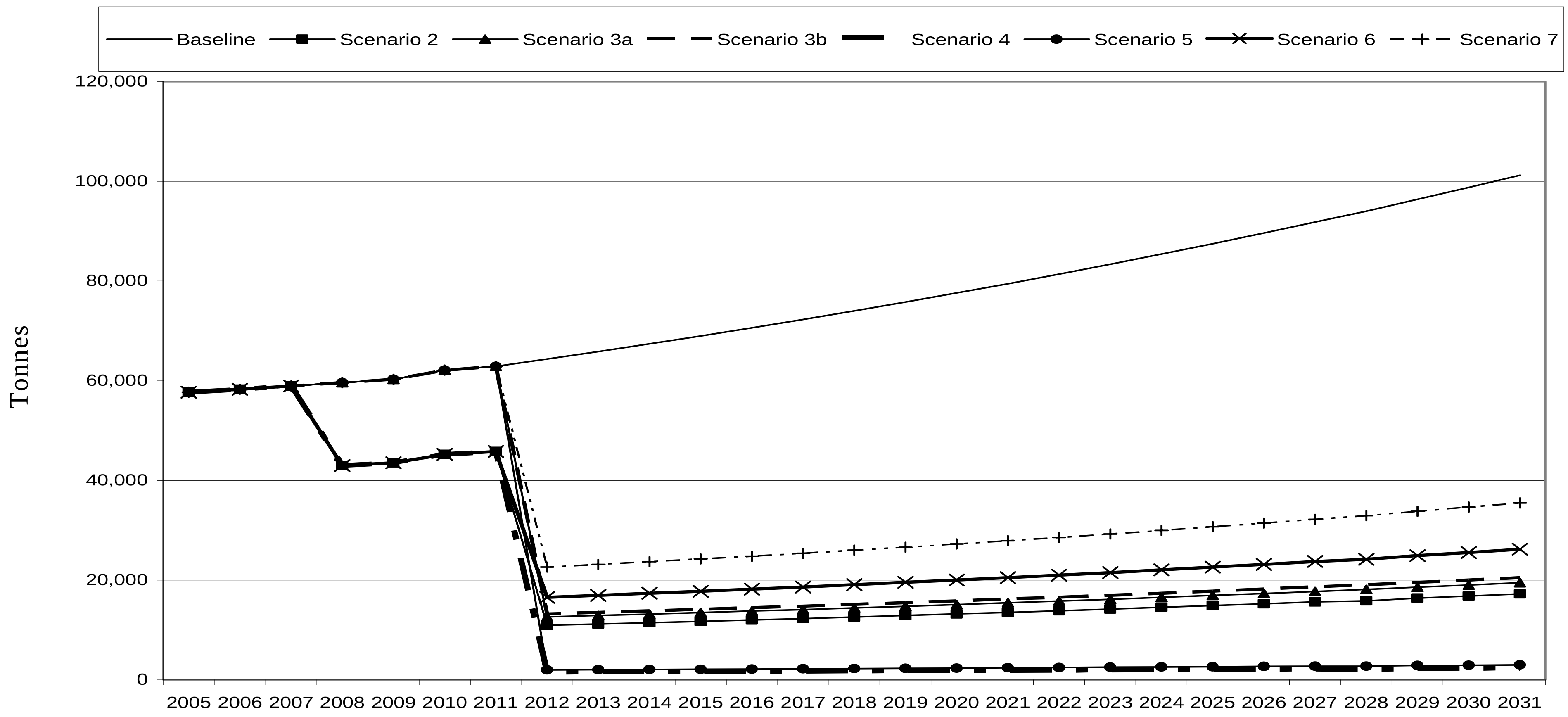
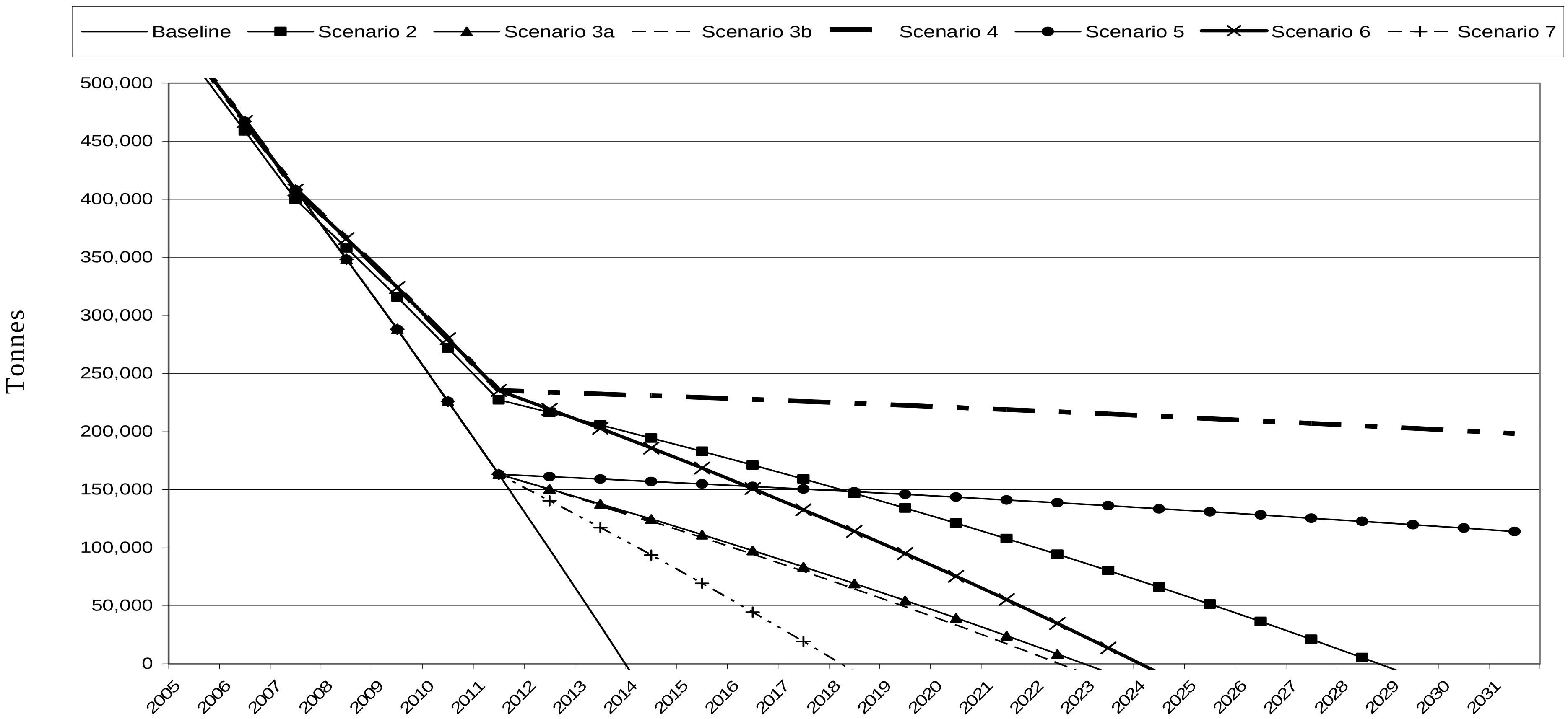


Figure 32 The Predicted Annual Capacity for Mont Cuet Landfill Site for Each Scenario



3.10.1 Discussion on Modelling Outputs

Figure 31 and Figure 32 shows the year Mont Cuet landfill site is predicted to reach capacity for each scenario. Using this information, the scenarios can be ranked according to their performance as follows:

Scenario	Year Mont Cuet landfill site reaches capacity	Waste diverted from Mont Cuet landfill site by facility (%)
4 – High recycling with EfW	Beyond 2031	100
5 - Current recycling with EfW	Beyond 2031	100
2 – High recycling with MBT (AD) & EfW	2029	79
6 – High recycling with ATT	2024	67
3a – Current recycling with MBT (AD) & EfW	2023	83
3b – No recycling with MBT (AD) & EfW	2023	85
7 – Current recycling with ATT	2018	67
Baseline	2014	0

The figures demonstrates that both EfW facility scenarios (Scenarios 4 and 5) significantly extend the landfill capacity at Mont Cuet landfill site and it is predicted these will not reach capacity during the period modelled. The remaining capacity after 2031 is in the region of 198,000 and 114,000 tonnes respectively. This is because this option diverts almost 100% of the waste (entering the facility) from Mont Cuet landfill site. Therefore the waste disposed to landfill is only non-conforming waste (e.g. hazardous waste etc.) in the region of 1,000 to 3,000 tonnes per annum (see Figure 31).

However the life expectancy of Mont Cuet landfill for these scenarios (4 and 5) is reliant on the development and continuation of markets / outlets of the inert waste (bottom ash) to Longue Hougue or as aggregates.

Figure 32 shows the scenario predicted to extend the longevity at Mont Cuet landfill site next most is Scenario 2 – high recycling with MBT facility feeding AD with RDF to EfW facility. The high recycling scheme begins in 2008, four years before the MBT facility is operational. This increases the life expectancy of Mont Cuet landfill site compared to Scenarios 3a and 3b. Scenario 2 results in a smaller sized facility being required due to the high level of recycling. In this scenario the waste entering the MBT facility has a lower proportion of material suitable for an AD or to be pulled out by the mechanical sorting in comparison with Scenarios 3a and 3b. Therefore a greater proportion of the waste entering the MBT facility will go to landfill in Scenario 2 (21%) compared to Scenario 3a (17%) and then 3b (15%) as shown in Table 22.

The success of any of the MBT facility scenarios is dependent on an EfW facility being available to accept the RDF and the organic fraction as an output from the MBT / AD combination. In Scenario 2, if the EfW facility is not built, either another outlet or disposal route for 25,000 tonnes will be required in 2012 (as shown in Table 22). It has been modelled that there would be an EfW facility with a capacity of 41,000tpa, however in reality the minimum viable capacity of an EfW facility is approximately 50,000tpa.

Figure 32 shows the time differences, with regard to life expectancy for Mont Cuet landfill site. Differences between Scenarios 2 and 3a and 3b are due to the impact of recycling and the timings for implementing the recycling schemes. In Scenario 2, the high recycling scheme begins in 2008, 4 years before to the MBT facility is operational. This increases the life expectancy of Mont Cuet landfill site by five years and also affects the size of the facility, decreasing it to 71,000tpa (as shown in Table 22) compared to Scenario 3a (which is current recycling with the with an MBT facility of 98,000 tpa capacity.)

However Scenario 3a continues with the existing recycling schemes and Scenario 3b stops recycling in the same year as the facility is operational (i.e. 2012). For both Scenarios 3a and 3b Mont Cuet landfill site is predicted to reach capacity in 2023. This is because 3a and 3b are modelled in the same way up to 2011. In 2012, Scenario 3b sends 5% more waste to Mont Cuet landfill site than Scenario 3a. However this is in the region of only 600 tonnes of additional waste for Scenario 3b above 12,600 tonnes sent in Scenario 3a. Therefore at this stage the "no recycling" (Scenario 3b) has little difference in waste flows compared to the results of "current recycling" (Scenario 3a).

In comparing Scenarios 3a and 3b only, the size of the required facility is altered, Scenario 3a – 98,000tpa and 3b – 114,000tpa (as shown in

Table 22). However there is little impact on extending the life expectancy of Mont Cuet landfill site if “no recycling” is introduced at the same time as the facility.

The date of implementing “no recycling” has major implications. If introduced prior to the facility being operational it will decrease the life expectancy of Mont Cuet landfill site.

High recycling with ATT (Scenario 6) increases the life expectancy of Mont Cuet landfill site to 2024 (as shown in Figure 32), as it diverts 67% of the waste entering the ATT facility from landfill. Again, the high recycling option increases the life expectancy compared to current recycling with ATT (Scenario 7) which predicts the landfill will reach capacity in 2018. Whilst landfill capacity is not extended as long as by other scenarios, if the Char (bottom ash of ATT) were further treated and classified inert, Scenario 6 and Scenario 7 would be a comparable to the conventional EfW.

The scenario that produces the greatest amount of waste to be disposed of to landfill and has the shortest landfill life expectancy is the Baseline Scenario. This scenario results in Mont Cuet landfill site reaching capacity by 2014.

3.10.2 Other Issues

Section 3.10.1 discusses the scenarios in relation to the main outputs including tonnages to Mont Cuet landfill site, the year Mont Cuet reaches capacity and diversion of waste. However there are also other issues that need to be considered and that have been raised in the summary of each scenario.

These include:

- **Feedstock;**
  - MBT and ATT facilities do not have a proven track record with variable feedstock of MSW and C&I waste
  - EfW facilities do have a proven track record with variable feedstock of both MSW and C&I waste
- **Outputs from the facilities;**
  - There are limited markets available on Guernsey.
  - MBT facility will require a market for recyclates and RDF (Scenario 2, 3a and 3b).

- EfW facility will require use of the existing market for the bottom ash (inert waste) (Scenario 4 & 5).

- ATT will require a market for syngas (Scenario 6 & 7).

- **Other benefits**

  - EfW, AD and ATT facilities all enable electricity to be generated. This can be utilised on Guernsey. (All scenarios)

- **Recycling Schemes**

  - For the **“High Recycling”** scenarios, markets will need to be developed. The high recycling scenario is based on best practice of high recycling rates in the UK. However, it should be noted that the model does not imply that these recycling rates are achievable or practical on Guernsey. With increased recycling, there is an increased need for markets, for storage and export of this material. In addition further infrastructure and investment will be required to support any increased recycling levels (Scenarios 2, 4 & 6)

  - **Current Recycling** can continue with existing facilities (Scenarios 3a, 5 & 7)

  - **No Recycling** may have a risk of resistance to apparently decreasing the recycling provision on the Island. Whilst there is no recycling in advance of waste deliveries to the facility, recyclates are extracted as part of the process.

Further details and issues on the generic technologies are addressed in the New Technologies report [Enviros 2006c].

KEY ISSUES:	**Comparing Waste Flows for All Scenarios**	
Ranking of End Year	1. Scenario 4	Beyond 2031
	2. Scenario 5	Beyond 2031
	3. Scenario 2	2029
	4. Scenario 6	2024
	5. Scenario 3a	2023
	6. Scenario 3b	2023
	7. Scenario 7	2018
	8. Baseline	2014
Time Scales	Facilities on line in 2012 Decision: 2007, Planning: 1-2yrs, Construction: 2-3yrs, Total: 3 – 5 yrs	
Size of facilities	High Recycling scenarios (2, 4 & 6).	71,000t
	Start throughout in 2012	44,000t
	End throughput in 2031	71,000t
	Current Recycling scenarios (3a, 5 & 7)	98,000t
	Start throughout in 2012	62,000t
	End throughput in 2031	98,000t
	No Recycling scenario (3b)	114,000t
	Start throughout in 2012	72,000t
	End throughput in 2031	114,000t
Other Considerations		
Increased recycling	Scenario 2, 4 and 6 will all require further investment and infrastructure to achieve these high recycling and green diversion rates.	
Markets for outputs from facility	Scenarios 4 & 5 have markets on the island. Scenarios 2, 3a & 3b need to develop recyclate market on Guernsey or export recyclate. Also need EfW facility for RDF. Scenarios 6 & 7 need to develop a market for Syngas	
Feedstock	Only Scenarios 4 & 5 have a proven track record for variable waste streams	
Power/ electricity	All facilities modelled, except the Baseline, generate electricity.	

4. COSTS

In order to understand the relative costs of the waste treatment options being assessed in this report a cost modelling exercise has been undertaken.

The potential costs of the technology options described in the eight Scenarios were modelled for comparative purposes only. As Enviros has considered "generic" treatment solutions at this stage cost information is based on U.K. reported costs and cost information supplied by the Environment Department of the States of Guernsey. Actual costs will depend on variables such as the treatment technology supplier, the configuration of the facility and there may be additional costs attributable to Guernsey's location. The methodology and assumptions used in the cost modelling are given below.

4.1 Methodology

The tonnage outputs from the material flows model for each scenario were fed into the cost model in order to calculate the capital and operating expenditure associated with each of the residual waste treatment options, including the cost of residual waste being disposed via Mont Cuet landfill site. The model has calculated the year on year and total project costs of the selected residual waste treatment technologies options.

The cost modelling exercise is intended to allow comparison between the different technology options and associated revenues. However it excludes any collection costs and revenues from separated recyclates and inerts (i.e. recyclates and inerts separated from the residual waste prior to treatment). The modelling also does not take account of any procurement, planning or financing costs. The results have been displayed as both nominal costs (non-discounted costs with present day costs with inflation rate applied) and Net Present Value (NPV), the present value of the expected future cash flows, by using a discount rate of 5% on the nominal value.

This methodology provides indicative costs for the different scenarios for comparative purposes only.

4.2 Assumptions

4.2.1 New Waste Treatment Facility Development and Operation

Facility Capacities

The estimate of the facility development period has been based on the assumption that a decision on the preferred technology will be taken by early 2007. The procurement process will start immediately with the planning phase due to start in 2009 and construction in 2010 (optimum times have been estimated for the cost modelling).

Table 23 Facility Development Phasing Assumptions

Facility Type	Planning	Construction	Total Development Period	Year facility comes on line
MBT-AD	1 yrs	2 yrs	3 yrs	2012
EfW	1 yrs	2 yrs	3 yrs	2012
ATT	1 yrs	2 yrs	3yrs	2012
Assume no land acquisition required as facilities will be built on The States of Guernsey land				
Assume commissioning carried out during construction				

Each residual waste treatment facility was sized to ensure that all waste could be processed each year up to and including 2031 (Table 24).

Table 24 Waste Treatment Facilities Capacities ('000 tpa) Required for each scenario

Technology	MBT-AD	EfW	ATT
Year facility in operational	2012	2012	2012
Baseline	n/a	n/a	n/a
Scenario 2	71	41	n/a
Scenario 3a	98	58	n/a
Scenario 3b	114	68	n/a
Scenario 4	n/a	71	n/a
Scenario 5	n/a	98	n/a
Scenario 6	n/a	n/a	71
Scenario 7	n/a	n/a	98

The EfW facility in Scenario 2 is modelled at 41,000 tpa, however an EfW facility of this scale may not be viable. Therefore the EfW facility in this scenario will likely be at a minimum of 50,000tpa. However the costs have all be based on the facility capacity of 41,000tpa, to provide a like for like comparison.

Capital and Operational Expenditure Costs

Current (2005) nominal capital expenditure (Capex) and operational expenditure (Opex) costs were used. These costs were then inflated at a rate of 2% [Enviros, 2006b] from 2005 to the year in which the facility is constructed/operated. Both Capex and Opex were adjusted to reflect economies of scale of increased facility capacity. Capex costs for facilities were obtained from Enviros' previous working experiences, combined with published data sources [EA, 2006]. These sources provide examples of technologies, similar in capacity and nature, to those that could potentially be used by the States of Guernsey. However the Capex and Opex are not actual contract values as these will vary by supplier and local area / logistics. The costs outlined in Table 25 are purely for comparative purposes and Guernsey should expect higher construction costs. Opex costs (£/t) vary between scenarios for the same technology due to the assumed impact of technology capacity on Opex cost.

The Opex has been assumed to be constant through out the modelling period (see Table 25), however in reality there would be cost efficiencies through the life time of the waste facility. Most waste facilities are cost efficient when operating close to full capacity. Enviros has based the size of the facilities on the predicted input to the facility in 2031, however when the facility comes into operation in 2012 it will not be operating at full capacity. Therefore in reality there will be a variation in Opex through time that varies with the tonnage input to the facility. In this comparative modelling, the Opex remains constant and is linked directly with the tonnage input to the facility.

Table 25 Facility Costs (Capex and Opex)*

Technology	MBT-AD		EfW		ATT	
Year** / Scenario	2012		2012		2012	
	Capex	Opex	Capex	Opex	Capex	Opex
Baseline	—	—	—	—	—	—
Scenario 2	£25m	£40/t	£18m	£52/t	—	—
Scenario 3a	£31m	£36/t	£23m	£46/t	—	—
Scenario 3b	£35m	£34/t	£26m	£43/t	—	—
Scenario 4	—	—	£27m	£42/t	—	—
Scenario 5	—	—	£34m	£38/t	—	—
Scenario 6	—	—	—	—	£81m	£49/t
Scenario 7	—	—	—	—	£102m	£44/t

* Opex costs increase with inflation (2.0%) from year of commencement of operation.

** Year facility is operational.

For Scenarios 2, 3a and 3b the biogas output from the MBT (AD) facility will require a gas engine as part of the capital expenditure. However the Capex of a gas engine is relatively small compared to the Capex of any of the waste facilities modelled and therefore is considered negligible.

Table 26 outlines the landfill costs for non hazardous and hazardous wastes disposed at Mont Cuet landfill site and inert waste (from the waste facility) disposed at Longue Hougue. Mont Cuet landfill site cannot accept hazardous fly ash from ATT or EfW facilities. Therefore this waste would be exported for disposal in the U.K.

Table 26 Landfill Costs

Year	2005 Cost / tonne
Landfill Cost (non-hazardous) *	£86.20
Landfill Cost (Hazardous) **	£122.40
Inert Landfill Cost†	£7.30
Export of Fly ash††	£200.00

* "Notice to All Waste Disposal customers" dated 3rd October 2005. The Mont Cuet landfill gate fee is £86.20 per tonne; this is assumed to be the cost.

** Notice to All Waste Disposal customers" dated 3rd October 2005. The Mont Cuet landfill for special waste gate fee is £122.40 per tonne; this is assumed to be the cost.

† "Notice to All Waste Disposal customers" dated 3rd October 2005. Longue Hougue cost per tonne is taken to be equal to the gate fee for inerts at £7.30 per tonne.

†† Cost includes export and gate fee to a suitable landfill site in the U.K.[31]

Table 27 Metal and Energy Revenues from Facilities

Materials[31]	Net price (£/t)
Metals (from MBT, ATT & EfW)*	(£45)
Energy from EfW	£22.55
Energy from ATT	£22.55
Energy from AD biogas	£4.10

Energy prices are presented as pound sterling per tonne of waste input to the facility. This price has been calculated assuming revenue from the sale of energy is 4.1p/kWh[31]. The EfW facility is assumed to create 550 kWh/t[31]. This equates to a revenue of £22.55 per tonne for energy produced in the EfW facility. The same rate has been assumed for the ATT facility. The same approach has been used to calculate the revenue from the sale of the biogas from the AD facility assuming an energy yield of approximately 100 kWh/t. This equates to a revenue of £4.10 per tonne of input waste.

31 Source: Environment Department of the States of Guernsey

It must be noted that any recyclates, organics or inerts separated from the residual waste before entering Mont Cuet landfill site or the waste facility are not included as part of this comparative cost exercise.

4.2.2 Modelling Timeframe and Project Scope

To allow the scenarios to be compared on a like for like basis, all scenarios are modelled from 2005 until 2031. However, for those Scenarios where Mont Cuet landfill site has reached capacity before the end of the modelled period, it is assumed that the waste which would have been disposed of to Mont Cuet Landfill site is exported off-island for disposal. An export and disposal cost of £130 per tonne 32[31] is assumed

4.3 Results

4.3.1 Results Presentation

The results of the cost modelling exercise are summarised in Sections 4.3.2 and 4.3.3 . The results are presented as both nominal and NPV costs of each of the waste technologies facilities for the different scenarios and are broken down into the following sections:

- **Capex** includes the total capital expenditure on the waste facilities for each scenario.
- **Opex** includes the operational cost for each waste facility and any export costs for residual or rejects once Mont Cuet has reached capacity and export costs for any hazardous fly ash that require export.
- **Facility Revenue** includes revenues from energy and any recyclates derived from the facility.
- **Landfill Costs** include the cost to dispose of any residual and hazardous waste to Mont Cuet landfill site and any inerts into Longue Hougue.
- **Total** is the Capex, Opex, Facility Revenue and Landfill costs combined.

The detailed results for each scenario in key years are provided in Appendix 7.

32S Source: Environment Department of the States of Guernsey [Billet D'Etat 2006].

However two examples are provided below to explain different costs through time. Table 28 shows that when Mont Cuet landfill site reaches capacity in 2014, there are no longer any landfill costs on island. The residual waste is assumed to be exported from this point and included as the Opex costs. (See Appendix 7).

Table 28 Baseline Scenario Nominal Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	-
Opex	-	-	-	13.7	17.8	22.2	277.4
Facility Revenue	-	-	-	-	-	-	-
Landfill cost	4.9	5.4	6.3	-	-	-	54.1
Total	**4.9**	**5.4**	**6.3**	**13.7**	**17.8**	**22.2**	**331.4**

Table 29 Scenario 3a Nominal Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	54.9
Opex	-	-	4.3	6.1	11.5	14.3	166.1
Facility Revenue	-	-	- 1.0	- 1.4	- 1.8	- 2.3	-30.9
Landfill cost	4.9	5.4	1.3	1.8	0.1	0.1	57.9
Total	**4.9**	**5.4**	**4.6**	**6.5**	**9.7**	**12.1**	**248.0**

Table 29 shows nominal costs for Scenario 3a and in this scenario Mont Cuet landfill site reaches capacity in 2023. The residual waste from the MBT facility is assumed to be exported from this point and included as the Opex costs. However the MBT and EfW facilities also produce an inert waste (bottom ash in the case of EfW facility) which is disposed of at Longue Hougue with the cost showing in the landfill row.

4.3.2 Total Nominal Costs

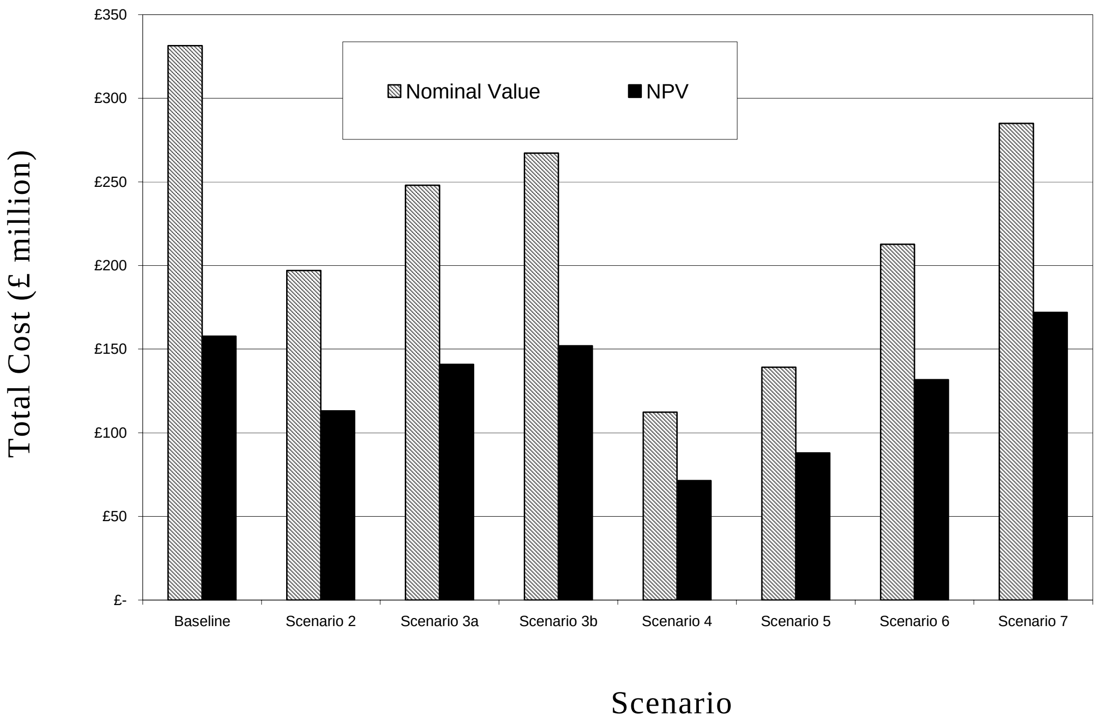
Results for total nominal costs are shown in Table 30 and Figure 33 . The Baseline Scenario has the highest total (2005 to 2031) nominal cost (£331 million). Scenario 7 is the next highest at £285 million. However, Scenarios 4 and 5 are the cheapest in nominal terms, around £200 million less than the Baseline Scenario. Scenario 4, combining high recycling with EfW facility is £27 million less than the low recycling Scenario 5. This is due to a number of factors; lower landfill costs; the diversion of the outputs as an inert into Longue Hougue and increased revenues from electricity generation.

Table 30 Total Nominal Costs of Scenarios (£ million)

Costs for 2005 to 2031	Baseline Scenario	Scenario 2	Scenario 3a	Scenario 3b	Scenario 4	Scenario 5	Scenario 6	Scenario 7
Capex		43.5	54.9	61.1	27.1	33.9	81.3	101.9
Opex	277.4	117.2	166.1	182.5	77.3	98.2	103.5	172.0
Facility Revenues		- 23.6	-30.9	-34.7	-32.4	-42.9	-30.9	-44.3
Landfill costs	54.1	59.6	57.9	58.2	40.4	49.9	58.7	55.3
Total	**331.4**	**196.9**	**248.0**	**267.2**	**112.3**	**139.2**	**212.7**	**285.0**

Both low recycling and high recycling scenarios combined with EfW facility (Scenarios 5 and 4 respectively) represent the cheapest residual waste treatment scenarios. They are less costly than the Baseline Scenarios by £219 million and £192 million, respectively, due to revenue from electricity and cheaper disposal of inerts compared to residual waste into Mont Cuet. Scenarios 4 and 5 are also the only two options for which landfill capacity is not exceeded during the modelling period.

Figure 33 Total Costs for each Scenario from 2001 to 2031 (Nominal and NPV)



4.3.3 Net Present Value

Table 31 and Figure 33 summarises the scenario costs expressed as discounted rates (in terms of their NPV). Scenario 7 is now the most expensive scenario, being £14 million more than the Baseline Scenario. This is because the Baseline Scenario has no Capex to discount over the modelling period, whereas Scenario 7 has the largest Capex and therefore becomes the most expensive when expressed in this way.

Table 31 Total NPV Costs of Scenarios (£ million)

Costs for 2005 to 2031	Baseline Scenario	Scenario 2	Scenario 3a	Scenario 3b	Scenario 4	Scenario 5	Scenario 6	Scenario 7
Capex		33.2	42.0	46.8	20.7	25.9	62.2	78.0
Opex	114.0	49.3	68.8	76.7	33.4	42.6	41.2	69.7
Facility Revenues		-10.2	-13.3	-15.2	-14.0	-18.5	-13.5	-19.1
Landfill costs	43.8	40.7	43.4	43.7	31.4	38.0	41.8	43.4
Total	**157.8**	**113.0**	**140.9**	**152.0**	**71,5**	**87.9**	**131.7**	**171.9**

Scenario 4 remains the cheapest option at £71 million, some £85 million less than the Baseline and £100 million less than Scenario 7.

Scenarios 4 and 5 are the best performing in terms of prolonging the life of Mont Cuet landfill site. They are also the cheapest because some of the costs are offset by the revenue gained from the sale of energy from the EfW facilities at £22.55 per tonne.

4.3.4 Cost Per Tonne

Table 32 and Figure 34 summarises the nominal and NPV cost per tonne for each scenario. This includes costs for dealing with the waste via treatment facilities, disposal at Mont Cuet landfill site and the cost of handling facility outputs as recyclates for reprocessing, inert disposal at Longue Hougue, rejects disposal at Mont Cuet and any export once Mont Cuet landfill site is at capacity.

Table 32 Nominal and NPV Cost per Tonne

2005 to 2031	Baseline Scenario	Scenario 2	Scenario 3a	Scenario 3b	Scenario 4	Scenario 5	Scenario 6	Scenario 7
Tonnage	2,045,874	1,542,954	2,045,874	2,304,803	1,542,954	2,045,874	1,542,954	2,045,874
Nominal Cost per tonne (£/t)	162	130	121	116	74	68	141	139
NPV Cost per tonne (£/t)	77	74	69	66	47	43	87	84

Table 32 shows that considering nominal costs the most expensive scenario per tonne is the Baseline Scenario at £162/t, followed by Scenario 6 at £141/t. Scenarios 5 and 4 are the cheapest a nominal cost of £68/t and £74/t respectfully. In general the larger facility the more cost effective it is per tonne of waste entering the facility.

Looking at the NPV cost per tonne, Scenario 6 is now the most expensive scenario at £87/t, followed by Scenario 6 at £84/t and the Baseline Scenario is £77/t. Again Scenarios 5 and 4 are the cheapest at £43/t and £47/t.

Figure 34 Cost per tonne for each Scenario from 2001 to 2031 (Nominal and NPV)

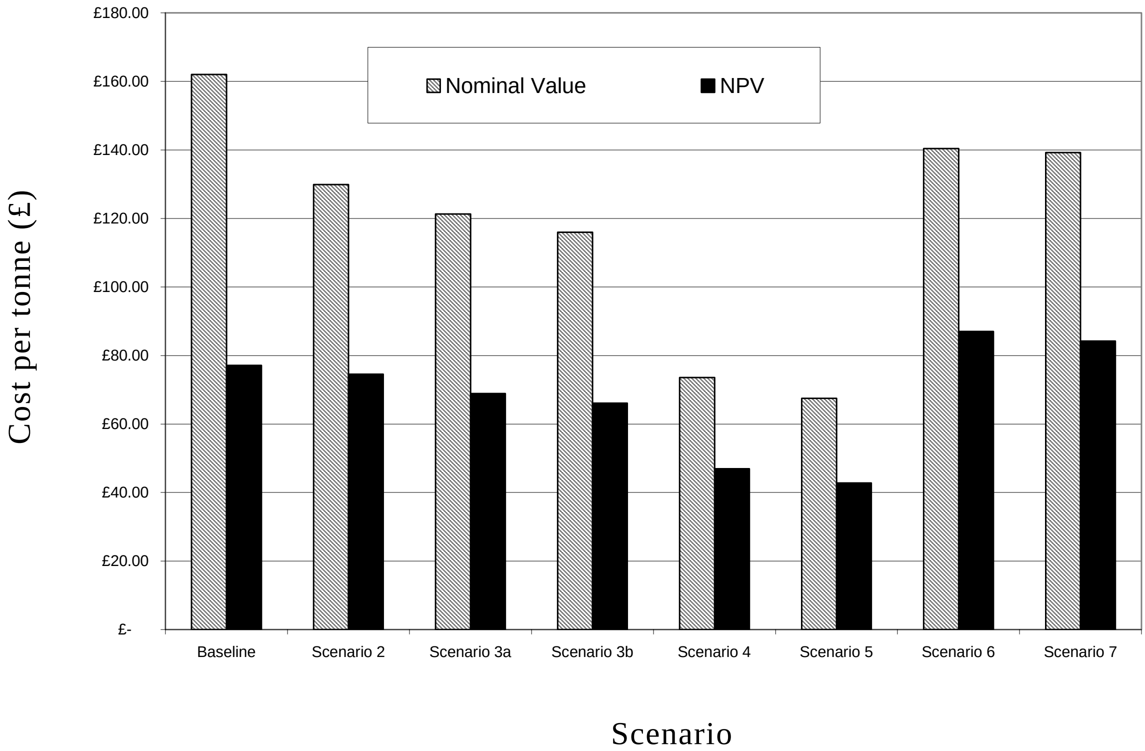


Figure 34 and Table 33 show the cost per tonne of waste that enters Mont Cuet and the waste facilities in ranking order based on the cheapest ranked first, down to the most expensive ranked last;

Table 33 Ranking of Scenarios In Cost per Tonne

Rank	Rank of Nominal cost per tonne	Rank of NPV cost per tonne
Baseline Scenario	8	6
Scenario 2 (High Recycling with MBT & EfW)	5	5
Scenario 3a (Current Recycling with MBT & EfW)	4	4
Scenario 3b (No Recycling with MBT & EfW)	3	3
Scenario 4 (High Recycling with EfW)	2	2
Scenario 5 (Current Recycling with EfW)	1	1
Scenario 6 (EfW Recycling with ATT)	6	7
Scenario 7 (Current Recycling with ATT)	7	8

5. SUMMARY OF SCENARIOS

This report compares the different waste management scenarios for dealing with all of Guernsey's waste. It provides understanding of the effect of the scenarios on extending the life of Mont Cuet landfill site, and assesses the potential impacts of the time scales and indicative costs required for constructing and operating the different technologies.

The initial aims of this report were to:

- Assess of each scenario's effect on extending the life of Mont Cuet landfill site;
- Compare the different technologies and recycling scenarios;
- Understand the critical issues of timing and the influence on time scales for the different scenarios;
- Identify of total waste tonnages for disposal (after treatment) to be dealt with by the States of Guernsey; and
- Compare the indicative costs of the facilities for each scenario.

This section provides a summary of the outcomes from the modelling of the scenarios.

5.1 Life Expectancy of Mont Cuet Landfill Site

The modelling exercise specifically looked at the effects of various waste management scenarios on extending Mont Cuet landfill site's life expectancy and section 3.10 provides further discussion and comparison. The scenarios have been ranked in the following order as shown in Table 34:

Table 34 Scenarios Ranked in order of extending Mont Cuet's Landfill Site's Life Expectancy

Rank	Scenario	Year Mont Cuet Landfill Site Reaches Capacity
1	Scenario 4 (High Recycling with EfW)	Beyond 2031
2	Scenario 5 (Current Recycling with EfW)	Beyond 2031
3	Scenario 2 (High Recycling with MBT (AD) & EfW)	2029
4	Scenario 6 (High Recycling with ATT)	2024
5	Scenario 3b(no Recycling with MBT (AD) & EfW)	2023
6	Scenario 3a (Current Recycling with MBT (AD) & EfW)	2023
7	Scenario 7(High Recycling with ATT)	2018
8	Baseline	2014

The life expectancy of Mont Cuet landfill site links directly with the end use of any outputs from the waste management facilities. Both Scenarios 4 and 5 rely on the bottom ash being utilised at Longue Hougue and the hazardous fly ash being exported for disposal in an appropriate manner. These scenarios are based on the assumption that these EfW facilities will divert from landfill almost 100% of the waste entering the new facility. Scenarios 4 and 5 will therefore only require a consistently small amount of waste to be disposed of at Mont Cuet landfill site (i.e. the non-conforming or hazardous wastes) which are not suitable for delivery to an EfW facility.

In addition the success of Scenarios 2, 3a and 3b all depend on a reliable outlet for the RDF and the organic fraction (which will be incorporated within the RDF). If this outlet is not established the life expectancy associated with these scenarios will decrease. Within the modelling it has been assumed that Guernsey will build an EfW facility specifically as an outlet for the RDF. Any delays in commissioning this facility will result in a shortening of Mont Cuet landfill site life expectancy. As the RDF is sent to an EfW facility it relies on the bottom ash being utilised at Longue Hougue and the hazardous fly ash being exported for disposal in an appropriate manner. Therefore the RDF is diverted 100% from Mont Cuet landfill site. Only rejects from the MBT facility and any waste that cannot enter the facilities will be disposed of at Mont Cuet landfill site. The MBT facilities have rejects for disposal at Mont Cuet landfill site in the order of 21% for Scenario 2, 17% for Scenario 3a and 15% for Scenario 3b.

Scenarios with high recycling with ATT (Scenario 6) and current recycling with ATT (Scenario 7) show that in each case there is an output that will need to be landfilled. However if the ATT facility outputs (Char) were further treated, classified as inert and could therefore be deposited at Longue Hogue, then of Mont Cuet landfill site's life expectancy would be increased beyond that indicated by the modelling. In that case Scenarios 6 and 7 would be more comparable with the EfW scenarios (Scenarios 4 and 5).

Another factor that affects Mont Cuet landfill site life expectancy is the amount of recycling assumed to take place. The introduction of increased recycling and green diversion prolongs the life expectancy of Mont Cuet landfill site, potentially by as much as 6 years:

- In Scenario 2 Mont Cuet Landfill Site reaches capacity in: 2029
- In Scenario 3a Mont Cuet Landfill Site reaches capacity in: 2023
- Additional Life Expectancy with this facility due to high recycling **6 years**
- In Scenario 6 Mont Cuet Landfill Site reaches capacity in: 2023
- In Scenario 7 Mont Cuet Landfill Site reaches capacity in: 2018
- Additional Life Expectancy with this facility due to high recycling **6 years**

Without any proposed facilities the high recycling / green diversion will increase Mont Cuet landfill site's life expectancy by 2 years and it will reach capacity in 2016.

The scenario that results in the shortest landfill life expectancy is the Baseline Scenario, (i.e. continuing as at present), which predicts that Mont Cuet landfill site will reach capacity in 2014.

5.2 Time scales

All the scenarios assume that a decision on the waste management option to be concluded in 2007 and that the facilities will be operational in 2012, based on the following programme:

- Planning 1 -2 years;
- Construction 2 – 3 years; and
- In total 3 – 5 years.

Any delays in the programme for implementing the selected technology will result in the life of the landfill being correspondingly reduced.

The key date for Guernsey is 2014, as this is the year when, with current recycling schemes and waste management practices, Mont Cuet landfill site is predicted to reach capacity. The new waste management facility needs to be operating in advance of this year to ensure that there is remaining landfill capacity to accept rejects and residuals.

If the facility is built after 2014 then an interim waste management solution would need to be developed.

5.3 Comparison of Technologies and Recycling Scenarios

A comparison of the technologies is made in both Section 3.10 and The New Technologies report [Enviros, 2006c]. The key details are summarised in Table 35.

Table 35 Summary of Comparison of Technologies

Scenario	Recycling	Facility Type & Size (tpa)	Life Expectancy of Mont Cuet landfill site	% of waste entering facility diverted from Mont Cuet landfill site
Baseline	Current	None	2014	0%
2	High	MBT 71,000 EfW 41,000	2029	79%
3a	Current	MBT 98,000 EfW 58,000	2023	83%
3b	None	MBT 114,000 EfW 68,000	2023	85%
4	High	EfW 71,000	Beyond 2031	100%
5	Current	EfW 98,00	Beyond 2031	100%
6	High	ATT 71,000	2024	67%
7	Current	ATT 98,000	2018	67%

Table 35 shows the amount of waste treated by the facility and diverted from landfill to be greatest with an EfW facility (Scenarios 4 and 5). Therefore these scenarios result in the greatest diversion and longest life expectancy for the Mont Cuet landfill site and are viable options for Guernsey to consider. Scenario 2 also increases the longevity of Mont Cuet landfill site, predicted to reach capacity in 2029.

All the MBT scenarios (Scenarios 2, 3a and 3b) rely on an outlet for the RDF in the form of an EfW facility. However the diversion of waste entering the MBT facility depends on the separate recycling scenarios. For example "no recycling" with an MBT (Scenario 3b) has a greater proportion of recyclates and green waste that can be treated through the MBT facility, compared with "high recycling" with MBT facility (Scenario 2). This is because in Scenario 2 a high proportion of recyclates are taken out of the waste stream before they enter the waste facility (MBT). This is the reason the Scenario 2 (high recycling) diverts 79% of the waste entering the MBT facility compared to Scenario 3b (no recycling) with 85% diverted.

The recycling scenarios also have an effect on the amount of waste that will enter the treatment facility. As more recycling is carried out, more recyclates are diverted from the residual waste stream and therefore less residual waste requires treatment. Therefore the facility sizes and input to the facility are linked to the specific recycling scenario:

Recycling Option	**Scenario**	**2012 (t)**	**2031 (t)**	**Facility Size (t)**
No Recycling	3b	72,000	114,000	114,000
Current recycling	Baseline, 3a, 5 &7	62,000	98,000	98,000
High Recycling	2, 4 & 6	44,000	71,000	71,000

Other issues regarding the technologies have also been discussed in this report, including:

- Proven track record in dealing with the variable feedstocks such as MSW & C&I waste;
- Markets for outputs and recyclates;
- Other benefits such as electricity generation; and
- Management of hazardous fly ash.

For further information on the waste technologies see report [Enviros 2006c] and [Enviros 2006b].

5.4 Guernsey's Total Tonnage Requiring Disposal

The model predicts that Guernsey's total waste arisings will be approximately 255,000 tonnes in 2012 and 306,000 tonnes in 2031. The different scenarios look at various methods of diverting waste from Mont Cuet Landfill Site via recycling and waste treatment facilities.

Mont Cuet landfill site's life expectancy is exceeded before 2031 in several scenarios and therefore further disposal capacity for residual wastes will be required within this time frame. Full details of predicted inputs to Mont Cuet year by year for each scenario, up to 2031, are given in Appendix 6. The Baseline Scenario predicts there will be a need for disposal of 1,463,000 tonnes of residual waste for which there is no current capacity. Scenario 7 requires the next largest amount of residual waste that will require further disposal once Mont Cuet landfill site has reached capacity, at 405,000 tonnes.

Only Scenarios 4 and 5 have additional capacity at Mont Cuet landfill site at the end of the modelling period (2031) as only 1,000 to 3,000 tpa of non-conforming waste will need to be deposited at the landfill site once the EfW is operating.

5.5 Comparative Costs of the Scenarios

The potential costs of the technology options described in the eight Scenarios were modelled for comparative purposes only, and discussed in detail in Chapter 4.

As Enviros has considered "generic" treatment solutions at this stage cost information is based on U.K. reported costs and cost information supplied by the Environment Department of the States of Guernsey. Actual costs will depend on variables such as the treatment technology supplier, the configuration of the facility and there may be additional costs attributable to Guernsey's location.

The results are summarised in Table 36.

Table 36 Scenario Costs

Scenario	Total Nominal Cost (£ million)	Total NPV Cost (£ million)	Nominal Cost per tonne (£/t)	NPV Cost per tonne (£/t)
Baseline	331	158	162	77
2	197	113	130	75
3a	248	141	121	69
3b	267	152	116	66
4	112	71	74	47
5	139	87	68	43
6	213	131	141	87
7	285	172	139	84

The total costs were estimated for the different scenarios for the modelling period (2005 to 2031). The Baseline Scenario has the highest total nominal cost at £331 million, followed by Scenario 7 at £285 million. However when considering the costs on a Net Present Value (NPV) basis, using a discount rate of 5%, Scenario 7 is the most expensive at £172 million followed by the Baseline Scenario. This is because the Baseline Scenario has no capital expenditure costs, whereas Scenario 7 has the largest Capex. The cheapest options (both nominal and NPV) are Scenarios 4 and 5.

The cheapest options (both nominal and NPV) are Scenarios 4 and 5.

Table 35 also shows the both nominal and NPV cost per tonne for each scenario. The most expensive scenarios are the Baseline and Scenario 6, whereas Scenario 5 is the most cost effective per tonne [33].

5.6 Summary

As extending Mont Cuet landfill site's life expectancy is a key objective for Guernsey, Scenarios 4 (high recycling with EfW) and 5 (current recycling with EfW) are the most attractive options. Furthermore they are also the cheapest scenarios in terms of both total costs and cost per tonne.

33 For Further details on Costs see Chapter 4.

High recycling with an MBT (AD) facility and smaller capacity EfW facility (Scenario 2) significantly extends the longevity of Mont Cuet landfill site and therefore may be a viable option, which should be investigated further. It is also the third cheapest option on a total costs basis, however it becomes an expensive option when compared on a cost per tonne. A more detailed feasibility study would investigate the appropriateness of this scenario on Guernsey and research specific technologies.

Waste management strategies based on processes similar to Scenario 2 have been successfully developed in some regions of Europe, and are being actively procured currently in the UK. Scenario 2 satisfies the objective of achieving a high recycling rate and therefore efficient management of resources. It maximises the recovery of energy from residual black bag wastes by

- Separating out the organic rich materials to produce biogas, which in the UK qualifies as a renewable energy source, and
- Separating out the high calorific value materials into RDF, to be combusted and therefore also recovering the available energy resource. A smaller EfW facility would be required than in Scenarios 4 and 5.

Whilst it is difficult to prioritise between Scenarios 4/5 and 2 on purely technical criteria, there may be local preferences for a waste management scenario which does maximise the recovery of resources and is not entirely dependant on incineration, in which case Scenario 2 would justify serious consideration, despite some of the problems of implementing such a strategy on Guernsey.

High or current levels of recycling with ATT (Scenarios 6 and 7) would be viable facility options if their outputs (Char) were further treated, classified as inert and could therefore be deposited at Longue Hogue. In such circumstances Scenarios 6 and 7 would be comparable with the EfW scenarios (Scenarios 4 and 5).

There are a large number of caveats or provisos in reaching these conclusions, including

- the limited availability of markets for recyclates,
- the additional costs of construction and operation on Guernsey,
- the market appetite for or interest in providing Guernsey with an appropriate, long-term waste management solution and

- the nature and extent of the comparative cost analysis carried out here.

It is recommended that an outline business case and a “soft market testing” exercise are completed, to gather more reliable information. The procurement process is being investigated and much of the work for an outline business case and soft testing of the market has already been carried out, by the States of Guernsey and their consultants. The conclusions from the various reports and work streams should be drawn together and summarised in a formal report, taking account of all the factors which influence the decision on the future waste management strategy for Guernsey, and making a recommendation on the way forward.

5.7 Key Issues and Points

The following key points and issues can be identified as a result of the modelling exercise:

- The “Do Nothing” Option will result in there being no active landfill sites on Guernsey within 10 years.
- A waste management facility must be in operation by 2012. Any delays in the facilities being commissioned will further reduce the life expectancy of Mont Cuet landfill site.
- If the waste management facility is built after 2014, an interim waste management solution would be necessary.
- Increasing recycling and diverting green waste will extend the life expectancy of Mont Cuet landfill site. However these schemes and the necessary facilities need to be introduced as soon as possible to significantly increase the life expectancy of Mont Cuet landfill site. The modelled recycling scenarios are based on best practice examples in the UK applying high rates of recycling of household and C&I wastes to all of Guernsey’s waste. It may not be possible to achieve similar high recycling rates on Guernsey. With a new waste facility the high recycling potentially increases Mont Cuet landfill sites life expectancy by 6 years. Without a new waste facility which diverts a large proportion of waste, the increased recycling will only increase Mont Cuet landfill site’s life expectancy by 2 years.
- Increasing recycling and diverting green waste will decrease the required size of any new disposal facility. Using best practice for recycling and composting, the smallest facility capacity is modelled to be 71,000tpa to cover the modelling period (starting with input tonnage of 44,000tpa in 2012).
- Using current recycling or diversion of green waste, the facility capacity is modelled to be larger at 98,000tpa (starting with input tonnage of 62,000tpa in 2012).
- The required size of the facility will increase if there is no recycling or diversion of green waste, up to 114,000tpa (starting with input tonnage of 72,000tpa in 2012).

- The success of any MBT facility depends on the outlet for the RDF and the organic fraction. If there is no EfW facility to accept this output, then an alternative market or disposal route will need to be found. This would be difficult.

- The ATT facility scenarios (Scenarios 6 and 7) produce an output (Char) that would require disposal to landfill of all the scenarios and therefore ATT produces the shortest extension to Mont Cuet landfill site's life expectancy. However if the output were further treated, classified as inert and could therefore be deposited at Longue Hogue, it may provide a viable option.

- An EfW facility is modelled to produce the smallest amount of residual waste to require final disposal at the landfill. EfW scenarios therefore achieve the longest extension of Mont Cuet landfill site's life expectancy.

- (Scenario 4) High Recycling with an EfW facility represents the cheapest residual waste treatment scenarios when looking at total costs. The total nominal cost is £219 million less than the Baseline Scenario and NPV is £87 million less than the Baseline Scenario.

- Scenario 5 (current recycling with an EfW facility) is predicted to have a nominal cost of £68 per tonne and a NPV cost of £43 per tonne, which is the cheapest scenario per tonne in comparison with the other scenarios. This is due to the revenue gained from the sale of energy and the large proportion of inerts as an output from the EfW facility.

- As the key objective is the longevity of Mont Cuet's Landfill site's life expectancy high recycling with EFW (Scenario 4) and current recycling with EfW (Scenario 5) are the most attractive options.

- As the key objective is the longevity of Mont Cuet's Landfill site's life expectancy the high recycling with an MBT (AD) facility and a smaller EFW (Scenario 2) considerably extends Mont Cuet landfill life expectancy and therefore is a viable option but requires further investigation.

6. REFERENCES

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APPENDICES

1. BASE DATA

Table 37 Base Data for Guernsey for 2001[34]

Main Waste Arisings Categories	Sub sections	2001 Base data (t)
Household waste	Mixed Domestic refuse (Parish waste)	14,750
	Paper	1,900
	Glass	1,045
	Aluminium	25
	Steel	100
	Textiles	225
	Garden[35]	1,000
	Bulk Refuse[35]	6,510
Total Household Waste		**25,555**
Commercial Waste	Commercial Paper	2,650
Non Hazardous Industrial Waste	Mixed	28,900
	Separate Metals	6,725
	Electrical and Electronic	1,600
Hazardous Industrial	Batteries	50
	Oils	750
	Fluorescent Tubes	2
	Asbestos	500
	Other Hazardous	83
Total Commercial & Industrial		**41,260**
Agricultural & Horticultural	Abattoir	350
	Animal Manure	6,000
	Plastics	50
	Horticultural	6,000

34 Source: The States of Guernsey
35 Collected at the Civic Amenity Site

Main Waste Arisings Categories	Sub sections	2001 Base data (t)
Total Agricultural & Horticultural		**12,400**
Construction & Demolition36	Aggregate	100,000
	Inert	50,000
	Mixed	17,750
Total Construction & Demolition		**167,750**
Other Non-Household Waste (Healthcare, ELV, tyres & water treatment Sludge).	Hospital	300
	Other Healthcare	100
	End of Life Vehicles (ELVs)	2,000
	Tyres	300
	Water Treatment Sludge	350
TOTAL Other Waste		**3,050**
Total Waste Arisings On Guernsey		**250,015**

36 Breakdown of C&D waste summarised from previous report [ISL 2004]

2. 2004 DATA USED FOR CALIBRATION

Table 38 2004 Data Used for Calibrating

Main Waste Arisings Categories	Sub sections	2004 Base data (t)
Household waste	Mixed Domestic refuse (Parish waste)	16,438
	Paper[37]	2,342
	Glass	1,510
	Tins and cans	88
	Textiles	261
	Metal[38]	230
	Garden[39]	1,179
	Bulk Refuse[35]	4,147
Total Household Waste[40]		**26,195**
Commercial and Industrial waste	Commercial Paper	2,730
	Mixed[41]	24,609
	Separate Metals[42]	5,770
	Electrical and Electronic	1,600
	Batteries, oils, fluorescent tubes[43]	842
	Asbestos	304
	Other Hazardous	74
Total Commercial & Industrial		**35,929**

37 Includes card collected at the CA site and paper via the bring sites
38 Metal collected via the public from the CA site
39 Garden waste collected at the Chouet composting site.
40 Total household waste arisings from previous work [Enviros 2006b] has been re-adjusted for all flows & further information. This now includes metal collected at the CA site
41 Mixed C&I waste includes all direct C&I waste into Mont Cuet and rejects from Fountaine Vinery MRF. Adjustments to exclude any double counting [Enviros 2006b] (e.g. healthcare, abattoir outputs disposed at Mont Cuet (288t) & fragmentised metal from ELV (820t Source: Guernsey metals estimate) and water treatment sludge (275t) and farm plastics (22t).
42 Adjusted to exclude metal collected at the CA site
43 ISL predictions as no information was available.

Main Waste Arisings Categories	Sub sections	2004 Base data (t)
Other Non-Household	Hospital and other healthcare	566
	Water Treatment Sludge	275
	Abattoir	300
	Animal Manure	6,000
	Farm Plastics	22
	Tyres	300
	Horticultural	5,000
	End of Life Vehicles (ELVs)	2,285
Total Other Non-household		**14,748**
Construction & Demolition[44]	Inert	154,000
	Mixed	53,913
Total Construction & Demolition		**207,913**
Total Waste Arisings On Guernsey		**284,785**

44 Breakdown of C&D waste summarised from previous report [ISL 2004]. Mixed C&D inclusive of aggregates from Ronez (45,000t in 2004) and 8,913 tonnes of builders waste into Mont Cuet). Longue Hougue accepted 154,000 tonnes for a 12 month period in 2004.

3. GENERIC ASSUMPTIONS

The following tables illustrate the generic assumptions (based on validated sources [ISL 2002b & Enviros 2006b]) which apply to all scenarios within the Enviros model:

Table 39 Guernsey Generic Data Assumptions

Category	Assumption[45]
Other Non-Household waste	6,000t of horticultural waste assumed to be green waste in 2001 6,000t of manure assumed to be other putrescibles in 2001 50t of farm plastics in 2001 350t of abattoir waste assumed to be hazardous waste in 2001 300t of tyres assumed to be plastic in 2001 2,000t of ELV assumed to be metal in 2001 750t of hazardous waste; water treatment sludge (350t), hospital & other health care (400t) in 2001 Since the tonnage arisings for these waste streams are small and will ultimately not affect the size of the residual waste treatment facility, all this waste is combined under 'other non-household' for modelling purposes. 15% metal composition assumed to be scrap metal due to ELV.
C & D wastes	167,750t of C&D waste in 2001 consisting of: 127,000t of inerts of which 100,000tpa goes to Longue Hougue and 27,000t to Ronez, aggregate crushing. 40,750t of mixed waste of which 17,750t is delivered to Mont Cuet landfill site and 23,000t to Ronez.
C & I waste composition	25% of C&I wastes assumed to be metals; this is split 20% metal, 5% WEEE. 16% of C&I wastes assumed to be misc. non-combustibles; this is split 2.6% potentially hazardous, 1.4% hazardous and 12% misc. non-

45 Tonnages for base data are in respect to 2001.

Category	Assumption[45]
	combustible to bring recycling rates of hazardous wastes less than 100%.
Waste water treatment plant sludges	The new WWTP is assumed to be operational from 2010 and to produce 1,120t of sewage sludge in 2010 increasing by 1.65% per annum until 2012 and by 2.75% thereafter.
Landfill capacity	Mont Cuet landfill site capacity is 927,336 m^3 to final dome. The long term insitu density of the waste at Mont Cuet is 0.917 t m^{-3}

4. RECYCLING ASSUMPTIONS

This appendix presents detailed assumptions about the different recycling schemes employed during the modelling exercise.

Table 40 Baseline Scenario Current Recycling Assumptions

Baseline Scenario Recycling Assumptions	**Details**	**Recycling rate/ percentage diverted from Mont Cuet landfill site**
Kerbside	No Collection	
Bring	Glass Paper Tins and Cans Textiles	62% 29% 12% 31%
CA	Green Metal Paper	45% 47% 64%
C&I	Paper Metal WEEE Potentially Hazardous Hazardous	51% 80% 89% 90% (exported to UK for recycling & disposal) 4% (exported to UK for processing & disposal)
C&D	Miscellaneous non-combustibles (inerts)	98% (Longue Hougue or Ronez) No other materials diverted or recycled
Other Non-Household	Metal Plastic Green Other Organic (manure) Hazardous Waste	64% (remainder is fragmentised waste sent to Mont Cuet landfill site) 93% (tyres exported to energy recovery facility in UK) 75% 100% 51% (remainder is ash from the abattoir and hospital, water treatment sent to Mont Cuet)

Table 41 High Recycling Assumptions

High Recycling Assumptions	**Details**	**Recycling rate/ percentage diverted from Mont Cuet landfill site**
Kerbside[46]	Glass Paper Plastics Tins and Cans Kitchen Waste Green Waste **Overall**	35% 35% 35% 35% 35% 35% **28.8%**
Bring[46]	Glass Paper Tins and Cans Textiles **Overall**	67% 31% 13% 34% **21.3%** It is assumed that a successful campaign to raise awareness is run increasing participation from 70% to 78%.
CA	Green Paper Glass Timber Metal WEEE Textiles Inerts Hazardous Reusables **Overall**	60% 64% 48% 30% 65% 15% 2% 66% 15% 5% **46.5%**[47]
C&I	Paper Plastics Green	86.5%[48] 40 %[49] 50.0%[48]

46 Based on scheme performance in St. Edmundsbury B.C at 50.6%. Kerbside and Bring Recycling in the High Recycling Assumption produce a combined rate of 50%.
47 http://www.networkrecycling.co.uk/pdf/nacas/nacas_chapter2.pdf Average Best Practice for Rural CA site (with low level of deprivation) is 46.7% in 2002/3 (table 2.1.6, page 37). Table 2.3.5 provided recovery rates at an example site. Rates used in this modelling example are based on this.
48 Source: Environment Agency (E.A) C&I waste survey 2002. Recycling rates for paper, green and metal based on C&I combined.
49 St. Edmunsbury B.C. best practice – introduced a kerbside recycling schemes to businesses including plastics.

High Recycling Assumptions	**Details**	**Recycling rate/ percentage diverted from Mont Cuet landfill site**
	Metal WEEE Potentially Hazardous Hazardous	91.0%[48] 89%[50] 90% (exported to UK for recycling & disposal) 4% (exported to UK for processing & disposal)
C&D	Metal Timber Miscellaneous non-combustibles	80% 80% 98% (Longue Hougue or Ronez)
Other Non-Household	Green	100%[51]

Table 42 No Recycling Assumptions

No Recycling Assumptions	**Details**	**Recycling rate/ percentage diverted from Mont Cuet landfill site**
Kerbside	No Collection	0%
Bring	No Bring Sites	0%
CA	No Green Diversion	0%
C&I	Paper Metal WEEE Potentially Hazardous Hazardous	0% 80% 89% 90% (exported to UK for recycling) 4% (exported to UK for processing)
C&D	Miscellaneous non-combustibles (inerts)	98% (Longue Hougue or Ronez) No other materials diverted or recycled
Other Non-Household	Green No change to other waste	0%

50 WEEE recycling remains at 78%, as Guernsey baseline information is higher than the information sourced from the E.A. C&I waste survey 2002.
51 Green waste currently sent to landfill from Chouet composting site assumed to be diverted

5. FACILITY ASSUMPTIONS

Section 2.4.2 provides flow diagrams demonstrating the different facilities modelled in this exercise. The tables below illustrate the facility assumptions as they are used in the model.

Any water vapour, carbon dioxide or "gas to air" is modelled as mass loss.

Table 43 MBT Feeding AD Assumptions

Material \ Destination	Recycled	Mass Loss	RDF	Landfill	TOTAL
Glass	90%			10%	100%
Paper & Card		15%	85%		100%
Metal	95%			5%	100%
Plastic			90%	10%	100%
Textiles			70%	30%	100%
Green Waste		30%	60%	10%	100%
Other Organics (incl. Kitchen)		45%	55%		100%
Timber		15%	50%	35%	100%
WEEE	5%		5%	90%	100%
Potentially Hazardous				100%	100%
Miscellaneous Combustibles		5%	80%	15%	100%
Miscellaneous-non combustibles				100%	100%
Hazardous waste				100%	100%
Fines			90%	10%	100%

Table 44 ATT Assumptions

Destination / Material	Recycled	Mass Loss	Landfill	Hazardous Landfill[52]	Total
Glass	65%		33%	2%	100%
Paper & Card	5%	60%	33%	2%	100%
Metal	65%		33%	2%	100%
Plastic	5%	60%	33%	2%	100%
Textiles	5%	60%	33%	2%	100%
Green Waste	5%	60%	33%	2%	100%
Other Organics (incl. Kitchen)	5%	60%	33%	2%	100%
Timber	5%	60%	33%	2%	100%
WEEE	5%	60%	33%	2%	100%
Potentially Hazardous	5%	60%	33%	2%	100%
Miscellaneous Combustibles	5%	60%	33%	2%	100%
Miscellaneous-non combustibles	5%	60%	33%	2%	100%
Hazardous waste		60%		40%	100%
Fines	5%	60%	33%	2%	100%

52 Hazardous waste as output from ATT and EfW will be exported for disposal at an appropriate hazardous landfill site in the U.K.

Table 45 EfW Assumptions

Material / Destination	Recycled	Mass Loss	Inert Landfill	Hazardous Landfill[52]	Total
Glass			95%	5%	100%
Paper & Card		65%	30%	5%	100%
Metal	95%			5%	100%
Plastic		65%	30%	5%	100%
Textiles		65%	30%	5%	100%
Green Waste		65%	30%	5%	100%
Other Organics (incl. Kitchen)		65%	30%	5%	100%
Timber		85%	10%	5%	100%
WEEE		65%	30%	5%	100%
Potentially Hazardous		65%	30%	5%	100%
Miscellaneous Combustibles		65%	30%	5%	100%
Miscellaneous-non combustibles		25%	60%	15%	100%
Hazardous waste		65%	30%	5%	100%
Fines		65%	30%	5%	100%

6. FULL RESULTS

The results below provide key information and are calculated in the following format:

- Year — 1st January to 31st December
- Total waste arisings — Total waste arisings
- Total Diversion — This includes any up front diversion – including recycling, composting, diversion via aggregates to Ronez and manure spreading.
- Inerts to Longue Hougue — Predicted annual input to Longue Hougue
- Remaining landfill capacity — Predicted tonnage remaining at Mont Cuet
- Tonnage to Mont Cuet — Annual tonnage entering Mont Cuet
- Tonnage processed through the facility — Annual input to the proposed facility

Table 46 Baseline Scenario Waste Data

Year	Total waste arisings (t)	Total Diversion (including Recycling, composting etc) (t)	Inerts to Longue Hougue (t)	Remaining landfill capacity at Mont Cuet (t)	Tonnage to Mont Cuet	Tonnage processed through facility (t)
2005	279,615	72,540	149,380	525,343	57,695	0
2006	274,656	71,450	144,899	467,036	58,307	0
2007	269,902	70,405	140,552	408,091	58,945	0
2008	265,350	69,406	136,335	348,482	59,609	0
2009	260,994	68,450	132,245	288,183	60,298	0
2010	257,949	67,538	128,278	226,050	62,134	0
2011	253,990	66,667	124,429	163,156	62,894	0
2012	255,976	67,190	124,429	98,799	64,357	0
2013	258,018	67,727	124,429	32,937	65,861	0
2014	260,115	68,279	124,429	-34,470	67,407	0
2015	262,269	68,845	124,429	-103,464	68,995	0
2016	264,483	69,428	124,429	-174,090	70,626	0
2017	266,757	70,026	124,429	-246,392	72,302	0
2018	269,094	70,640	124,429	-320,417	74,025	0
2019	271,495	71,272	124,429	-396,211	75,794	0
2020	273,962	71,920	124,429	-473,824	77,613	0
2021	276,497	72,586	124,429	-553,305	79,481	0

2022	279,101	73,271	124,429	-634,706	81,401	0
2023	281,776	73,974	124,429	-718,079	83,373	0
2024	284,525	74,696	124,429	-803,479	85,400	0
2025	287,349	75,438	124,429	-890,961	87,482	0
2026	290,251	76,200	124,429	-980,582	89,622	0
2027	293,233	76,984	124,429	-1,072,402	91,820	0
2028	296,296	77,788	124,429	-1,166,417	94,015	0
2029	299,444	78,615	124,429	-1,262,817	96,400	0
2030	302,678	79,464	124,429	-1,361,602	98,784	0
2031	306,000	80,336	124,429	-1,462,836	101,235	0

Table 47 Scenario 2 (high recycling with MBT) Waste Data

Year	Total waste arisings (t)	Total Diversion (including Recycling, composting etc) (t)	Inerts to Longue Hougue (t)	Remaining landfill capacity at Mont Cuet (t)	Tonnage to Mont Cuet	Tonnage processed through facility (t)
2005	279,615	72,540	149,380	525,343	57,695	0
2006	274,656	71,450	144,899	467,036	58,307	0
2007	269,902	70,405	140,552	408,091	58,945	0
2008	265,350	87,263	136,335	366,338	41,752	0
2009	260,994	86,451	132,245	324,040	42,298	0
2010	257,949	85,690	128,278	280,059	43,981	0
2011	253,990	84,980	124,429	235,479	44,580	0
2012	255,976	85,883	128,203	224,779	10,700	44,179
2013	258,018	86,810	128,298	213,822	10,956	45,259
2014	260,115	87,762	128,396	202,603	11,220	46,369
2015	262,269	88,741	128,497	191,112	11,490	47,510
2016	264,483	89,746	128,600	179,344	11,768	48,681
2017	266,757	90,779	128,706	167,290	12,054	49,885
2018	269,094	91,840	128,815	154,943	12,347	51,122
2019	271,495	92,930	128,927	142,294	12,649	52,394
2020	273,962	94,050	129,042	129,336	12,959	53,700
2021	276,497	95,201	129,161	116,059	13,277	55,042
2022	279,101	96,383	129,282	102,455	13,604	56,420
2023	281,776	97,598	129,407	88,515	13,940	57,837
2024	284,525	98,845	129,535	74,229	14,285	59,293
2025	287,349	100,127	129,667	59,589	14,640	60,789
2026	290,251	101,444	129,803	44,584	15,005	62,325
2027	293,233	102,797	129,942	29,205	15,379	63,904
2028	296,296	104,188	130,085	13,607	15,598	65,527
2029	299,444	105,616	130,232	-2,553	16,160	67,194
2030	302,678	107,083	130,383	-19,118	16,566	68,907
2031	306,000	108,591	130,538	-36,102	16,983	70,667

Table 48 Scenario 3a (Current Recycling with MBT (AD) and EfW) Waste Data

Year	Total waste arisings (t)	Total Diversion (including Recycling, composting etc) (t)	Inerts to Longue Hougue (t)	Remaining landfill capacity at Mont Cuet (t)	Tonnage to Mont Cuet	Tonnage processed through facility (t)
2005	279,615	72,540	149,380	525,343	57,695	0
2006	274,656	71,450	144,899	467,036	58,307	0
2007	269,902	70,405	140,552	408,091	58,945	0
2008	265,350	69,406	136,335	348,482	59,609	0
2009	260,994	68,450	132,245	288,183	60,298	0
2010	257,949	67,538	128,278	226,050	62,134	0
2011	253,990	66,667	124,429	163,156	62,894	0
2012	255,976	67,190	129,803	150,612	12,544	62,360
2013	258,018	67,727	129,936	137,788	12,824	63,822
2014	260,115	68,279	130,073	124,677	13,111	65,325
2015	262,269	68,845	130,213	111,270	13,407	66,868
2016	264,483	69,428	130,358	97,561	13,710	68,455
2017	266,757	70,026	130,506	83,539	14,022	70,085
2018	269,094	70,640	130,658	69,197	14,342	71,759
2019	271,495	71,272	130,815	54,526	14,671	73,480
2020	273,962	71,920	130,976	39,516	15,009	75,248
2021	276,497	72,586	131,141	24,160	15,357	77,065
2022	279,101	73,271	131,311	8,446	15,714	78,931
2023	281,776	73,974	131,486	-7,635	16,081	80,849
2024	284,525	74,696	131,665	-24,092	16,457	82,819
2025	287,349	75,438	131,849	-40,937	16,845	84,844
2026	290,251	76,200	132,039	-58,179	17,243	86,924
2027	293,233	76,984	132,233	-75,831	17,651	89,062
2028	296,296	77,788	132,433	-93,902	18,071	91,258
2029	299,444	78,615	132,639	-112,405	18,503	93,515
2030	302,678	79,464	132,850	-131,352	18,946	95,834
2031	306,000	80,336	133,067	-150,754	19,402	98,216

Table 49 Scenario 3b (No Recycling with MBT (AD) and EfW) Waste Data

Year	Total waste arisings (t)	Total Diversion (including Recycling, composting etc) (t)	Inerts to Longue Hougue (t)	Remaining landfill capacity at Mont Cuet (t)	Tonnage to Mont Cuet	Tonnage processed through facility (t)
2005	279,615	72,540	149,380	525,343	57,695	0
2006	274,656	71,450	144,899	467,036	58,307	0
2007	269,902	70,405	140,552	408,091	58,945	0
2008	265,350	69,406	136,335	348,482	59,609	0
2009	260,994	68,450	132,245	288,183	60,298	0
2010	257,949	67,538	128,278	226,050	62,134	0
2011	253,990	66,667	124,429	163,156	62,894	0
2012	255,976	57,308	130,701	150,000	13,156	72,064
2013	258,018	57,574	130,859	136,547	13,453	73,793
2014	260,115	57,846	131,021	122,790	13,757	75,569
2015	262,269	58,126	131,188	108,719	14,071	77,395
2016	264,483	58,414	131,359	94,327	14,392	79,271
2017	266,757	58,709	131,535	79,604	14,723	81,198
2018	269,094	59,012	131,715	64,542	15,062	83,178
2019	271,495	59,324	131,901	49,130	15,411	85,213
2020	273,962	59,644	132,092	33,361	15,770	87,304
2021	276,497	59,972	132,288	17,222	16,138	89,452
2022	279,101	60,310	132,489	706	16,517	91,659
2023	281,776	60,656	132,696	-16,200	16,906	93,927
2024	284,525	61,013	132,909	-33,505	17,305	96,257
2025	287,349	61,378	133,127	-51,221	17,716	98,651
2026	290,251	61,754	133,352	-69,358	18,138	101,111
2027	293,233	62,140	133,583	-87,929	18,571	103,639
2028	296,296	62,536	133,820	-106,945	19,016	106,236
2029	299,444	62,943	134,063	-126,419	19,474	108,905
2030	302,678	63,362	134,313	-146,363	19,944	111,647
2031	306,000	63,791	134,571	-166,790	20,427	114,464

Table 50 Scenario 4 (High Recycling with EfW) Waste Data

Year	Total waste arisings (t)	Total Diversion (including Recycling, composting etc) (t)	Inerts to Longue Hougue (t)	Remaining landfill capacity at Mont Cuet (t)	Tonnage to Mont Cuet	Tonnage processed through facility (t)
2005	279,615	72,540	149,380	525,343	57,695	0
2006	274,656	71,450	144,899	467,036	58,307	0
2007	269,902	70,405	140,552	408,091	58,945	0
2008	265,350	87,263	136,335	366,338	41,752	0
2009	260,994	86,451	132,245	324,040	42,298	0
2010	257,949	85,690	128,278	280,059	43,981	0
2011	253,990	84,980	124,429	235,479	44,580	0
2012	255,976	85,883	137,574	233,994	1,485	44,179
2013	258,018	86,810	137,899	232,474	1,519	45,259
2014	260,115	87,762	138,233	230,921	1,554	46,369
2015	262,269	88,741	138,577	229,331	1,589	47,510
2016	264,483	89,746	138,930	227,705	1,626	48,681
2017	266,757	90,779	139,292	226,042	1,664	49,885
2018	269,094	91,840	139,665	224,340	1,702	51,122
2019	271,495	92,930	140,048	222,598	1,742	52,394
2020	273,962	94,050	140,441	220,815	1,783	53,700
2021	276,497	95,201	140,992	218,990	1,825	55,042
2022	279,101	96,383	136,131	217,122	1,868	56,420
2023	281,776	97,598	141,687	215,210	1,912	57,837
2024	284,525	98,845	142,125	213,253	1,958	59,293
2025	287,349	100,127	142,576	211,248	2,004	60,789
2026	290,251	101,444	143,038	209,196	2,052	62,325
2027	293,233	102,797	143,514	207,094	2,102	63,904
2028	296,296	104,188	144,003	205,108	1,986	65,527
2029	299,444	105,616	144,505	202,904	2,204	67,194
2030	302,678	107,083	145,021	200,646	2,258	68,907
2031	306,000	108,591	145,551	198,333	2,313	70,667

Table 51 Scenario 5 (Current Recycling with EfW) Waste Data

Year	Total waste arisings (t)	Total Diversion (including Recycling, composting etc) (t)	Inerts to Longue Hougue (t)	Remaining landfill capacity at Mont Cuet (t)	Tonnage to Mont Cuet	Tonnage processed through facility (t)
2005	279,615	72,540	149,380	525,343	57,695	0
2006	274,656	71,450	144,899	467,036	58,307	0
2007	269,902	70,405	140,552	408,091	58,945	0
2008	265,350	69,406	136,335	348,482	59,609	0
2009	260,994	68,450	132,245	288,183	60,298	0
2010	257,949	67,538	128,278	226,050	62,134	0
2011	253,990	66,667	124,429	163,156	62,894	0
2012	255,976	67,190	142,789	161,158	1,998	62,360
2013	258,018	67,727	143,242	159,119	2,039	63,822
2014	260,115	68,279	143,708	157,037	2,082	65,325
2015	262,269	68,845	144,186	154,911	2,126	66,868
2016	264,483	69,428	144,677	152,739	2,171	68,455
2017	266,757	70,026	145,182	150,522	2,218	70,085
2018	269,094	70,640	145,701	148,256	2,265	71,759
2019	271,495	71,272	146,234	145,942	2,314	73,480
2020	273,962	71,920	146,782	143,577	2,365	75,248
2021	276,497	72,586	147,345	141,161	2,416	77,065
2022	279,101	73,271	147,923	138,691	2,470	78,931
2023	281,776	73,974	148,517	136,167	2,524	80,849
2024	284,525	74,696	149,127	133,586	2,580	82,819
2025	287,349	75,438	149,755	130,948	2,638	84,844
2026	290,251	76,200	150,399	128,251	2,697	86,924
2027	293,233	76,984	151,061	125,493	2,758	89,062
2028	296,296	77,788	151,742	122,736	2,757	91,258
2029	299,444	78,615	152,441	119,851	2,885	93,515
2030	302,678	79,464	153,159	116,900	2,951	95,834
2031	306,000	80,336	153,897	113,881	3,019	98,216

Table 52 Scenario 6 (High Recycling with ATT) Waste Data

Year	Total waste arisings (t)	Total Diversion (including Recycling, composting etc) (t)	Inerts to Longue Hougue (t)	Remaining landfill capacity at Mont Cuet (t)	Tonnage to Mont Cuet	Tonnage processed through facility (t)
2005	279,615	72,540	149,380	525,343	57,695	0
2006	274,656	71,450	144,899	467,036	58,307	0
2007	269,902	70,405	140,552	408,091	58,945	0
2008	265,350	87,263	136,335	366,338	41,752	0
2009	260,994	86,451	132,245	324,040	42,298	0
2010	257,949	85,690	128,278	280,059	43,981	0
2011	253,990	84,980	124,429	235,479	44,580	0
2012	255,976	85,883	124,429	219,360	16,119	44,179
2013	258,018	86,810	124,429	202,849	16,510	45,259
2014	260,115	87,762	124,429	185,937	16,912	46,369
2015	262,269	88,741	124,429	168,613	17,325	47,510
2016	264,483	89,746	124,429	150,863	17,749	48,681
2017	266,757	90,779	124,429	132,679	18,185	49,885
2018	269,094	91,840	124,429	114,046	18,633	51,122
2019	271,495	92,930	124,429	94,953	19,093	52,394
2020	273,962	94,050	124,429	75,387	19,566	53,700
2021	276,497	95,201	124,429	55,336	20,051	55,042
2022	279,101	96,383	124,429	34,785	20,551	56,420
2023	281,776	97,598	124,429	13,722	21,063	57,837
2024	284,525	98,845	124,429	-7,869	21,590	59,293
2025	287,349	100,127	124,429	-30,001	22,132	60,789
2026	290,251	101,444	124,429	-52,689	22,688	62,325
2027	293,233	102,797	124,429	-75,949	23,260	63,904
2028	296,296	104,188	124,429	-99,630	23,681	65,527
2029	299,444	105,616	124,429	-124,080	24,451	67,194
2030	302,678	107,083	124,429	-149,151	25,071	68,907
2031	306,000	108,591	124,429	-174,859	25,708	70,667

Table 53 Scenario 7 (Current Recycling with ATT) Waste Data

Year	Total waste arisings (t)	Total Diversion (including Recycling, composting etc) (t)	Inerts to Longue Hougue (t)	Remaining landfill capacity at Mont Cuet (t)	Tonnage to Mont Cuet	Tonnage processed through facility (t)
2005	279,615	72,540	149,380	525,343	57,695	0
2006	274,656	71,450	144,899	467,036	58,307	0
2007	269,902	70,405	140,552	408,091	58,945	0
2008	265,350	69,406	136,335	348,482	59,609	0
2009	260,994	68,450	132,245	288,183	60,298	0
2010	257,949	67,538	128,278	226,050	62,134	0
2011	253,990	66,667	124,429	163,156	62,894	0
2012	255,976	67,190	124,429	140,525	22,631	62,360
2013	258,018	67,727	124,429	117,369	23,156	63,822
2014	260,115	68,279	124,429	93,673	23,696	65,325
2015	262,269	68,845	124,429	69,423	24,250	66,868
2016	264,483	69,428	124,429	44,603	24,820	68,455
2017	266,757	70,026	124,429	19,198	25,405	70,085
2018	269,094	70,640	124,429	-6,808	26,006	71,759
2019	271,495	71,272	124,429	-33,432	26,624	73,480
2020	273,962	71,920	124,429	-60,690	27,259	75,248
2021	276,497	72,586	124,429	-88,601	27,911	77,064
2022	279,101	73,271	124,429	-117,182	28,581	78,931
2023	281,776	73,974	124,429	-146,451	29,270	80,849
2024	284,525	74,696	124,429	-176,428	29,977	82,819
2025	287,349	75,438	124,429	-207,132	30,704	84,844
2026	290,251	76,200	124,429	-238,583	31,451	86,924
2027	293,233	76,984	124,429	-270,801	32,218	89,062
2028	296,296	77,788	124,429	-303,744	32,943	91,258
2029	299,444	78,615	124,429	-337,561	33,817	93,515
2030	302,678	79,464	124,429	-372,211	34,650	95,834
2031	306,000	80,336	124,429	-407,716	35,505	98,216

7. FULL SCENARIO COST RESULTS

Baseline Scenario

Table 54 shows the nominal costs of the Baseline Scenario; the total cost over the life of the project is £331 million.

Table 54 Baseline Scenario Nominal Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	-
Opex	-	-	-	13.7	17.8	22.2	277.4
Facility Revenue	-	-	-	-	-	-	-
Landfill cost	4.9	5.4	6.3	-	-	-	54.1
Total	**4.9**	**5.4**	**6.3**	**13.7**	**17.8**	**22.2**	**331.4**

Table 55 shows the NPV costs of the Baseline Scenario; the total cost over the life of the project is £158 million.

Table 55 Baseline Scenario NPV Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	-
Opex	-	-	-	6.6	6.4	6.2	114.0
Facility Revenue	-	-	-	-	-	-	-
Landfill cost	4.9	4.7	4.5	-	-	-	43.8
Total	**4.9**	**4.7**	**4.5**	**6.6**	**6.4**	**6.2**	**157.8**

Scenario 2 – High Recycling with MBT (AD) and EfW

Table 56 shows the nominal costs of Scenario 2; the total cost over the life of the project is £197 million.

Table 56 Scenario 2 Nominal Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	43.5
Opex	-	-	3.4	4.8	6.3	11.8	117.2
Facility Revenue	-	-	- 0.7	- 1.1	- 1.4	- 1.8	-23.6
Landfill cost	4.9	3.8	1.1	1.6	2.1	0.1	59.9
Total	**4.9**	**3.8**	**3.8**	**5.4**	**7.0**	**10.1**	**196.9**

Table 57 shows the NPV costs of Scenario 2; the total cost over the life of the project is £113 million.

Table 57 Scenario 2 NPV Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	33.2
Opex	-	-	2.4	2.3	2.3	3.3	49.3
Facility Revenue	-	-	- 0.5	- 0.5	- 0.5	- 0.5	-10.2
Landfill cost	4.9	3.3	0.8	0.8	0.7	0.0	40.7
Total	**4.9**	**3.3**	**2.7**	**2.6**	**2.5**	**2.8**	**113.0**

Scenario 3a – Current Recycling with MBT (AD) and EfW

Table 58 shows the nominal costs of Scenario 3a; the total cost over the life of the project is £248 million.

Table 58 Scenario 3a Nominal Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	54.9
Opex	-	-	4.3	6.1	11.5	14.3	166.1
Facility Revenue	-	-	- 1.0	- 1.4	- 1.8	- 2.3	-30.9
Landfill cost	4.9	5.4	1.3	1.8	0.1	0.1	57.9
Total	**4.9**	**5.4**	**4.6**	**6.5**	**9.7**	**12.1**	**248.0**

Table 59 shows the NPV costs of Scenario 3a; the total cost over the life of the project is £141 million.

Table 59 Scenario 3a NPV Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	42.0
Opex	-	-	3.0	2.9	4.1	4.0	68.8
Facility Revenue	-	-	- 0.7	- 0.7	- 0.7	- 0.7	-13.3
Landfill cost	4.9	4.7	0.9	0.9	0.0	0.0	43.4
Total	**4.9**	**4.7**	**3.3**	**3.1**	**3.5**	**3.4**	**140.9**

Scenario 3b – No Recycling with MBT (AD) and EfW

Table 60 shows the nominal costs of Scenario 3b; the total cost over the life of the project is £267 million.

Table 60 Scenario 3b Nominal Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	61.1
Opex	-	-	6.9	6.7	12.1	15.1	182.5
Facility Revenue	-	-	- 1.1	- 1.7	- 2.2	- 2.8	-34.7
Landfill cost	4.9	5.4	1.4	1.9	0.1	0.1	58.2
Total	**4.9**	**5.4**	**7.2**	**7.0**	**10.0**	**12.5**	**267.2**

Table 60 shows the NPV costs of Scenario 3b; the total cost over the life of the project is £152 million.

Table 61 Scenario 3b NPV Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	46.8
Opex	-	-	4.9	3.2	4.3	4.3	76.7
Facility Revenue	-	-	- 0.8	- 0.8	- 0.8	- 0.8	-15.2
Landfill cost	4.9	4.7	1.0	0.9	0.0	0.0	43.7
Total	**4.9**	**4.7**	**5.1**	**3.4**	**3.6**	**3.5**	**152.0**

Scenario 4 – High Recycling with EfW

Table 62 shows the nominal costs of Scenario 4; the total cost over the life of the project is £112 million.

Table 62 Scenario 4 Nominal Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	27.1
Opex	-	-	2.5	3.5	4.6	5.7	77.3
Facility Revenue	-	-	- 1.0	- 1.5	- 1.9	- 2.4	-32.4
Landfill cost	4.9	3.8	0.3	0.4	0.5	0.7	40.4
Total	**4.9**	**3.8**	**1.7**	**2.5**	**3.2**	**4.0**	**112.3**

Table 63 shows the NPV costs of Scenario 4; the total cost over the life of the project is £72 million.

Table 63 Scenario 4 NVP Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	20.7
Opex	-	-	1.7	1.7	1.6	1.6	33.4
Facility Revenue	-	-	- 0.7	- 0.7	- 0.7	- 0.7	-14.0
Landfill cost	4.9	3.3	0.2	0.2	0.2	0.2	31.4
Total	**4.9**	**3.3**	**1.2**	**1.2**	**1.1**	**1.1**	**71.5**

Scenario 5 – Current Recycling with EfW

Table 64 shows the nominal costs of Scenario 5; the total cost over the life of the project is £139 million.

Table 64 Scenario 5 Nominal Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	33.9
Opex	-	-	3.1	4.4	5.8	7.2	98.2
Facility Revenue	-	-	- 1.3	- 1.9	- 2.5	- 3.2	-42.9
Landfill cost	4.9	5.4	0.4	0.5	0.7	0.9	49.9
Total	**4.9**	**5.4**	**2.2**	**3.1**	**4.0**	**4.9**	**139.2**

Table 65 shows the NPV costs of Scenario 5; the total cost over the life of the project is £88 million.

Table 65 Scenario 5 NPV Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	25.9
Opex	-	-	2.2	2.1	2.1	2.0	42.6
Facility Revenue	-	-	- 1.0	- 0.9	- 0.9	- 0.9	-18.5
Landfill cost	4.9	4.7	0.3	0.3	0.3	0.2	38.0
Total	**4.9**	**4.7**	**1.6**	**1.5**	**1.4**	**1.4**	**87.9**

Scenario 6 – High Recycling with ATT

Table 66 shows the nominal costs of Scenario 6; the total cost over the life of the project is £213 million.

Table 66 Scenario 6 Nominal Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	81.3
Opex	-	-	2.3	3.2	8.9	11.1	103.5
Facility Revenue	-	-	- 1.0	- 1.5	- 1.9	- 2.4	-30.9
Landfill cost	4.9	3.8	1.6	2.3	-	-	58.7
Total	**4.9**	**3.8**	**2.9**	**4.0**	**6.9**	**8.6**	**212.7**

Table 67 shows the NPV costs of Scenario 6; the total cost over the life of the project is £132 million.

Table 67 Scenario 6 NPV Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	62.2
Opex	-	-	1.6	1.6	3.2	3.1	41.2
Facility Revenue	-	-	- 0.7	- 0.7	- 0.7	- 0.7	-13.5
Landfill cost	4.9	3.3	1.1	1.1	-	-	41.8
Total	**4.9**	**3.3**	**2.0**	**1.9**	**2.5**	**2.4**	**131.7**

Scenario 7 – Current Recycling with ATT

Table 68 shows the nominal costs of Scenario 7; the total cost over the life of the project is £285 million.

Table 68 Scenario 7 Nominal Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	101.9
Opex	-	-	2.9	9.0	11.7	14.6	172.0
Facility Revenue	-	-	- 1.4	- 2.0	- 2.6	- 3.3	-44.3
Landfill cost	4.9	5.4	2.2	-	-	-	55.3
Total	**4.9**	**5.4**	**3.8**	**7.0**	**9.1**	**11.3**	**285.0**

Table 69 shows the NPV costs of Scenario 7; the total cost over the life of the project is £172 million.

Table 69 Scenario 7 NPV Costs (£ million)

COST	2005	2008	2012	2020	2026	2031	Total
Capex	-	-	-	-	-	-	78.0
Opex	-	-	2.1	4.3	4.2	4.1	69.7
Facility Revenue	-	-	- 1.0	- 1.0	- 0.9	- 0.9	-19.1
Landfill cost	4.9	4.7	1.6	-	-	-	43.4
Total	**4.9**	**4.7**	**2.7**	**3.4**	**3.3**	**3.2**	**171.9**

Appendix 5

A REPORT BY ENVIROS CONSULTING LIMITED: AUGUST 2006

STATES OF GUERNSEY – ENVIRONMENT DEPARTMENT

NEW TECHNOLOGIES FOR THE TREATMENT OF RESIDUAL WASTE

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EXECUTIVE SUMMARY

Abbreviation	
AD	Anaerobic Digestion
A & H	Agriculture and Horticulture
ATT	Advanced Thermal Treatment
BVPI	Best Value Performance Indicators
C & D	Construction and Demolition
C & I	Commercial and Industrial
CA	Civic Amenity
EfW	Energy from Waste
ELV	End of Life Vehicles
ISL	Integrated Skills Limited
MBT	Mechanical Biological Treatment
MHT	Mechanical Heat Treatment
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
NPV	Net Present Value
RDF	Refuse Derived Fuel
tpa	Tonnes per annum
WEEE	Waste Electrical and Electronic Equipment
WIP	Waste Implementation Programme
WWTP	Waste Water Treatment Plant

EXECUTIVE SUMMARY

This report provides an overview of the different types of technology that are currently available for the treatment of mixed solid waste streams. The report focuses on four generic technology types: mechanical biological treatment (MBT), mechanical heat treatment (MHT), advanced thermal treatment (ATT – including pyrolysis and gasification), as well as mass burn incineration. In addition to these four technology types, attention is also focused, where relevant, on the preparation, sorting and separation technologies. These may be combined with the four generic technology types to provide an integrated waste management solution for the Island. Issues and approaches to waste collection systems are not addressed in this report.

As well as providing a description of the science and engineering behind the different technology options, the report identifies the opportunities and risks that may be associated with particular technologies given Guernsey's waste management needs. Each of the different technology options is assessed against the issues of track record and reliability; suitability of the technology to Guernsey's waste; capacity to deal with Guernsey's waste; and the flexibility / scalability of the technology to meet changes in waste composition and arisings on the Island over time.

A consideration of the benefits and costs associated with the different technology options is also presented. In particular the need to divert significant quantities of waste away from landfill is considered; as well as the problems associated with the public's perception of different waste technologies, and whether different technologies can capture the energy value of the waste and thereby contribute to the energy supply on the Island.

In terms of the costs associated with building and operating new waste treatment facilities the report identifies the paucity of publicly available data on the capital and operating costs of new waste treatment technologies.

The selection and implementation of new waste treatment capacity on Guernsey will be influenced by a range of factors. The implications of Island specific factors, off-Island factors, and technology related factors are briefly considered in the report.

The report concludes that a number of the new and emerging waste treatment technologies could provide the basis of a solution for Guernsey's waste management needs. However, in selecting a particular technology or combination of technologies, the States of Guernsey should be mindful of the need for securing reliable and long term outlets

for the outputs from the selected waste treatment technology. The absence of such outlets will result in materials re-entering the waste stream and requiring disposal via landfill.

The report recommends that the States of Guernsey gives due consideration to the possibility of adopting a combination of technologies to provide an integrated waste management solution for the Island. Such a combination may involve a pre-processing technology coupled with some form of thermal treatment option. However, in anticipation of an adverse public reaction to any proposed thermal treatment option it is recommended that Guernsey considers some form of public consultation exercise to elucidate public opinion on issues such as incineration.

Finally, it is recommended that some form of outline business case and a “soft market testing” exercise is undertaken to gather more reliable information on the costs associated with constructing and operating new waste treatment facilities on the Island, and as a means of stimulating market interest.

1. INTRODUCTION

The Environment Department, States of Guernsey, appointed Enviros Consulting Ltd to review the current waste strategies that have been developed for the Island and to provide independent information regarding new technologies and procurement issues. This report builds upon previous work undertaken by Enviros on behalf of the States of Guernsey. The purpose of this report is to provide an overview of the range of alternative technologies (other than landfill) for the management of Guernsey's waste. Information is presented on the following technologies:

- Preparation, Sorting and Separation Technologies
- Mechanical Biological Treatment (MBT), including
  - Bio-drying / RDF (Refuse Derived Fuel) production
  - In-vessel Composting (IVC)
  - Anaerobic Digestion (AD)
- Mechanical Heat Treatment (MHT) / Autoclaving
- Advanced Thermal Treatment (ATT), including
  - Pyrolysis
  - Gasification
- Mass Burn Incineration, including
- Energy from Waste (EfW), and
- Combined Heat and Power (CHP).

Although a number of these processes are generally described as "new" or "emerging" technologies in a UK waste management context, many of them have an established track record elsewhere in the world, or within other industries, and what is new is their application to the management of municipal solid waste (MSW) or other heterogeneous waste streams particularly in the UK. Furthermore, a number of these individual processes may be combined to provide a technological solution that is best suited to the management of wastes for a given situation.

The majority of the technologies listed above are more akin to industrial processes than traditional waste management facilities, and as a result many have significant quantities of outputs (the majority of which are still classified as wastes in many European countries). These outputs require further management or treatment before final recovery or disposal. Moreover, the process dynamics and economics of some of these technologies are heavily reliant upon the existence of markets for the outputs, the absence of which can lead to an increased amount of material requiring disposal via landfill (or incineration), and also adversely affect the operating costs of the facility.

Throughout this report reference is made to providers or locations of particular technologies. The technologies that have been selected are meant to be indicative and have been selected on the basis of the availability of data (particularly information relating to outputs and costs). The presentation of any particular proprietary process is not meant to imply endorsement of any particular process or technology provider.

2. TECHNOLOGIES FOR THE TREATMENT OF WASTE

The technologies described below are capable of treating mixed, unsorted (black bag or Parish) waste, as well as source separated waste. With the exception of mass burn incineration, the various technologies usually include preparation, sorting, and separation processes at some stage of the waste treatment process in order to free the waste from any collection receptacle (e.g. black bags); reduce its physical size / homogenise the waste; and extract for example recyclable material (recyclate) from the waste. For a number of the technologies, the mechanical preparation, sorting, and separation of the waste is undertaken prior to processing the waste either biologically or thermally. However, some configurations of the technologies (including a number of mechanical biological treatment or mechanical heat treatment processes) are designed to sort the waste and separate out any recyclate after the biological or thermal processing stage has been completed. Further detail on specific technologies, details of the process, examples of typical plant throughput and costs are included in Section 4.

2.1 Preparation, Sorting and Separation Technologies

The processes described in this section of the report are those typically employed in “dirty” MRFs (materials recovery facilities), where mixed wastes are separated and sorted mechanically. Recyclate material is separated from the waste and the residual waste, is then either diverted for further processing or sent to final disposal.

The waste preparation technologies that are commonly employed in waste treatment plants include:

- Hammer mills
- Shredders
- Rotating drums
- Ball mills
- Wet rotating drums with knives; and
- Bag splitters.

These processes split open any bags that contain the waste and reduce the physical size of the waste and its constituents. Oversized, or ‘problem’ materials (e.g. mattresses, gas cylinders, concrete blocks, etc) are usually removed from the waste at this stage.

After preparation, the waste is sorted using separation technologies that may involve the following:

- Trommels and screens
- Manual separation
- Magnetic separation
- Eddy current separation
- Wet separation technologies
- Air classification
- Ballistic separation
- Optical separation.

The waste (and any separated fractions) is usually transported around the treatment facility using a variety of conveyor belts. The sorted fractions (i.e. the recyclate, compostable material or fuel fraction) are bulked up and / or further processed before dispatch for recycling or to another waste treatment process.

The waste reception areas, together with the preparation and sorting equipment of a waste treatment plant, are typically housed in an industrial warehouse type of building. The buildings are usually operated under negative pressure so that air and odours can be collected and treated (either by biological filters or thermally) before being discharged to the surrounding environment.

2.2 Mechanical Biological Treatment (MBT)

2.2.1 Introduction

Mechanical Biological Treatment is a generic term for the integration of several processes commonly found in other waste management technologies such as materials recovery facilities, sorting and composting plant. MBT plant can incorporate a number of different processes in a variety of combinations. Additionally, MBT plant can be built for a range of purposes.

A common aspect of all MBT plant used for MSW management is to sort mixed waste into different fractions using mechanical means; and to extract materials for recycling, in combination with the biological degradation of the organic fraction of the waste. It should be noted that the segregated waste types and materials from an MBT plant are likely to be contaminated, of low quality and of low value compared to source segregated materials.. The exact mix of technologies and the operational conditions employed in an MBT facility will depend on the additional objectives of the plant. These objectives would typically be one or more of the following:

- Part stabilise the waste prior to landfilling;
- Biologically process a segregated “organic rich” component of the waste (for example to form a low grade soil conditioner); or
- Produce a segregated high calorific value waste to feed an appropriate thermal process to utilise its energy potential.

The biological element of an MBT process may either take place prior to, or after mechanical sorting of the waste. Each approach has its own particular application.

Biological treatment of the waste is concerned with the use of technologies to treat biodegradable wastes using controlled biological processes.

All biological waste treatment processes involve the decomposition of biodegradable wastes by living microorganisms (microbes) – bacteria, actinomycetes and fungi – which use waste materials as a food source for growth and proliferation.

These microbes excrete enzymes to digest the complicated organic substances in waste (e.g. complex carbohydrates, proteins and fats) into simple nutrients (e.g. sugars, amino acids, fatty acids) that are absorbed for microbial nutrition. As the microbes grow they convert a significant proportion of the organic matter into heat, gases and water, which can account for large mass transfers during biological waste treatment.

There are two main types of conditions in which such microbes live, and therefore two main types of biological processes used to treat biodegradable waste:

- Aerobic treatment (composting) in the presence of free oxygen (e.g. bio-drying or in-vessel composting); and
- Anaerobic treatment (digestion) in the absence of free oxygen.

2.2.2 Bio-drying

In technological terms, perhaps the simplest form of MBT involves the "bio-drying" of the waste prior to the extraction of recyclate material and the preparation of most of the remaining waste material as a refuse-derived fuel (RDF). This type of MBT facility has been operational in central and southern Europe for over ten years and is the type of approach employed in processes such as those of VKW, Ecodeco and Herhof.

After the waste has been prepared, it is either spread out on beds within a large drying bunker (e.g. VKW, Ecodeco) or emplaced within tunnels or boxes (e.g. Herhof). Air is then drawn through or forced into the wastes via the use of fans. The biodegradable fraction of the waste partly breaks down in the presence of air and in the process releases significant quantities of heat that are used to dry the waste. The heat drives off the moisture present in the waste and thereby making the waste easier to handle and process, whilst at the same time reducing the mass and increasing the calorific value (CV) of the processed waste. Once the waste has dried sufficiently the recyclates are removed using methods describedin section above, and the remaining material either baled, bulked or compacted (often in the form of pellets) as a fuel. This is variously known as refuse derived fuel (RDF) or solid recovered fuel (SRF) (a standard is ascribed to the latter), which may be used as a replacement fuel in an industrial process or as a feedstock for an energy recovery process (e.g. energy from waste plant or advanced thermal treatment process).

2.2.3 In-Vessel Composting (IVC)

Although some wastes may be composted in the open air using windrows, many MBT facilities employ in-vessel composting as a means of aerobically treating the organic fraction of the waste. The main advantage of IVC over windrow composting is that IVC allows the processing of the waste under carefully controlled conditions, to produce a partially stabilized output, free from pathogens. Because of this, IVC is highly suited to the processing of mixed wastes that contain kitchen and catering wastes, thereby overcoming concerns associated with the spread of diseases such as foot and mouth from infected wastes applied to land or in contact with birds, vermin or ruminants. This is in contrast to open windrow composting systems which are more applicable to source segregated gardens and parks organic wastes.

In-vessel composting technologies come in a range of designs. All systems supply oxygen and control temperature and moisture levels to optimise the biological stabilisation, and achieve sanitisation, subject to temperature and duration of treatment. They may also provide for the addition and optimisation of the nutrient levels.. In-vessel composting facilities are either contained within buildings or specifically designed vessels (e.g. tunnels, drums or towers). The methods used to control oxygen supply, temperature and moisture loss are through mechanical agitation e.g. Bioganix and / or forced aeration (fan assisted) e.g. Herhof.

Almost all MBT plant initially sort waste by size, usually dividing the waste into a large fraction (mostly paper, plastics, card) and a finer fraction (organic wastes, broken glass, miscellaneous combustible and inert materials). Following the preparation of the waste and this initial sort by size, the finer organic fraction of remaining waste is placed in the composting vessel. During aerobic decomposition, organic material is converted into a residual solid, heat, carbon dioxide and water through microbial respiration in the presence of oxygen. A relatively dry process, it is used for materials with high solids content – moisture/content ratio of 40 to 60 per cent.

Aerobic processes create large amounts of biologically produced heat as microbes respire and are associated with high (thermophilic) temperatures of between 50^0 and 70^0 C. Such high temperatures, if maintained and controlled, have the advantage of sanitising (killing potentially pathogenic organisms) and drying the material.

As the process progresses, heat, carbon dioxide and moisture are lost to the atmosphere, leaving a mixture of woody fragments, microbes and a complex decomposition by-product called humus.

This stable, dried organic mixture, together with any non-biodegradable material already in the process (often known as contraries) is known as “compost” when produced from source segregated waste; or “stabilized biowaste” or “soil conditioner” when produced from non source segregated waste.

2.2.4 Anaerobic Digestion (AD)

During anaerobic digestion organic material is converted into a residual solid and/or slurry, a biogas and water through microbial fermentation in the absence of oxygen. Anaerobic digestion plant are sometimes referred to as ‘biogas’ plant. The AD process is typically a liquid process used for materials with low solids content and moisture contents ranging between 60 and 95 per cent. Anaerobic processes create much lower amounts of biologically produced heat compared to aerobic processes and additional heat may be required to maintain optimal temperatures at 35 to 40^0C.

The waste feedstock is macerated with a large proportion of process water to provide a dilute thin ("wet") or thick ("dry") slurry that can be fed into a digester tank. This stage is also often used as a decontamination stage to remove heavy and light contaminants through wet gravimetric separation.

The AD process can be operated at mesophilic (typically 30 – 40^0C) or thermophilic (typically 50 – 60^0C) temperatures. Dry AD processes lend themselves to thermophilic temperatures, whereas wet processes can be either meso- or thermophilic with the former being dominant. The EU Animal By-Products Regulations require Pasteurisation of mixed source AD waste to a standard 70^0C for one hour. UK legislation requires treatment at 70^0C or higher for at least one hour or, in the case of biogas plant, 57^0C for 5 hours.

The digestion process takes place in sealed tanks (digesters) that are usually mixed thoroughly to maximise contact between microbes and waste. Mixing can be achieved using mechanical stirring devices, gas or slurry recirculation.

AD processes can be single step processes where all the waste is placed into a single digestion stage / tank, or multiple step processes. Multiple step processes involve a separate hydrolysis stage, which can be either aerobic or anaerobic, to optimize the breakdown of complex organic material into soluble compounds. This is followed by a high-rate AD process for biogas production. This process may take place in a number of vessels, normally two are employed, one as a separate hydrolysis vessel and the second as a digester.

A combustible gas known as "biogas" is produced, consisting primarily of a mixture of methane and carbon dioxide, which can be used for heat and/or electricity production. This gas is usually collected in an appropriately sized tank, prior to its combustion in either an internal combustion engine or boiler. As well as biogas, a complex mixture of microbes (biomass), decomposition by-products, humus and woody fragments remain in a liquid suspension know as "digestate".

Due to the high moisture content of the waste material entering the process and the loss of solids during digestion, the final digestate still contains high moisture content upon leaving the process. This digestate can be mechanically separated into its solids (fibre) and liquid (effluent) fractions.

The de-watered fibre may be used directly on land as a soil improver provided it meets appropriate regulatory criteria, or aerobically treated (matured, usually through a composting process) prior to its use.

Alternatively, the fibre may be combined with other combustible materials to form a refuse derived fuel (RDF).

The liquid effluent may be recycled in the AD process, used directly as a liquid fertilizer if meeting appropriate criteria, used in subsequent aerobic (composting) treatment of the fibre, or discharged to sewer (subject to consent conditions).

2.3 Mechanical Heat Treatment (MHT) / Autoclaving

Mechanical Heat Treatment is a term used to describe configurations of mechanical and thermal (including steam) based technologies. The most common system being promoted for the treatment of MSW is autoclaving. This technology is in common use for the treatment of some clinical wastes and also for certain rendering processes for animal wastes. However, its application to MSW is a recent innovation, and there is limited commercial experience on this feedstock material.

Different MHT systems may be configured to meet various objectives with regard to the waste outputs from the process. The options available (depending on the objectives and the system employed) may include one or more of the following:

- Separate an "organic rich" component of the waste for subsequent biological processing (for example to produce a low grade soil conditioner);
- Produce a segregated high calorific value waste (RDF) to be applied in an appropriate process to utilise its energy potential; and
- Extract materials for recycling (typically glass and metals, potentially plastics and the "fibrous" organic and paper fraction).

Whilst a variety of treatment and mechanical separation options are offered (e.g. Sterecycle in USA, Estech in Germany, Fairport in UK), these need to be optimised in terms of the outputs in order to find outlets for the various materials/fuels derived from the process. It is important to retain flexibility to adapt the process to produce different outputs to meet the needs of the market.

The autoclaving of waste is usually undertaken as a batch process where the waste, following its preparation (e.g. bag splitting, and size reduction), is placed in a sealed container and steam is injected into the vessel under pressure. The waste is left to "cook" for a predetermined period of time (typically an hour, although some "flash" processes claim to be able to treat batches of waste in a matter of minutes). After treatment, the waste is removed from the vessel and sorted. The heat and pressure typically deform the plastic components of the waste, and remove labels from bottles and cans. The processed organic material usually ends up as a "floc-like" material, which may then be further treated. One proposed use for the floc is as a soil conditioner following further treatment via a composting process, although recent research at Southampton University suggests that the MHT process itself inhibits the decomposition of the organic material. Other suggested uses include the preparation of a refuse-derived fuel from the floc (after drying), or the production of a building material / use as a raw material by encasing the floc in a resin or cementitious matrix.

2.4 Advanced Thermal Treatment (ATT)

2.4.1 Introduction

There is a range of thermal treatment options which are typically described as separate processes but which in fact represent a continuum between different process characteristics. In particular the availability of air (or oxygen) determines the characteristics of thermal treatment. Pyrolysis occurs in the complete absence of oxygen and therefore is not a combustion process. Gasification has controlled limited quantities of oxygen and results in partial combustion. Conventional mass burn incineration takes place in the presence of excess oxygen and results in full combustion. In reality several commercially available process technologies combine more than one of these different conditions in different parts of the combustion chamber.

The advanced thermal treatment technologies considered here are primarily those that employ pyrolysis and/or gasification to process municipal solid waste.

The gasification and pyrolysis of solid materials is not a new concept. They have been used extensively to produce fuels such as charcoal, coke and town or producer gas. Charcoal and coke are produced by pyrolysing wood and coal respectively, and producer gas is a combustible gas produced by the gasification of coke in the presence of air and steam.

It is only in relatively recent years that pyrolysis and gasification have been commercially applied to the treatment of MSW. The development of pyrolysis and gasification technologies is in its infancy in the UK but some medium to large scale plants have been built and are in operation in Europe, North America and Japan.

2.4.2 Pyrolysis

Pyrolysis is the thermal degradation of a substance in the absence of oxygen. This process requires an external heat source to maintain the temperature required. Typically, relatively low temperatures of between 300^0 and 800^0C are used during pyrolysis of materials such as MSW. The products generated from pyrolysing MSW are a solid residue and a synthetic gas (syngas). The solid residue (sometimes described as a char) is a combination of non-combustible materials and carbon. Syngas is a mixture of gases (its combustible constituents include carbon monoxide, hydrogen, methane and a broad range of other volatile organic compounds). A proportion of these can be condensed to produce oils, waxes and tars. The syngas has a net calorific value (NCV) of between 10 and 20 MJ/Nm^3. If required, the condensable fraction can be collected by cooling the syngas, potentially for use as a liquid fuel (pyrolysis oil).

2.4.3 Gasification

Gasification involves the partial oxidation of a substance. This means that oxygen is added but the amounts are not sufficient to allow the fuel to be completely oxidised and full combustion does not occur. The temperatures employed are typically above 750^0C. The main product is a syngas, which contains carbon monoxide, hydrogen and methane. Typically, the gas generated from gasification will have a net calorific value of 4 – 10 MJ/Nm^3. For reference, the calorific value of syngas from pyrolysis and gasification is far lower than natural gas, which has a net calorific value of around 38 MJ/Nm^3. The other principal product produced by gasification is a solid residue of non-combustible materials (ash) which contains a relatively low level of carbon.

The actual plant design and configuration of ATT facilities will differ considerably between technology providers. However, an ATT plant will typically consist of the following key elements:

- Waste reception, handling and pre-treatment;
- Thermal treatment reactor;
- Gas and residue treatment plant (optional);
- Energy recovery plant (optional); and
- Emissions clean-up plant.

One of the potential benefits of pyrolysis and gasification is that the syngas can be used in a number of ways. In terms of producing energy, the most common configuration is to burn the syngas in a boiler to generate steam. The steam can then be used to generate electricity by passing it through a steam turbine and, if there is a demand local to the plant, for heating. Using the heat in addition to generating electricity improves the overall energy efficiency of the system significantly.

The syngas can also be used to fuel a dedicated gas engine. A syngas derived from an efficiently run gasifier, or which has been further processed for example by reforming, may be suitable for use in a gas turbine. Running these types of plant on syngas is still in its infancy and would require cleaning and cooling prior to use. However, using a gas engine or gas turbine could increase efficiencies for electricity generation.

In addition to using the syngas as an energy source, it could also be used as a chemical feedstock. This offers a further option for utilising the syngas but would require the treatment plant to be near to the end user, in order to be a practicable solution.

Advanced thermal treatment technologies operate more efficiently on wastes that have undergone a considerable amount of pre-processing than they do on raw wastes (that have only undergone the preparation and sorting phases). Indeed, it is becoming increasingly common for ATT plants to be promoted to operate on RDF produced either from an MBT or an MHT plant.

2.5 Mass Burn Incineration

2.5.1 Introduction

The thermal combustion of waste has a long tradition within Western Europe and elsewhere, and until the 1990s was a significant means of disposing of municipal solid waste in the UK. However, the introduction of stringent emissions control legislation within the last 15 or so years led to a significant reduction in the number of incinerators operating within the UK as the cost of retro-fitting pollution abatement equipment rendered the existing plant obsolete. On the other hand, incineration has remained an important means of waste disposal in other parts of Europe, particularly in countries where the large scale landfilling of waste was not possible due to the limited availability of suitable sites.

Due to an increase in public concern over the emission of dioxins and furans from old incinerators, proposals to build and commission incinerators, or ‘energy from waste’ (EfW) plants in the UK have been largely met with public outcry, despite the fact that all existing and new combustion plant have to comply with the stringent requirements of the European Waste Incineration Directive (WID). Notwithstanding this, there is a growing recognition within the UK that incineration is on the increase and will form an important part of the future strategy for waste management in the UK, and elsewhere.

Mass burn incineration has distinct advantages over other forms of waste treatment and disposal. In particular, mass burn incineration has a long established track record throughout the world; it effectively eliminates the biodegradable fraction of municipal solid waste; and the energy content of the waste can be captured via electricity production and/or combined heat and power production.

Other benefits of incineration include:

- A reduction in the volume and weight of waste, especially of bulky solids with a high combustible content. The reduction can be up to 90% of the volume and 75% of the weight of materials

- Destruction of some wastes and detoxification of others to render them more suitable for final disposal, although many of the toxic materials will be captured in the air pollution control residue which requires specialist disposal

- The replacement of fossil fuel for energy generation with beneficial environmental consequences

2.5.2 Energy from Waste (EfW)

The mass burn incineration of waste is today generally referred to as energy from waste (EfW) process, although there are other means of obtaining energy from waste materials, including anaerobic digestion, gasification, and pyrolysis. Effectively the mass burn incineration of waste entails the combustion of unsorted mixed waste, usually on a moving grate, but oscillating and fluidised bed grates are also sometimes used particularly for smaller scale plant. Although, it is becoming increasingly common for mixed wastes to be sorted prior to their combustion, the majority of mass burn incinerators operate on wastes delivered in the form of raw MSW (black bag wastes), with metals being recovered from the bottom ash after combustion.

The operation of an energy from waste facility entails the following process steps:

- Waste is tipped into a pit and is mixed by an overhead crane before being transferred into a charging hopper, where it is fed on to a moving metal grate or fluidised bed.

- The grate transfers and agitates the waste across the combustion chamber and air is introduced under the grate which initiates combustion and also cools the grate.

- Air above the grate helps to mix the combustion gases and ensure complete combustion of the waste, and reduces the production of oxides of nitrogen.

- The energy from the hot flue gases is transferred across the walls of a boiler, and is used to heat the boiler water and raise steam.

- The steam is then either used to turn turbines for electricity production, and / or is used locally for heating purposes. Where both heat and electricity are captured this is known as Combined Heat & Power (CHP, see below).

- The cooled flue gases then pass through air pollution control (APC) equipment, including scrubbers (for acid gas removal), electrostatic precipitators (for dust removal), and/or fabric filters (for the removal of fine particulates), and then activated carbon filters (for dioxin and mercury control), before being discharged to the atmosphere via the stack.

- The residues from the air pollution control equipment are generally classified as hazardous waste and require appropriate disposal.

- The solid material remaining after the combustion process (bottom ash) is carried from the end of the moving grate into a bunker. The bottom ash is largely inert material that is discharged to a water quench tank to cool.

- The metals in the bottom ash are generally recovered at this stage and recycled. The bottom ash material may either be sent to landfill or (commonly) graded for use for replacement aggregate construction or road building purposes.

The energy efficiency of a typical EfW plant is in the region of 20% to 25%. However the overall energy efficiency of an EfW plant can be significantly improved through the utilization of a combined heat and power system. CHP schemes have been successfully adopted in a number of cities, particularly in Scandinavia and Northern Germany. CHP schemes provide district heating to local residential and commercial areas. The use of CHP schemes can raise the overall efficiency of an EfW plant to somewhere in the region of 75%. In the UK, CHP schemes have been introduced in Sheffield, Coventry and Nottingham. In Nottingham, the EfW plant provides 10 MW_e electricity, and 50 MW_{th} of heat to 4,800 houses, a shopping centre, a university, and the Inland Revenue building.

3. OPPORTUNITIES AND RISKS

This section provides an overview of the opportunities and risks associated with the task of selecting a technology or a combination of technologies to meet Guernsey's waste management needs. The generic technologies that are described in section 2 above are discussed under the following headings:

- Track record and reliability of the technology
- Suitability of the technology to Guernsey's waste
- Capacity to deal with Guernsey's waste
- Flexibility / Scalability of the technology

3.1 Track Record and Reliability of the Technology

3.1.1 Introduction

When selecting a technology option, the track record of that option has to be a key consideration. The point was made earlier in this report that the majority of the so-called new waste management technologies are not new as such, but many of the technologies have only a limited track record with respect to their application to the management of MSW. In tandem with the consideration of track record, is the reliability of a particular technology. For example the Defra New Technologies Demonstrator Project requires its selected show-case examples to operate for 8,000 trouble free hours (approximately 2 years of operation), in order to be considered to be reliable, and only time will tell whether the selected demonstration plants will meet this criteria. Therefore a yardstick of a minimum of two years operational experience on MSW or similar wastes will be used when assessing the track record of the generic technologies.

3.1.2 Preparation, Sorting, and Separation Technologies

The majority of the mechanical preparation, sorting and separation technologies have been developed in other industries (most notably the minerals extractive industry). The application of these processes to waste management has for the most part been successful. However, operational difficulties can be experienced, particularly when the machinery comes into contact with oversized material, or material that is particularly hard or dense.

There is currently a wide range of suitable equipment manufacturers and suppliers operating in Europe and worldwide, many with an established reputation for the supply and installation of the equipment listed in section 2.1 above.

3.1.3 MBT

MBT is a concept developed in Austria and Germany in the mid 1990s. It was originally used to reflect an approach to waste management that eschewed thermal processing[1]. Many of the early plants were loose combinations of low-technology sorting processes coupled with simple biological treatment processes such as windrow composting. Over the course of the past decade, MBT facilities have become increasingly sophisticated in their design and integration.

There are a growing number of specialist technology providers (most notably from Germany) that offer a range of MBT technologies, from bio-drying through to integrated materials reclamation with biogas / energy recovery.

There are a wide range of MBT technology providers who exhibit varying track records on MSW. There have been issues with effectively marrying the various mechanical and biological components within the plant and also matching the configurations of plant with different waste compositions. Issues with either of these can adversely affect both commissioning timescales and reliability. A key risk issue with MBT is aligning the process to generate outputs which meet the demands of the market / outlet to which the materials are required to enter.

3.1.4 MHT

As stated above in section 2.3, MHT or autoclaving has only been applied to mixed waste sources relatively recently. There have been a number of pilot plants that have operated for short periods of time on MSW. The most notable examples have included the Alliance Technology Group Inc. (ATG) which has developed a demonstration facility in Minneapolis in the USA; and the static Estech Fibrecycle plant that was developed in Scotland.

The reliability of MHT technology with respect to its operation on mixed MSW is as yet unproven. However, at least one waste disposal authority in the UK has selected MHT as its preferred technology option for the treatment of MSW.

1 MBT A Guide for Decision Makers – Processes, Policies and Markets, Juniper (2005)

The track record therefore is limited, and the technology has similar risks as MBT with regard to aligning the process to generate outputs which meet the demands of the market / outlet to which the materials are required to enter. Whilst MHT is a relatively simple technology, there remain risks over the optimum configuration of the plant to tackle different compositions of MSW, and this has the potential to result in commissioning risks and reliability issues. However this issue is considered to be of secondary importance to that of establishing sustainable markets / outlets for the outputs.

3.1.5 ATT

As with MHT, the application of advanced thermal treatment processes to MSW is a relatively recent development. However, worldwide there are over one hundred facilities operating or ordered, with a combined processing capability of over 4 million tonnes of waste per year. The greatest proliferation of ATT plants is in Japan, where some of the plants have been operational for nearly a decade. Nevertheless, many of these have only operated at a pilot scale, and some of the facilities have experienced difficulties.

The track record of ATT plant processing MSW may be considered ‘patchy’. Several processes marketed in Europe have switched their attentions to Japan where the market to date has been more favourable. Certain facilities (e.g. Energos, Techtrade) have a good track record in Europe whilst others have either failed technically or ceased trading. The variability of MSW is difficult for some less robust ATT systems to cope with, and appropriate pre-treatment is required to ensure a feedstock of sufficient homogeneity for gasification / pyrolysis.

3.1.6 Mass Burn Incineration

The mass burn incineration of waste has the longest tradition of all of the technologies described in this report. With a pedigree stretching back well over one hundred years, incineration continues to be one the main means of treating and disposing of MSW. The vast majority of modern waste incinerators are designed to recover the energy content of the waste, and operate to very high emission standards.

There are a range of companies that specialise in the provision of mass burn incineration, with or without combined heat and power.

The track record and reliability of most moving grate incineration systems is well established. There is less of a track record for fluidised bed systems operating on MSW, and there may be risks over commissioning such facilities. Fluidised bed facilities may be more appropriate for smaller scale, consistent feed stock inputs e.g. RDF. The bespoke smaller scale oscillating kiln designs (e.g.Tiru Cyclerval), also have a lesser track record than moving grate systems however there are reference plant operating in France / Belgium on MSW or similar wastes, in some cases for over twenty years. All EfW plant will operate within a thermal envelope, wastes of too high or too low a CV will cause problems for such plant. Most incinerators however are designed to cope with a wide range of waste compositions before throughput and operations are significantly affected.

3.2 Suitability of the Technology to Guernsey's Waste

3.2.1 Introduction

It is our understanding that the States of Guernsey is seeking a waste management solution that will effectively deal with all of its current waste arisings, and have the capacity to continue to do so for at least 25 years. In addition, the waste management solution should look to maximise the amount of remaining capacity in the existing landfill at Mont Cuet. Therefore, it is important that the selected technology, or combinations of technologies is capable of dealing with all of the waste fractions arising on the Island (with the exception of inert wastes that will be utilized for reclamation work at Longue Hougue, or hazardous waste, which may be exported from the Island).

In addition to this, in consideration of the various technologies it is important to assess the availability of outlets or markets for the outputs of the different technologies. As mentioned above, a number of the new technologies are reliant upon the existence of outlets or markets for outputs, and the limited capacity of these (described in Enviros, 2005) may render certain technologies inapplicable to Guernsey's waste management needs.

3.2.2 Preparation, Sorting, and Separation Technologies

The preparation, sorting and separation technologies described in section 2.1 above would be capable of dealing with Guernsey's waste, but only as part of an integrated waste management solution. Moreover, the sorting and separation technologies would be essential if the States of Guernsey were seeking to recycle materials from parish waste (particularly if high levels of recycling were required). In addition to this, the preparation, sorting and separation technologies would have to be combined with other treatment or disposal technologies in order to deal with the other fractions of the waste stream (including the biodegradable element of the waste).

3.2.3 MBT

There is little doubt that within the range of treatment technologies that are currently available under the generic term of mechanical biological treatment, a combination of technologies and processes could be selected that would treat a significant proportion of Guernsey's waste. However, an important consideration when assessing the suitability of MBT as an appropriate solution to Guernsey's waste management needs is that of the management of the outputs from the process, as these impact on both the technical and financial viability of the option, and the residual quantity of waste going to landfill.

If the MBT processes were to be based upon the bio-drying option, then an outlet for the RDF produced by the process would be required either overseas or on the Island. Given that there is currently a negative market for RDF in the UK and mainland Europe, the cost of exporting the RDF coupled with the gate fee charged for the material by the user, it is likely to render the export of RDF uneconomic. The alternative would be to install capacity on the Island to dispose of the RDF, either via gasification / pyrolysis or through firing it in a conventional incinerator (capable of managing the higher CV wastes) or other boiler.

If an in-vessel composting plant received only source separated green waste and or kitchen type wastes, a high quality compost could be produced. On the other hand, if an MBT facility with IVC were to take unseparated parish (or possibly C&I) waste to derive a usable organic stream, a low quality soil conditioner would be the anticipated output. If C&I wastes were to be received then non-conforming materials would have to be separated prior to composting.

Currently, best practice in the UK does not allow the spreading of soil conditioner (i.e. that produced from mixed waste) on agricultural land, whereas farmers are being encouraged to trial the use of compost produced from source separated waste. Moreover, in an earlier report compiled by Enviros for the States of Guernsey, it was identified that the 7,500 tonnes of green waste (excluding catering waste) produced on the Island each year could be composted to produce approximately 4,500 tonnes of compost per year. Theoretically all of this compost could be applied to farmland on the Island at a rate of 30 tonnes per hectare; however this would require almost all of the cereal-sown land available in Guernsey to be used every year, but there would be economies in reduced fertiliser required and a general positive environmental impact in this regard.

3.2.4 MHT

Guernsey's waste could be treated via an MHT / autoclaving facility. Such a facility would facilitate the recovery of recyclates, including metals, glass and plastics, together with an organic floc. If the States of Guernsey were to follow a scenario of high recycling, then an MHT treatment facility may be a viable alternative to an approach involving MBT. Again, as with MBT, an important caveat to the choice of MHT is the identification of markets for the outlets, in particular the organic floc. At the moment, there is no proven market for this material in the UK or Western Europe. As a consequence, it is likely that the floc would either have to be disposed of via landfill, or used as a fuel (RDF) for incineration or advanced thermal treatment.

3.2.5 ATT

An advanced thermal treatment facility could be used to treat Guernsey's waste, and would permit the recycling of glass and metals from mixed commercial and household wastes. It is likely that any ATT facility on the Island would be optimised for energy recovery, rather than the production of liquid fuels or chemical feedstock. This would entail additional investment in an appropriate boiler / gas engine. The overall efficiency of a boiler / turbine arrangement could be improved by the use of a combined heat and power system, but this would require a demand for the heat local to the energy recovery facility (which could be domestic, commercial, or industrial). Such a demand has not been identified on Guernsey.

3.2.6 Mass Burn Incineration

A mass burn incinerator could deal with Guernsey's residual waste. Ideally, the facility would be designed to recover the energy value of the waste through electricity production, with the possibility of utilising the heat as well. As with ATT, any use of the heat would require a demand local to the plant.

3.3 Capacity to Deal with Guernsey's Waste

We understand that total waste arisings on the Island are currently in the region of 250,000 tonnes per year. Full details of the requirements for the capacity of the selected facilities are included in Enviros, 2006 modelling report,

- Assuming 'current' recycling rates are maintained but not significantly increased results in a required facility capacity of 98,000 tonnes of waste per year in 2031,

- Assuming 'high' recycling rates gives rise to a required facility capacity of 71,000 tonnes of waste per year in 2031.

Other reports prepared by Enviros discuss the potential to achieve high recycling rates up to about 50%. There is evidence that in some communities such high recycling rates of household waste arisings have been achieved. However, our view is that this will be difficult to achieve on Guernsey, and in current market conditions for recycled materials high recycling would not be economically justifiable. A counter view is that it is intrinsically good and environmentally beneficial to maximise the recycling rate in order to protect global resources and achieve the most sustainable waste and resources management strategy. These issues are extremely difficult to rationalise and fully evaluate. There is an increasing trend in Europe to use Life Cycle Analysis techniques to compare the full environmental impacts of different collection, transport, recycling, treatment and disposal options for wastes. Such techniques however can only be used if a large amount of reliable data is available. Furthermore, such LCA studies as have been conducted do not lead to unambiguous results; it is argued by some that the life cycle impacts of collecting, sorting and recycling some materials are greater than recovering the energy they contain by means of a thermal recovery technology.

For illustrative and comparison purposes, and for the purposes of this report only, it is suggested that any new waste treatment facility on the Island should have the capacity to manage approximately 100,000 tonnes of waste per year.

3.3.1 Preparation, Sorting, and Separation Technologies

The preparation, sorting and separation technologies listed in section 2.1 can all be combined to deal with an indicative 100,000 tonnes of waste per year.

3.3.2 MBT

Commercial MBT plants have been built at both small scale (less than 50,000 tonnes per annum) and at large scale (greater than 200,000 tonnes per annum)[2]. The largest known commercially operating MBT plant is on the outskirts of Madrid (480,000 tonnes per year), although only half of the waste that this plant receives is processed through the biological treatment element of the facility. Although it is possible to build large scale MBT facilities, the majority of plants that have been built have a capacity of less than 100,000 tonnes per year.

2 MBT A Guide for Decision Makers – Processes, Policies and Markets, Juniper (2005)

3.3.3 MHT

Given the novelty of MHT with respect to the treatment of MSW, it is difficult to predict the capacities of future plants based on this form of technology. To date, Estech has operated a 25,000 tonne per year plant in Scotland for a limited period of time, and the same company is also promoting a mobile 5,000 tonne per year facility. Sterecycle has been operating a 70,000 tonnes per year plant in Minnesota, USA since July 2004.

3.3.4 ATT

Advanced thermal treatment facilities have been designed to operate at a range of scales from small scale local systems (30,000 tonnes per year) to large scale regional facilities (150,000 to 500,000 tonnes per year)[3]. However, a typical ATT plant would be less than 100,000 tonnes per year.

3.3.5 Mass Burn Incineration

Mass burn incinerators can operate at a range of scales. Table 1 below lists the twenty energy from waste plants (i.e. those based on mass burn incineration), that are currently operating in the UK, plus the Isle of Man. In terms of capacity these plants range from the 26,000 tonnes per annum EfW plant at Lerwick on the Shetland Isles to the 600,000 tonnes per annum EfW plant at Edmonton in London[4]. Given this range of capacities, there seems to be little doubt that an appropriately sized mass burn incinerator could be sourced to meet Guernsey's waste management needs.

3 Juniper Consultancy Services, Technology Reviews 2003.
4 Extending ROC Eligibility to Energy from Waste with CHP, Ilex Energy Consulting, Sept. 2005

Table 1 Waste Capacity and Energy Recovery of Energy from Waste Plant in the UK

Location	Operator	MSWkt/yr	Output Elec/Heat	Commissioned
Allington	WRG	500	43MWe	2006
Basingstoke	Veolia	90	8 MWe	2003
Bolton	Greater Manchester Waste Ltd	120	10 MWe	2000
Edmonton	London Waste Ltd (50% SITA)	600	32MWe	1994
Coventry and Solihull	Coventry and Solihull Waste Disposal	250	12.9 MWe 4.5MWe/9 MWth	1976 1992 – 2000
Dudley	Dudley Waste Services Ltd	90	7.4 MWe	1998
Dundee	Dundee Energy Recycling Ltd	120	10.7 MWe	1999
Kirklees	SITA	136	10 MWe	2003
Lerwick	Shetland Heat Energy and Power	26	Heat only (mixed use)	2000
Marchwood	Veolia	165	15 MWe	2005
Grimsby	TIRU-Cyclerval	56	3 MWe/3 MWth	2003
Nottingham	WasteNotts	147	10 MWe / 50 MWth	1972 / 1996
Portsmouth	Veolia	165	15 MWe	2005
SELCHP	Veolia	420	31 MWe	1994
Sheffield	Veolia [to be replaced with]	115 225	7 MWe / 26 MWth 20 MWe / 32 MWth	1988 2005

Location	Operator	MSWkt/yr	Output Elec/Heat	Commissioned
Stoke	Hanford Waste Services	200	16 MWe	1999
Teeside	SITA	180	19 MWe	1998
Tyseley	Veolia	370	25 MWe	1996
Wolverhampton	Wolverhampton Waste Services	105	7 MWe	1998
Isle of Man5	SITA	60	6.8 MWe	2004

3.4 Flexibility / Scalability of the Technology

3.4.1 Introduction

It is important to understand that the waste management solution that is chosen by the States of Guernsey will need to be able to adapt to accommodate changes in the amount of waste that is produced on the Island and any variations in its composition, over a time period of not less than twenty-five years. Some of the technologies described above are inherently more flexible and scalable than others. Two other factors that should be borne in mind in this context are:

(a) The ability to easily add additional capacity to the facility may allow a phased period for capital investment; and

(b) A reduction in the amount of waste arising on the Island, or a significant change in its composition, may lead to the facility operating at sub-optimal levels, which may impact adversely on process efficiencies and alter the economic basis of the plant.

Many of the technology providers and equipment suppliers claim that their systems are inherently flexible, allowing operators to increase their handling capabilities by adding additional processing lines as and when necessary. Whilst this may be true as a general statement, it should be borne in mind that for many of the generic technology types, additional capacity can only be added in step-changes, rather than in a linear fashion. For technologies other than those for preparation, sorting and

5 SITA Isle of Man Annual Public Report 2004-5

separation of waste, additional modules or lines are likely to be designed to handle a minimum of 10,000 tonnes of waste per year (with the possible exception of the mobile, 5,000 tonnes per year MHT plants cited above). The thermal facilities are certainly less flexible in this regard and would entail the greatest additional cost if a new line were required to accept an additional quantity of waste.

One natural consequence of this is that there is a tendency to specify the capacity of a new waste management facility to allow for an increase in total waste arisings over time. This could pose problems during the early years of operation of the facility (due to a reduction in overall process efficiencies), unless sufficient tolerances are accommodated for in the overall waste management system. Such issues may be compounded in the medium to long term if the anticipated increase in waste arisings does not occur, for example due to an economic downturn reducing the level of consumption of the Islanders.

It would be prudent when considering any of the options below, however to ensure that there is sufficient capacity (available land and access etc.) at relevant infrastructure sites for expansion to meet the needs of any unpredicted increase in waste arisings.

3.4.2 Preparation, Sorting, and Separation Technologies

It is unlikely that the preparation, sorting and separation technologies that form part of any integrated waste management solution alongside MBT, MHT, ATT, or even mass burn incineration, will pose insurmountable problems with regard to flexibility / scalability in response to changes in total waste arisings or the composition of the Island's waste. Such variations can often be managed through shift patterns or relatively inexpensive modifications to sorting infrastructure.

3.4.3 MBT

It is possible to add additional processing capacity to an MBT facility. This could take the form of extra biological processing units (e.g. anaerobic digestion reactors and gas storage tanks, or more in-vessel composting tunnels). However, any additional increase in the operating capacity of the back-end of an MBT process is likely to also require an increase in the capacity of the preparation, sorting and separation equipment at the front end of the plant. The bulk of the increased cost of an expansion would lie in the expansion of the biological treatment aspect and the need for additional land for maturation / storage of outputs. There is also a risk issue dependent on having sufficient capacity in markets or outlets for receipt of the additional outputs from the process. In the case of an MBT plant using AD, there would also be a need to expand the electricity generation capacity if the efficiencies of the process are to be retained.

3.4.4 MHT

MHT is typically a batch process, and individual vessels / autoclaves can be commissioned as part of a phased programme of investment, and once commissioned can be operated, or taken out of operation in response to fluctuations in demand. However, as with MBT, any increase in the overall operational capacity of the MHT, will have a requirement for additional preparation, sorting and separation capacity at the plant. The bulk of the increased cost of an expansion would lie in the expansion of the thermal treatment aspect and the need for additional land for maturation / storage of outputs. There is also a risk issue dependent on having sufficient capacity in markets or outlets for receipt of the additional outputs from the process.

3.4.5 ATT

Additional processing capacity can be added to an ATT facility, but this will be costly and achieved in a step-wise fashion, through the installation of additional reactors / vessels. In addition to this, there will probably be a requirement to uprate air pollution control capability of the plant, and increase the size of any gas storage facility / boiler and generation capacity. Any additional capacity of plant will also require additional disposal / recycling capacity for the extra ash or char generated by the ATT process. The significant costs involved in expansion of an ATT plant would need to be rigorously justified in the light of alternatives to tackle the extra waste (e.g. versus an expansion in recycling / composting activity / waste prevention measures). An additional line which was added but later rendered obsolete would be an economic disaster.

3.4.6 Mass Burn Incineration

A number of modern EfW plants are built with two or more processing lines (e.g. Marchwood, Isle of Man). This allows the plant to continue operating whilst one of the lines is out of operation for maintenance.

The common perception is that it is inherently difficult to add new lines to existing mass burn incineration facilities, not least for economic reasons and the challenges of gaining planning permission to extend a facility. This perception is borne out to a large degree by operational experience, and a number of EfW plants in the UK that have sought to do this have encountered significant problems (most notably

Nottingham[6]). The capital costs involved in developing a 'new line' for an EfW plant are significant as is the associated uprating of the APC treatment system and power generation infrastructure. Any additional capacity of plant will also require additional disposal / recycling capacity for the extra bottom ash generated by the EfW process. As is the case with ATT, the significant costs involved in expansion of an EfW plant would need to be rigorously justified in the light of alternatives to tackle the extra waste (e.g. versus an expansion in recycling / composting activity / waste prevention measures). An additional line which was added but later rendered obsolete would be an economic disaster.

3.5 Summary of Opportunities and Risks

Table 2 below provides a summary of the main opportunities and risks associated with the different generic waste technologies.

6 Jeff Lewis, Government Office East Midlands, pers.comm.

Table 2 Summary of the Opportunities and Risks Associated with the Generic Waste Treatment Technologies

Technology Type	Track Record and Reliability	Suitability to Guernsey's Waste	Capacity to Deal with Guernsey's Waste	Flexibility / Scalability
Preparation, Sorting and Separation	Established track record, wide range of providers	These technologies are capable of dealing with Guernsey's waste, but would have to be combined with other technologies to provide a waste management solution.	Technology has the capacity to deal with Guernsey's waste as part of an integrated waste management solution.	Changes in waste arisings and quantities can be accommodated through changes in shift patterns or relatively inexpensive modifications to sorting infrastructure.
MBT	Wide range of technology providers with varying track records, there have been difficulties matching the mechanical and biological technologies, and matching different configurations with different waste compositions.	Technology could be utilized, but dependent upon securing suitable outlets for the outputs of the process. Most reliable option would be the production of RDF.	Commercial plants have been built and are operating at a scale suitable to Guernsey's needs.	Additional processing capacity can be added to an MBT plant. The bulk of the increased cost of an expansion would lie in the increased biological treatment capacity and the need for additional land for maturation / storage of outputs.
MHT / Autoclaving	Very limited track record and has similar risks to MBT re aligning the process to generate outputs that meet the demands of the market / outlet.	Technology could be utilized, but similar concerns as MBT re outlets for outputs.	The evidence for the operation of MHT plants at a scale suitable for Guernsey is at best patchy.	Any increase in operational capacity will have a requirement for additional preparation, sorting and separation capacity at the plant. The increased cost would be

Technology Type	Track Record and Reliability	Suitability to Guernsey's Waste	Capacity to Deal with Guernsey's Waste	Flexibility / Scalability
				in increasing the thermal treatment aspect and the need for additional land for maturation / storage of outputs.
ATT	Track record is patchy, with examples in Europe and Japan. However, the variability of MSW is difficult for some less robust ATT Systems to cope with, pre-treatment of the waste is required to ensure homogeneity of the feedstock.	Technology could be utilised - the inclusion of ATT as part of a combined heat and power system would optimise energy recovery from the waste.	Although a typical ATT plant would be less than 100,000 tonnes per year, there is sufficient evidence to suggest that an ATT plant could deal with Guernsey's waste.	Additional processing capacity can be added, but this is likely to be costly and achieved in a step-wise fashion. The significant costs involved in expansion would need to be rigorously justified.
Mass Burn Incineration	The track record and reliability of most moving grate incineration systems is very well established. Fluidised bed and oscillating kiln designs have less of a track record.	Technology could be utilized - the inclusion of an incinerator as part of a combined heat and power system would optimise energy recovery from the waste.	A suitably sized mass burn incinerator could deal with Guernsey's waste.	The capital costs involved in adding a new operating line would be significant as would be the associated uprating of the flue gas treatment system and power generation infrastructure.

4. BENEFITS AND COSTS

4.1 Benefits and Costs

The benefits and costs associated with the selection and implementation of any waste management technology have to be assessed in the context of the policy drivers and public attitudes on the Island with respect to the adoption of a future waste management strategy. The most significant driver for the development of a future waste management strategy for Guernsey is the need to divert increasing amounts of waste away from landfill. It has been estimated that at current rates of disposal the existing landfill at Mont Cuet will be full by 2012[7]. Therefore, one of the key benefits sought from a new waste management technology, or combination of technologies, is the diversion of a significant proportion of the Island's waste stream away from landfill.

There are two broad technological approaches to diverting waste away from landfill:

(a) Through increasing recycling activity on the Island, coupled with the diversion of green waste so that materials are removed from the waste stream, either at the point at which they arise (through the source separation of recyclates and green waste), or at a central waste processing plant (e.g. an MBT or MHT facility) where the recyclates are removed from a mixed waste stream. In either case the green waste would require processing to produce either a soil conditioner or a fuel; or

(b) The thermal treatment of the Island's waste (by incineration or advanced thermal treatment), thereby reducing the quantity of solid waste that requires final disposal.

Both of the above approaches have their advantages and disadvantages. Increasing recycling rates means that waste is dealt with higher up the waste hierarchy and helps to ensure that there is a reduced loss of the materials themselves and the energy that was used in their extraction and manufacture. The downside is that there have to be markets or outlets for these materials (including the diverted green waste), otherwise these materials will re-enter the waste stream and require disposal via landfill.

The second approach, the thermal destruction of the waste, is a more certain method of removing materials from the waste stream and reducing the amount of waste that is sent to landfill. It also permits the recovery of energy from waste.

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7 Modelling of Selected Waste Treatment and Disposal Scenarios, Enviros Consulting Ltd 2006.

Despite the fact that the thermal treatment of waste is a more certain means of reducing the quantity of waste sent to landfill, the legacy of incinerators is such that they are perceived to be sources of a range of atmospheric pollutants. This concern has been addressed from a technical point of view by the development of sophisticated air pollution abatement equipment that is incorporated into modern incinerators. Indeed the Waste Incineration Directive requires all waste combustion plant in the European Union to fit appropriate air pollution abatement equipment. However, the general public in the UK still perceive waste incinerators to be an undesirable means of treating waste this is not the general perception in most countries in Europe nor in Japan. A second argument that is often presented against the thermal treatment of waste is that energy recovery from waste is lower down the waste hierarchy than recycling, and opponents of thermal treatment believe that incinerators and advanced thermal treatment plants actively work against recycling schemes. However, the evidence in Europe is that countries which have high incineration rates also have high recycling rates.

Another consideration that needs to be taken into account in the preparation of the Island’s future waste management strategy and the selection and implementation of waste treatment technologies is the potential for linking waste management with localised energy production. The convergence between waste management strategies and energy policies is becoming increasingly important, not least because of the continued rise in the price of fossil fuels (most notably oil and gas).

It is a fact that many wastes can be used as fuels, either through mass burn incineration or advanced thermal treatment. In addition, waste treatment technologies such as MBT and MHT can be used to prepare a refuse derived fuel (RDF). Guernsey currently imports eighty per cent of its electricity from Europe via a submarine cable. Despite this, Guernsey still maintains the capacity, through the diesel and gas turbines at its Vale Power station, to meet all the Island’s electricity needs if required. It is understood that the 11 MW gas turbine power plant was commissioned in May 2003. Notwithstanding this, it is also understood that Guernsey is investigating electricity production from renewable sources, including tidal power.

An energy from waste facility could be used to substitute some of the energy import or alternatively reduce the reliance on generating electricity from diesel. An analysis of the contribution that waste could make to the Island’s energy needs is outlined in Enviros, 2005, and the potential contribution provided by an EfW facility should not be underestimated when developing a waste strategy for the Island.

With respect to costs, unfortunately there is little publicly available data on the capital and operating costs of the technologies that are described above. There are a number of reasons for this: in the case of some of the technologies the processes are too novel, or have not been operated on a commercial basis to allow the production of meaningful cost data. It is also true that some of the technology providers are unwilling to release information on costs into the public domain, preferring to declare their costs in tender bids. An official source of cost data on new waste management technologies in the UK is the Defra / Environment Agency Waste Technologies Data Centre[8]. However, the information on the capital cost of the different technologies presented on the Environment Agency's website has been provided by the technology providers themselves, and should be considered as being an indicative, rather than a real cost.

Costs for waste management services are usually separated into those associated with capital expenditure (CAPEX), i.e. the cost of building the facility and its associated equipment; and operational expenditure (OPEX), the cost of running the facility, including energy input, man-power, consumables, etc. Further consideration of the benefits and costs associated with the different technology types is given below with reference to real world examples. The following sections present datasheets for proprietary processes for different waste treatment options. The processes that have been selected are meant to be indicative and have been selected on the basis of the availability of data (particularly information relating to outputs and costs). The presentation of any particular proprietary process is not meant to imply endorsement of any particular process or technology provider. Much of the data is available from the Environment Agency website[8].

8 Waste Technology Data Centre: http://www.environment-agency.gov.uk/wtd/

4.2 Reference Plants

4.2.1 MBT Bio-drying

Table 3 Ecodeco

Details	Description	
Process Name	Ecodeco	
Company Name	Sistema Ecodeco SpA	
Status	Proven technology. Technology is being promoted in the UK by Shanks Waste Services Ltd.	
Plant Scale	Modular 60,000 tpa units. Current range up to 120,000 tpa Planned range for UK: 180,000 to 600,000 tpa	
Waste Input Type	Residual mixed household waste/MSW	
Staff Employed	15 people for a 180,000 tpa plant	
Summary of Process	Ecodeco has developed an MBT process based on aerobic drying (the 'Biocubi' process) for treating MSW. The process drives off the moisture from the waste using the heat derived from the partial biological degradation of the organic fraction of the waste. The output is passed through a number of screening and sorting stages, for the removal of recyclates. The residual material is used to produce a pelletised RDF. In Italy the RDF is being used as a co-fuel in cement kilns and a fluidised bed boiler.	
Outputs (kg per tonne of input)	Ferrous metals	33
	Non-ferrous metals	4
	Plastics	50
	RDF	495
	Non-hazardous controlled waste to landfill	Between 170 kg and 665 kg per tonne dependent upon whether markets exist for the RDF
Emissions (kg per tonne of input)	Carbon dioxide	250
Landtake	Necessary: 15,000 m^2 for a 60,000 tpa plant; 35,000 m^2 for a 180,000 tpa plant.	

Public Perception	As it is new in the UK, issues likely to mirror those for composting plants and mixed waste MRFs i.e. odours/bio-aerosols and transport movements.
Capital Cost	£8,000,000 for a 60,000T.p.a plant. £25,000,000 for a 180,000 tpa plant.
Operating Costs	Total cost/t input: £50-55 (gate fee)
Revenues	
Reference Plants	In operation: ▪ Guissago (36,000 tpa, commenced operating 1996); ▪ Corteolona 120,000 tpa - 1996); ▪ Bergamo (60,000 tpa, - 1998); ▪ Montanasso (60,000 tpa - 2000); ▪ Biella (120,000 tpa, -2002); ▪ Lachiarella (60,000 tpa MSW/ 40,000 tpa compost).

4.2.2 MBT IVC

Table 4 Horstmann Tunnel

Details	Description
Process Name	Horstmann Tunnel
Company Name	Horstmann Recyclingtechnik GmbH
Status	Fully developed. Offered as a turnkey unit.
Plant Scale	20,000 to 500,000 tpa
Waste Input Type	Mixed household waste/MSW, catering waste, kitchen waste. Similar industrial and commercial waste and the organic residue from MBT plants.
Staff Employed	Not known
Summary of Process	The Horstmann MBT process is based upon a combination of mechanical pre-treatment and sorting with tunnel (IVC) composting as the core biological step. The processing technologies can be arranged in different configurations to optimise the process for different outputs. The process can be modified to produce either an RDF or a 'bio-stabilised' compost.

Details	Description	
Outputs (kg per tonne of input)	Ferrous and non-ferrous metals Plastics Soil conditioner Non-hazardous controlled waste to landfill	40 – 50 130 100 – 200 200 – 310
Emissions (kg per tonne of input)	No information is available on emissions from the operating plants. The process off-gasses from the plants in Spain are treated using a bio-filter before they are emitted to the atmosphere. In Germany, the MBT plants use thermal off-gas treatment in order for the emissions to meet the German regulations on total organic carbon (TOC). The process recycles all of the water generated in the composting process and no waste water is sent for treatment.	
Landtake (m^2)	20,000 (plant at 20,000 tpa) 100,000 (plant at 500,000 tpa)	
Public Perception	The Horstmann reference plants are configured in low profile structures. Public concerns about the process are likely to centre on the issues of odour and bio-aerosols.	
Capital Cost	Between £1,400,000 (for 20,000 tpa) and £14,000,000 (for 500,000 tpa)	
Operating Costs	£49 to £140 per tonne of input	
Revenues		
Reference Plants	▪ Madrid, Spain. 500,000 tpa ▪ Neath Port Talbot, Wales. 54,000 tpa (plant now closed) ▪ Enningerloh, Germany. 160,000 tpa ▪ Münster, Germany. 80,000 tpa ▪ MBA Pohlsche Heide, Minden; ▪ Lübeck. 80,000 tpa ▪ MBA Rosenow, OVVD.	

4.2.3 MBT AD

Table 5 ArrowBio

Details	Description	
Process Name	ArrowBio	
Company Name	ArrowBio an Israeli process which is promoted in the UK by Oaktech Ltd	
Status	Full scale unit built and tested	
Plant Scale	From 70,000 tpa, increasing in modules of 35,000t	
Waste Input Type	MSW or any source separated biodegradable fraction	
Staff Employed	7	
Summary of Process	The ArrowBio process uses a combination of wet pre-processing and mechanical separation to process mixed MSW to produce a suspension of biodegradable materials. The suspension is treated via a two-stage anaerobic digestion process producing a biogas that may be used in a gas engine, and a digestate, which is currently being used as a soil-conditioner / fertilizer in Israel.	
Outputs (kg per tonne of input)	Ferrous metals	39.3
	Non-ferrous metals	6.1
	Plastics	57
	Mineral fraction (glass & aggregate)	86.4
	Carbon removed	119.7
	Soil conditioner	210
	Energy (kWhe as electricity)	232
	Non-hazardous controlled waste to landfill	245
Emissions (kg per tonne of input)	Carbon dioxide	299
	Water	100
Landtake (m^2)	8,000 – 10,000 for a standard 70,000 tpa module.	

Public Perception	Anaerobic digestion is generally more popular with the public than other waste treatment technologies. The visual impact of the process is similar to that of a sewage treatment works or oil storage depot.
Capital Cost	£12,000,000 for a 75,000 tonnes per annum plant
Operating Costs	c.£32.49 per tonne of input
Revenues	c.£20 per tonne of input
Reference Plants	Hiriya and Hedera, both in Israel. ArrowBio has secured contracts to build facilities in Australia and Mexico.

4.2.4 MHT (Autoclaving)

Table 6 Sterecycle

Details	Description	
Process Name	Sterecycle	
Company Name	Sterecycle Ltd	
Status	2 plants in USA First plant in UK under construction, 80,000 tpa	
Plant Scale	50,000 tonnes pa and upwards, modular and scaleable	
Waste Input Type	Unsorted MSW - Household waste, suitable commercial wastes and sewage sludge	
Staff Employed	16 for a 100,000 tpa plant	
Summary of Process	The Sterecycle process is a two stage mechanical heat treatment process. The first stage involves the steam autoclaving of the waste followed by mechanical separation and sorting of the waste. The outputs of the process include recyclates (metals, glass, plastics and textiles) and a high-biomass fibre. The fibre may be composted, anaerobically digested, or used to produce an RDF for firing in a conventional boiler or gasified in an ATT plant.	
Outputs (kg per tonne of input)	Ferrous metals	60
	Non-ferrous metals	20
	Plastics	110
	Paper and card	320 (in fibre)
	Mineral fraction (glass and aggregate)	160
	Bio-fertilizer	530 (where fibre processed further)
	Soil conditioner	530 (where fibre processed further)
	RDF	530 (where fibre used for energy recovery)
		120 – 650 (dependent upon markets for recyclates, fibre and RDF)

Details	Description
Emissions (kg per tonne of input)	Not known
Landtake	3,000 for 100,000 tpa plus support roads, offices etc.
Public Perception	Too new to assess
Capital Cost	c. £10,000,000 for a 100,000 tpa plant
Operating Costs	Not known
Revenues	Not known
Reference Plants	Minnesota – 70,000 tpa plant from July 2005; Nevada – demonstration plant – 3 tonne vessels for demonstration and R&D

4.2.5 ATT Pyrolysis

Table 7 Techtrade

Details	Description
Process Name	Techtrade
Company Name	WasteGen (UK) Ltd
Status	Commercially proven. Trials commenced 1983 through to take-over by client in 1987.
Plant Scale	35,000 tpa
Waste Input Type	MSW, industrial/commercial waste, buky CA site waste (mattresses and carpets, for example) and sewage sludge.
Staff Employed	Not known
Summary of Process	The Techtrade process is based upon twin rotary pyrolysis kilns. Prior to the pyrolysis stage, the waste is mixed with sewage sludge and shredded. The shredded waste is heated to 550^{0}C in the pyrolysis kilns producing pyrolysis gas and char. The pyrolysis gas is burnt in a combustion unit and used to produce steam to drive a turbine-generator for electricity production. At the Burgau plant waste heat is also used to heat greenhouses.

Details	Description	
Outputs (kg per tonne of input)	Ferrous metals	50
	Non-ferrous metals	0
	Plastics	0
	Mineral fraction (glass & aggregate)	300
	Carbon removed	350
	Energy (kWhe as electricity)	300
	Non-hazardous controlled waste to landfill	300
	Hazardous waste to landfill	10 (air pollution control residues)
Emissions (kg per tonne of input)	Not known	
Landtake	28,000 - 32,000 for 35,000 tpa plant	
Public Perception	Not known	
Capital Cost	£17,000,000 for a 35,000 tpa plant	
Operating Costs	For a 4 kiln plant sized for the UK, WasteGen indicated a total operating cost figure of £18.40/t, increasing to ~£30/t for a smaller (2 kiln) plant	
Revenues	Electricity c £8 per tonne	
Reference Plants	High-CV commercial/municipal/industrial wastes: Hamm, 100 ktpa (the first Techtrade pyrolysis plant which is close-coupled with mainstream (RWE) power industry); Household waste/MSW: Burgau, Bavaria: Günzeburg Council, 36,000 t/pa MSW, commissioned 1984	

4.2.6 ATT Gasification

Table 8 Energos

Details	Description
Process Name	Energos
Company Name	Energos (Part of the ENER G group)
Status	Six Plants running in Europe, processing 400,000 tpa of waste. Two at Engineering stage.
Plant Scale	35000– 85000 tpa
Waste Input Type	• Municipal solid waste • Commercial waste • Industrial waste • Process capable of using a broad range of feeds.
Staff Employed	Not known
Summary of Process	The Energos thermal combustion process consists of two linked stages. The waste is first shredded and metals are removed. The shredded waste is then fed into the primary chamber where it is heated to produce a syngas. The syngas is then fed into the secondary combustion chamber where high temperature oxidation of the gas takes place. Heat is recovered from the hot gases via a steam generator.
Outputs (kg per tonne of input)	No information on outputs available.
Emissions (kg per tonne of input)	No information on emissions available.
Landtake	5,000 (40,000 tpa plant); 8,500 (80,000 tpa plant)
Public Perception	Not known
Capital Cost	£11,500,000 for a 40,000 tpa plant £19,000,000 for a 80,000 tpa plant
Operating Costs	Not known
Revenues	Not known
Reference	Norway, Ranheim, commissioned 1997

Details	Description
Plants	Norway, Averøy, commissioned 2000 Norway, Hurum, commissioned 2001 Germany, Minden, commissioned 2002 Norway, Forus, commissioned 2002 Norway, Sarpsborg, commissioned 2002 Sweden, Timsfors, commissioned 2004 Germany, Oberhavel, commissioned 2005

4.2.7 Mass Burn Incineration

Table 9 Lentjes UK

Details	Description	
Process Name	Lentjes UK	
Company Name	Lentjes UK (formerly Lurgi UK Ltd)	
Status	Lentjes are established suppliers of incineration plants.	
Plant Scale	136,000 tpa	
Waste Input Type	MSW	
Staff Employed	29	
Summary of Process	The SITA Kirklees incinerator uses the Lurgi moving grate technology. Waste is mixed using an overhead grab crane and transferred to a feed hopper. The plant operates a single feed stream and is designed for a nominal throughput of 17 tonnes per hour. The surface of the grate slopes downwards from the feeder end towards the residue discharge end via a series of alternate steps of fixed and moving grate bars which ensures continual rotation of the burning waste layer to a uniform depth. The bottom ash and oversize materials from the grate are segregated and the bottom ash then passes under a magnet to remove ferrous metals. The heat produced is used to generate electricity for export to the grid.	
Outputs (kg per tonne of input)	Ferrous metals	17.8
	Mineral fraction (glass and aggregates)	239
	Energy (as electricity kWh)	548

Details	Description	
	Non-hazardous controlled waste to landfill	125
	Hazardous waste to landfill	44
Emissions (kg per tonne of input)	Carbon dioxide	955
Landtake (m^2)	9,000 m^2 (plant area), 20,000 m^2 (site area)	
Public Perception	Generally incinerators have a negative public perception	
Capital Cost	£35,000,000 for a 136,000 tpa plant	
Operating Costs	£53 - £58 per tonne	
Revenues	Not known	
Reference Plants	• Edmonton • Kirklees • Cleveland • Isle of Man • C. 40 EfW plants in France	

4.3 Comparison of the Benefits of Different Technology Options

This section compares the benefits of the different technology types described in tables 3 to 9 above. The principal focus of the discussions is the ability of the technologies to divert waste away from landfill; the extent to which the technology is publicly acceptable; and whether the technology is able to make a net contribution to energy supply on the Island. The processes that have been selected are meant to be indicative and have been selected on the basis of the availability of data (particularly information relating to outputs and costs). The presentation of any particular proprietary process is not meant to imply endorsement of any particular process or technology provider

4.3.1 MBT Bio-drying

The Ecodeco MBT process has been developed largely as a means of producing a refuse derived fuel from mixed waste sources, but the process can be modified to produce a soil conditioner from the organic fraction of the waste, if this is desired. Although the process is aimed at the production of a fuel, the technology does not include the means for its combustion. Thus, the cost of building and operating a combustion or thermal treatment plant (ATT facility) would have to be added to the cost of the MBT facility.

Provided there was an outlet for the RDF and the recyclate, an MBT bio-drying process could reduce the amount of waste requiring disposal to landfill by approximately seventy per cent (for each tonne of waste treated 170 kg would be residue that would go directly to landfill plus approximately twenty per cent of 665 kg of the RDF produced would be residue from the incineration or thermal treatment process).

In terms of public acceptability, MBT is one of the less contentious technologies. Concerns about MBT typically centre on issues related to the control of odour and bio-aerosols. However, the addition of a thermal treatment plant (incinerator or ATT plant) might be viewed negatively by the general public.

With production of an RDF, an MBT process coupled to a heat and power plant could make a positive contribution to the Island’s energy supply.

4.3.2 MBT IVC

The Horstmann Tunnel Compost MBT is an established MBT technology that was originally designed to produce a soil conditioner from mixed waste (largely for land reclamation and landfill cover purposes). The use of the process to treat mixed waste will not produce a high quality compost. Alternatively, the process can be modified to produce an RDF.

Provided there was an outlet for either the soil conditioner or the RDF, and recyclates, an MBT IVC facility could divert up to eighty per cent of the mixed waste stream away from landfill. On the other hand, if outlets for the outputs from the process do not exist, the diversion of waste from landfill could fall to less than forty per cent. Moreover, if the facility produced an RDF, this could contribute to local energy needs, but as with an MBT bio-drying plant, this would require additional investment in some form of combustion or thermal treatment plant.

The issues relating to public acceptability of an MBT IVC process on the Island are likely to centre on odours and bio-aerosols.

4.3.3 MBT AD

The ArrowBio anaerobic digestion MBT design is technically more complex than the MBT bio-drying or MBT IVC processes. One of the important features of this type of MBT process is the significant reduction in carbon that can be achieved. This is largely a consequence of the AD process that converts some of the carbon in the waste into the biogas produced by the process. In other MBT processes this carbon either remains bound in the solid phase or is discharged directly to the environment as biogenic carbon dioxide. Of course, the combustion of the biogas will release the carbon to the atmosphere as carbon dioxide, but at least a significant proportion of the energy associated with the biogas carbon will be captured.

If outlets exist for the recyclates and soil conditioner produced by the process, up to seventy-five per cent of the incoming waste can be diverted from landfill. If outlets are not available for the soil conditioner and recyclates, the diversion rate can fall to around fifty per cent. An alternative outlet for the soil conditioner would be its use as an RDF, and as with the other two MBT processes described above, this fuel could be used in an appropriate heat and power plant, but this would entail additional capital expenditure.

The inclusion of the anaerobic digestion process is believed to influence the issue of public acceptability in a positive way. The anaerobic digestion of waste is generally perceived to be more desirable than energy production via mass burn incineration or advanced thermal treatment. Other environmental issues may centre on odour and bio-aerosols.

4.3.4 MHT (Autoclaving)

The autoclaving of mixed wastes has less of a pedigree of treating MSW or other mixed waste streams than the other technologies discussed in this report. MHT is seen by many experts as a pre-processing stage for the further treatment of the waste by another process rather than as a treatment process in its own right. In terms of diverting waste away from landfill, the Sterecycle process is a fairly typical MHT process, with approximately fifty per cent of the incoming waste remaining in the organic floc. Outlets for the floc are currently under developed, with the production of an RDF being the most realistic option. The absence of outlets for outputs from the MHT process would mean that the process offers little in terms of diverting waste away from landfill.

If the floc was used to produce an RDF then an MHT facility could be coupled with a thermal treatment facility (incineration or ATT) to further process the waste and capture its energy content. This would however require additional investment in a thermal treatment plant.

There is uncertainty with respect to the public acceptability of waste management facilities based upon MHT. Its strongest point is that the process sanitizes the waste, and therefore there is limited risk of the spread of pathogens from outputs from the process. Other than these observations there is too little experience to permit an objective assessment of the public's opinion on the process.

4.3.5 ATT Pyrolysis

Pyrolysis is an effective means of diverting waste away from landfill. The thermal degradation of the waste ensures a significant reduction in the mass and volume of the waste. The information presented for the Techtrade process in table 8 suggests that the process can divert approximately seventy per cent of the incoming waste from landfill. The majority of the residue from the process can be disposed of in a non-hazardous landfill, though there is the potential for further processing of the waste in a gasification plant. This additional plant would provide a further reduction in wastes to landfill, of particular importance for Guernsey in maintaining a "strategic reserve" (but see 4.3.6 below). The amount of hazardous waste produced by the pyrolysis process is approximately one quarter of that produced by a mass burn incinerator, with most of this arising from the air pollution control residues produced in the gas clean up stage (representing approximately one per cent of the in-going waste).

There is a net energy recovery from the process, which can be used to produce electricity as well as the potential of providing heat to neighbouring industries.

The public's perception of the pyrolysis of waste is currently unknown. Some environmental pressures groups argue that the pyrolysis of waste is similar to mass burn incineration, and certainly the economics of the process tend to work against the recycling of paper, card and plastics from a mixed waste stream because of the calorific value of these wastes.

4.3.6 ATT Gasification

The availability of data on gasification processes from public sources is extremely limited, particularly with respect to outputs and emissions from the process, and the information presented in table 8 is typical of that available for other proprietary gasification processes. The absence of any publicly available data makes it difficult to comment upon the quantities of residues from the process. However, it is reasonable to conclude that the volume and mass reduction of the in-going waste is likely to be similar (if not better) than that which occurs with pyrolysis, so a landfill diversion rate of about seventy per cent is likely to be achieved. Nevertheless, given the increased volumes of air used in the process (compared to a pyrolysis plant) it is likely that the quantity of hazardous air pollution control residues from a gasifier will be greater than the amounts produced by pyrolysis, but less than that produced by mass burn incineration.

As with pyrolysis, the gasification of waste produces energy that can be used to produce electricity, either through a gas engine or a boiler turbine set. The waste heat from the process can also be used for industrial or district heating purposes.

Public concern about the gasification of waste is as yet unknown, but the issues are likely to be similar to pyrolysis or mass burn incineration.

4.3.7 Mass Burn Incineration

The mass burn incineration of waste is an effective means of diverting waste away from landfill. The data in table 9 for the Lentjes (Lurgi) process show that residues sent to landfill can be less than twenty per cent of the waste entering the plant (approximately 12.5 per cent to non-hazardous landfill and 4.4 per cent to hazardous landfill). These figures are plant-specific and assume that outlets exist for the glass and aggregates that are produced from the bottom ash. More typical data refer to 20-25% bottom ash for non-hazardous landfill and 3-5% APC residues to hazardous landfill.

Mass burn incineration is a well established method for the recovery of energy from waste materials, allowing the production of energy via a boiler turbine set, with waste heat being available for district or industrial heating where appropriate.

In terms of public acceptance, the incineration of waste is an emotive issue and energy from waste schemes can provoke a hostile reaction from local residents and others, such as holidaymakers or visitors to the Island.

4.3.8 Summary of the Benefits of the Different Technology Options

Table 10 below presents an overview of the benefits associated with the four generic technology types (for the purposes of this discussion the preparation, sorting and separation technologies are considered to form part of the technology types).

Table 10 Comparison of the benefits brought by different generic technologies

Technology	Percentage of waste remaining after treatment	Public Perception	Energy Recovery from the waste
MBT	15 – 65 % (dependent on markets for recyclates)	Generally good	Only with the addition of AD, and / or RDF production followed by a thermal treatment plant
MHT	10 – 90 % (dependent on markets for recyclates)	Unknown	Only with the addition of AD and / or RDF production followed by a thermal treatment plant.
ATT	20 – 30 %	Unknown	Yes
Mass burn incineration	20 – 30 %	Generally negative	Yes

It can be seen from table 10 that all four technology types can potentially divert large proportions of waste away from landfill. However, the high levels of diversion associated with MBT and MHT are closely linked to the availability of markets or outlets for outputs.

4.4 Comparison of the Costs of Different Technology Options

Table 11 below presents capital costs (CAPEX) and operational costs (OPEX) for the technologies presented in tables 3 to 9 above. This information has been taken from the Environment Agency's Waste Technology Data Centre[9]. However, it is strongly recommended that the figures presented in table 11, as well as those available through the Environment Agency's website, or any other public source, be treated with a great deal of caution. The capital and operational costs for different generic processes are likely to vary for a number of reasons, not least being the degree to which the technology processes the waste and the nature of the outputs produced. Furthermore, the costs cited by different technology providers for similar technology types may also differ for a number of reasons including locational factors, energy and employment costs, construction costs, and the degree to which a contractor will price in the risks associated with the design, commissioning and operation of the plant.

The information on capital costs provided on the Data Centre and in table 11 is generally presented for plants of differing operational capacity. In an attempt to normalise the data for the purposes of comparison, a value of capital expenditure per tonne of waste treated over the lifetime of the plant has been calculated here, based on an operational period of 25 years (i.e. CAPEX £ per tonne, over 25 years). The calculation is based upon the following equation:

$$\text{CAPEX} / (\text{Capacity} \times 25)$$

The calculated figures do not take into account any financing costs that may be payable on loans secured to cover the cost of building the plant(s) or the depreciation of facility over the lifetime of the plant.

From this "normalised" figure for CAPEX per tonne (over 25 years) it can be seen that the relative capital cost of the selected technologies ranges from £2.80 per tonne for a 20,000 tonne per year Horstmann MBT plant to £19.43 per tonne for a 60,000 tonne per year Techtrade pyrolysis plant. In comparing the relative capital costs of the different technologies, it should be borne in mind that the "cheaper" technologies such as MBT and MHT produce significant quantities of outputs (particularly as soil conditioner, organic floc or RDF) which may incur a gate fee for disposal or further treatment. However, an alternative approach would be to combine a pre-processing technology such as MBT

9 Waste Technology Data Centre: http://www.environment-agency.gov.uk/wtd/

or MHT with a thermal treatment technology. Such a combination would provide the means of managing the Island's waste stream whilst minimising the amount of waste that requires final disposal via landfill. It also provides the opportunity of extracting those recyclates from the mixed waste for which there are viable outlets. Having said this, such a scenario would necessitate additional investment in the thermal treatment plant (either ATT or mass burn incineration), but such a plant would be sized to treat only the residue from the MBT or MHT process rather than the total amount of waste arising on the Island.

The capital cost of the thermal treatment options is significantly higher than those associated with the pre-processing (or partial processing technologies) such as MBT or MHT. The main reason for this difference is that the thermal treatment options require a heavier investment in process equipment (reactor vessels, furnaces, boilers, turbines, electrical switch-gear, etc) as well as air pollution control equipment. Such equipment has to be manufactured and installed to high specifications, and operated in the accordance with appropriate permits.

Table 11 Cost Estimates for New Waste Technologies

Provider	Capacity (tonnes per year)	CAPEX £	CAPEX £ per tonne (over 25 years)	OPEX £ per tonne
Aerobic MBT				
Ecodeco (bio-drying and RDF production)	60,000	£8 million	5.33	50 – 55
Horstmann (tunnel composting with RDF production)	20,000	£1.4 million	2.80	49 - 140
Anaerobic MBT				
ArrowBio (wet MRF + AD)	75,000	£12 million	6.40	32.49
MHT (autoclave)				
Sterecycle (autoclave)	100,000	£10 million	4.00	No information available
ATT				
Techtrade (pyrolysis)	35,000	£17 million	19.43	37
Energos (gasification)	40,000	£11.5 million	11.50	No information available
Mass Burn Incineration				
Lentjes (SITA (Kirklees)	136,000	£35 million	10.29	53 - 58

Data collated from Waste Technology Data Centre

The cited operating costs for the different technologies range from £32.49 per tonne for the ArrowBio MBT with AD plant to the £53 – 58 per tonne for the Lentjes incinerator (ignoring the £49 - £140 per tonne OPEX range for the Horstmann MBT, which Horstmann say is due to site location and arrangement of the plant, specification and quality of equipment, labour costs, general taxes, landfill tax, water costs, fuel, electric power, and maintenance).

As discussed above the MBT and MHT technologies will produce significant quantities of outputs that may incur a gate fee (i.e. an additional disposal cost), which may further increase the operational costs of these pre-processing technologies. The cost information associated with these technologies should not be considered as comparable total costs.

The operational costs for the different technologies may be subsidised by revenues generated from the sale of recyclates and other outputs. In particular, the revenues from the export of electricity and heat from the MBT AD, and thermal treatment technologies (ATT and mass burn incineration) may be significant.

It is not possible at this stage to be more specific about costs and revenues associated with the different technologies. However, it is recommended that these aspects be explored more fully during the preparation of an outline business case and a “soft market testing” phase prior to the preparation of a tender for future waste management services.

5. PROGRAMME IMPLICATIONS

The successful delivery of a waste management strategy for Guernsey will be influenced by a combination of on-Island (i.e. Guernsey specific) factors, off-Island factors, and other factors that are intrinsic to the different technologies themselves. These factors are discussed in the following sections.

5.1 On-Island Factors

The on-Island factors include the following:

- Political will
- Social acceptability and public support
- Finance and funding
- Interface with the existing waste management infrastructure
- Outlets for outputs
- Availability of sites for new facilities.

The development, adoption and implementation of a waste management strategy for the Island will require agreement and shared commitment amongst the political decision makers on the Island. Without such agreement and commitment, any strategy for the management of the Island’s waste may be subject to delays, reversals, and confusion. Following on from this, any new waste management facility is likely to be a subject of concern amongst the public, even those who may be visitors to the Island. Public angst with respect to proposed waste management facilities may engender a spectrum of protest from letters to local politicians, to well organised public opposition campaigns. Given Guernsey’s status as a favoured holiday resort within Western Europe, public opposition to certain types of waste management facility might stem from overseas, and adversely impact upon the Island’s tourist industry. Furthermore, it is understood that any new waste management facilities on the Island will be financed from the public purse (i.e. paid for by the States of Guernsey), and as the cost of delivering the waste management strategy is likely to be significant, the levels of investment required to deliver the waste management strategy will require a strong political will, combined with public support for the strategy.

The adopted waste management strategy will also need to consider the interface between the new waste management facilities on the Island and

Guernsey's existing waste management infrastructure. For example, if a strategy involving high levels of recycling and diversion of green waste were to be adopted, this may also require additional investment in the waste collection infrastructure (i.e. a source separated collection system) or the adoption of a complex materials separation system at the treatment facility (thus allowing the continuance of existing collection practices). On the other hand, the adoption of a strategy that does not require high levels of recycling or green waste diversion, will probably have only a minimal impact upon existing collection practices.

In considering its future waste management strategy and the selection of technology options, the States of Guernsey needs to understand that a number of the new and emerging technologies are more akin to industrial processes than traditional waste management facilities. There are two consequences of this fact, firstly there are likely to be significant levels of outputs from any new waste management facility on the Island, some of which (for example power and heat) should readily find a market on the Island, but others (including soil conditioner, or hazardous waste – including air pollution control residues) will have a negative market value, particularly if there is no means of managing or disposing of these outputs on the Island. Secondly, some of the generic treatment types described above are suited to co-location on existing, or new, industrial parks. For example, MBT, MHT and ATT plants are effectively waste processing plants, and the only principal difference between such facilities and other industrial processes is that these facilities process waste rather than other raw materials. Notwithstanding this, the availability of appropriate sites for the location of new waste management facilities is going to be one of the key considerations when drawing up the future waste management strategy for the Island.

5.2 Off-Island Factors

The States of Guernsey is considered unlikely to be able to draw upon sufficient depth and level of integrated waste facility expertise which will be available from European providers of technology or waste management solutions. It is recognised that local service providers should be given every opportunity to contribute. This effectively means that the States of Guernsey will have to compete within the international market to attract waste management technology and service providers to the Island. This suggests that there are two inter-related off-Island factors that may have implications for Guernsey's waste management strategy programme, these are:

- The limited number of technology / service providers; and

- Competition from other waste management procurement projects.

In May 2006 the UK's Office of Government Commerce (OGC) published the findings of the Second Kelly Market (SKM) (Municipal Waste) Study[10]. During the course of the SKM analysis, OGC collected information from a wide variety of sources, including a comprehensive survey of UK local authorities and their waste management plans. The following findings (paraphrased from the SKM Study) have relevance to the situation in Guernsey:

- There are few suppliers of integrated waste treatment and disposal services (8-9 suppliers manage at least 78% of municipal waste in the UK by weight), and most suppliers have a regional or local presence, not a national one.

- There is evidence that, particularly for waste disposal, a supplier's ability to bid effectively is dependent on an existing regional presence (i.e. the ability to utilise or expand existing infrastructure to bid for new contracts as they emerge).

- Suppliers in the waste management market have been consolidating in recent years, a trend that looks set to continue – which is likely to further reduce the number of suppliers competing for major contracts. A key factor encouraging consolidation is that regulatory changes are driving the need to develop new facilities, and larger companies are better placed to be able to secure the investment to fund such development.

- Whilst individual authorities are communicating their needs to the market, there is a lack of market intelligence available to suppliers on the public sector's procurement plans as a whole. Furthermore, market intelligence that is available is sometimes inconsistent and there is no coordinated source of reliable data. This complicates suppliers' forward planning, and makes it more difficult to attract new entrants into this market.

- Bid costs for all parties for waste management contracts are significant. Supply-side bid costs appear to be similar whether the project is small or large in scale.

- Potential new entrants perceive the waste management market as too risky. The construction sector is one source of possible new entrants into this market. Construction companies keen to enter this market

10 OGC Kelly Report to the Financial Secretary to the Treasury "Improving Competition and Capacity Planning in the Municipal Waste Market", May 2006.

identified a number of issues which they saw as constraints, including:

- High bid costs;
- Scarcity of local authority procurement skills to deliver complex waste procurements;
- Few opportunities to form consortia – to gain an understanding of the market and build capabilities;
- The limited range of funding / financing options available to local authorities for selection; and
- Few opportunities for early supplier involvement – currently infrequent but would ease the bid process.

With respect to the risks associated with "competition" from other waste management procurement projects, the OGC report makes the following comments:

- The current contract "pipeline" indicates that [in the UK] over 50 waste management contracts need to be awarded each year, for the next four years. These figures are based on the 71% response rate to the SKM survey; and so actual demand will be greater. Local government's overall approach to the market is uncoordinated, and it is highly probably that the market lacks sufficient capacity to react competitively to this deal flow.

- Given the relatively small number of suppliers, the small size of suppliers' bid teams, and the large number of contracts coming to market, there is the real prospect that public sector contracts will be competing against one another to attract the attentions of suppliers.

- There is a strong perception from industry that waste procurements are taking too long to complete and in some cases fail before financial close. In order to attract new entrants into this market, projects must be closed and facilities built at a much quicker pace.

In its recent "Global Search" for a waste management solution for the Island, the States of Guernsey received 32 expressions of interest. In analysing summaries of these expressions of interest with respect to the provider's track record, the suitability of the technology or solution to Guernsey's waste, and the adequacy of the data provided, Enviros concluded that the five EfW proposals and two ATT proposals would be appropriate for Guernsey's waste management needs. In addition seven mixed waste processing technologies (MBT, MHT or RDF production), two in-vessel composting proposals, and five other less easily classified proposals could contribute to managing Guernsey's waste in some way, but represent at best only partial solutions to the Island's waste management needs. Thus, only about one fifth of the expressions of interest received were deemed to be suitable for Guernsey's waste management needs, and it would be reasonable to conclude that this number would reduce further during the invitation to tender and due diligence phases of the procurement process.

5.3 Technology-related Factors

The delivery time for any facility is made up of a combination of a number of processes or phases, some of which have to happen sequentially. The letting of a major waste management procurement contract is likely to take at least twelve months, and perhaps as long as two years to complete. The time taken for the commercial investment decision phase can vary, but for the more complex technologies (or large facilities) this may take as long as twelve months. Completing the design of the facility and gaining planning permission for a major facility can be as long as three years in the UK (sometimes considerably longer than this – e.g. the eighteen years taken to obtain planning permission for the Belvedere EfW plant). It is possible that the time required on Guernsey to obtain planning permission may be shorter than the general experience in the UK, particularly given the preparatory work already carried out for the Longue Houge site. In the UK all new facilities that treat or dispose of waste require a PPC (Pollution Prevention and Control) Permit, and for a complex process, or one involving the thermal treatment of waste, this may take up to a year and a half to complete. The remaining phases of constructing and commissioning the new facility are likely to take in the region of eighteen months, irrespective of where the plant is being built. Further details of procurement, planning, construction and implementation periods for selected generic technologies are included in Enviros 2006, where a start year of 2012 has been used for modelling purposes.

6. CONCLUSIONS

This report has identified that there is a range of technologies that could be used to treat waste that arises on the Island of Guernsey, including parish (household or municipal solid waste), commercial, industrial, as well as agricultural and horticultural waste. The different technologies that are available can be broadly classified into four generic types:

- Mechanical biological treatment (MBT), including
  - In-Vessel Composting and
  - Anaerobic Digestion
- Mechanical heat treatment (MHT)
- Advanced thermal treatment (ATT), including:
  - Gasification, and
  - Pyrolysis
- Mass burn incineration.

The first two of these treatment types (MBT and MHT) can be considered to be pre-processing or partial treatment options as they produce significant quantities of outputs (sometimes in excess of fifty per cent of the in-going waste), which will require further treatment and / or disposal. The management of these outputs will be an important consideration in the selection and operation of facilities based upon these technologies. This is of particular importance in an Island situation where opportunities to process or utilize outputs (that may include recycled metals, plastics, paper, card, and soil conditioner or compost) may be limited or non-existent. A failure to find outlets for such outputs will mean that the outputs will re-enter the waste stream and may ultimately require disposal via landfill.

The two remaining generic technology types (ATT and mass burn incineration) represent less of a challenge with respect to the management of outputs. The solid residues from an ATT plant or an incinerator are likely to represent between twenty and thirty per cent of the mass of the in-going waste to the facility. This percentage may be further reduced if the ash residue can be recycled on the Island either as construction fill material or as the basis of building materials. Notwithstanding the possibility of recycling the bottom ash from these processes, it has to be acknowledged that both types of thermal treatment process will generate some hazardous waste as a result of the abatement of air pollution caused by the operation of the plant. The quantities of hazardous waste that are likely to be produced will be in the region of one to five per cent of the mass of the in-going waste. It is probable that the hazardous air pollution control residues will need to be exported from the Island for disposal (or long-term storage) in the UK.

One of the advantages of adopting a solution based upon the thermal treatment of waste is the prospect of capturing the energy content of the waste. Both types of advanced thermal treatment technologies (pyrolysis and gasification) and mass burn incineration can be used to produce heat and power from waste materials. Efficiencies of electricity production from waste materials can be as high as 30 per cent, but with the addition of district heating schemes through a combined heat and power system, the overall process efficiencies can be higher than fifty per cent. Therefore, a thermal treatment solution to Guernsey's waste management needs could make a significant contribution to the Island's energy supply, as outlined in Enviros 2005.

In terms of the risks associated with particular technology options, MBT, and mass burn incineration have the strongest track records with respect to the management of mixed waste streams (including MSW). Of the two remaining generic technology types, ATT represents a more robust solution than MHT, given the experience that has been acquired in Europe and Japan with respect to the pyrolysis and gasification of mixed waste streams during the last two decades. Mechanical heat treatment is a less certain technology in terms of the treatment of mixed wastes. Although MHT can sanitize mixed wastes, and allow the sorting and separation of recyclates, there are reservations over the availability of markets for the organic floc that remains after the retrieval of the recycled fractions.

The costs associated with the construction and operation of new waste treatment facilities is are difficult to estimate with any confidence at this time. Unfortunately there are no truly reliable public sources of information with respect to the costs of the different technology types. Indicative costs have been presented in this report, but these must be used with great caution given that many technology providers are either not prepared to publish costs, or when they do so, include significant caveats.

Other important issues that relate to the selection, implementation and operation of new waste treatment facilities for Guernsey include public acceptability, timescales, and external factors that may influence the decision making process.

Although any type of waste facility (whether it is a reception facility, treatment facility or disposal facility) is likely to engender some form of adverse public reaction, experience suggests that the MBT processes are generally more benign in terms of public acceptability. On the other hand, thermal treatment technologies (particularly mass burn incineration) are frequently the source of public protest in the UK. Public or political concern over a particular type of waste treatment facility is likely to lead to delays in the selection, planning and procurement phases of the project.

Other factors may also influence the timescales associated with the delivery of a fully working waste treatment facility. Not least of these is the likely rush to the market of some 200 waste disposal authorities in the UK which will require new waste treatment facilities in order to meet their legal requirements under the Landfill Directive. This rush to the market in the UK may have two important implications for Guernsey: there may be little interest from technology providers to bid for work on the Island; and secondly those companies that do bid may seek to raise the price of their bid on the basis that a “sellers’” market for technologies may come into being.

7. RECOMMENDATIONS

The success of any future waste management strategy for Guernsey has to be based upon informed decision-making. Whilst the new and emerging waste management technologies do offer the potential for a long term sustainable solution for the Island, the choice of a particular technology or combination of technologies is not an easy one.

Apart from the cost of constructing and operating a new waste management facility on the Island, the most important decision has to relate to the effectiveness of the chosen solution to divert a significant quantity of Guernsey’s waste away from landfill. Two of the technology options (MBT and MHT) may not achieve this to an acceptable degree if there are no outlets for the outputs from the processes. Therefore it is recommended that these technology types are only considered if appropriate outlets exist for the recyclates and the processed organic material produced by these technologies. One solution to this problem could be the coupling of the pre-processing technologies (MBT or MHT) with a thermal treatment solution (mass burn incineration or gasification).

On the other hand, the adoption of a solution based upon thermal treatment may provoke a public anxiety. This is a socio-political issue which has to be addressed by the authorities in the local context.

The confirmation of costs associated with new waste treatment technologies can only be taken further forward by some form of formal or informal approach to technology providers. Building upon the work of the global search, it is recommended that the States of Guernsey considers undertaking the preparation of an outline business case and a “soft market testing” exercise. Such an exercise would allow the authority to capture more reliable information on costs from potential technology providers, as well as perhaps stimulating interest within the market.