STATES OF JERSEY

SOLID WASTE STRATEGY

TECHNOLOGY REVIEW

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MANAGEMENT SUMMARY

Over 60 suppliers of various technologies for the treatment and disposal of residual solid waste have been considered. A description of the different types of technologies and comments on individual suppliers make up the main body of this report.

These technologies and suppliers have all been reviewed, in the context of whether they would be an appropriate solution for dealing with Jersey's solid waste. The prime consideration that has been agreed is that the technology chosen for Jersey must be tested and proven, to give a low risk solution, which will provide a long-term secure route for disposal of the solid waste. In addition, it is essential that the selected technology is capable, and demonstrated to be so, to dispose of all of Jersey's solid waste in an environmentally safe and cost effective manner.

The following types of technology have been considered, and a generic explanation of each process is provided in Section3:

- Energy from Waste (EfW) - Conventional Incineration
- EfW - Fluidised Bed Combustors
- EfW - Gasification and Pyrolysis
- Steam Autoclaves
- Anaerobic Digestion (AD)
- Mechanical Biological Treatment (MBT)
- Alternative technologies such as plasma gasification, bio-ethanol production or liming.

Each technology and individual suppliers have been considered in detail and the results of this review described in this report. The overall conclusions can be summarised as follows:

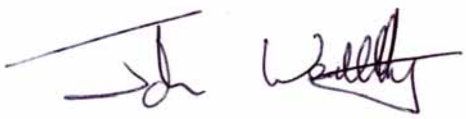
1) EfW - Conventional Incineration is generally considered to meet the selection criteria, and at least four suppliers have been identified for further investigation prior to inclusion on the short-list of tenderers.
2) EfW - Fluidised Bed Combustors. These are not considered suitable for Jersey due to the requirement for pre-treatment to remove unsuitable material, which must be disposed of in other ways.
3) EfW - Gasification and Pyrolysis – 20 suppliers have been considered and of these, only one is considered to have adequate reference plants to satisfy the selection criteria for inclusion on the short-list.
4) Steam Autoclaves – This is a pre-treatment process and separates the waste stream into a number of different output streams requiring further processing, including an EfW plant. The additional costs and difficulties involved in a further processing stage means that this technology is not considered suitable for Jersey.
5) Anaerobic Digestion – AD can only process organic wastes. It is necessary to separate the waste and disposal routes will be required for the non-organic material plus any rejects, together with the digestate from the ASD plant. The additional costs and difficulties involved means that this technology is not considered suitable for Jersey.

6) Mechanical Biological Treatment – MBT is a pre-treatment process, processing the waste to produce a number of output streams such as refuse derived fuel (RDF), organic material, inerts, metals and rejects. All these streams will require further processing, probably using an EfW plant. The additional costs and difficulties involved means that this technology is not considered suitable for Jersey.

7) Alternative Processes such as plasma gasification, bio-ethanol production and a liming process have all been considered, but not considered suitable due to a lack of adequate references, lack of proven flexibility to cope with all the incoming waste or doubts about the sustainability of the proposed disposal routes for the various output streams produced.

A key factor in determining the suitability of facilities has been the ability of the proposed process to deal with the whole waste stream. A number of technologies listed above are considered proven and commercially available, but have been rejected because they can only process part of Jersey's waste stream, or because they pre-treat the waste producing a number of streams requiring further treatment. For a small island such as Jersey, with limited land and a small workforce, these are not considered practical solutions.

It is the considered opinion of Babtie Fichtner, and the conclusion of this report that an EfW plant, of tried and tested and proven technology is the correct solution for dealing with Jersey's residual solid waste, in the particular circumstances and factors that apply to Jersey. This opinion is supported and endorsed by the Environment & Public Services Committee (E&PSC) and the Waste Strategy Steering Group (WSSG).



Dr. John Weatherby Mr. Phin Eddy

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1 INTRODUCTION

The Solid Waste Strategy for Jersey was passed by the States' Assembly in July 2005. Prior to proceeding to the procurement of an Energy from Waste (EfW) plant to replace the existing Bellozanne incinerator, it was agreed that a report would be produced summarising the technologies and suppliers of residual waste treatment facilities that had been considered.

This report has been prepared by Babtie Fichtner for Jersey PSD. It should be noted that the report concentrates on residual wastes, that is the waste left over following the various recycling and composting initiatives proposed in the Strategy.

The report summarises the processes offered by the various suppliers which have been investigated specifically for the Jersey project over the last few years. In addition, generally available information has been used to provide a short overview of each of the processes. The suitability, or otherwise, of each process for Jersey is noted.

It should be noted that this report only considers the applicability of the technology to Jersey. The report has not analysed the ability of each supplier to deliver its proposed solution. Indeed, some of the suppliers included in this list will not tender for a plant on Jersey. Having selected the best technical solutions, it will then be necessary to confirm that each supplier is capable of constructing the required facilities to time and budget, before determining the final short-list for tendering.

2 OVERVIEW OF TECHNOLOGIES

1) This report has considered the technologies and suppliers available to dispose of Jersey's solid residual waste. The main criteria for the selection of technologies are:

- Technology must be demonstrated, with significant reference plants in operation. It is essential for a small island such as Jersey, that no significant technology risks are introduced. As a selection criterion, any technology must be able to provide references for a plant which has been operating for several years and processing similar wastes.
- It is preferred that reference plants exist in Europe, although reference plants elsewhere have been considered if no European references exist. This is because reference plants in Europe are more likely to process similar waste, and also demonstrate the capability of the supplier to offer solutions for Jersey, rather than sub-contracting to companies with either limited knowledge of the technology or of European contracting.
- Environmental performance – the technology must be clean, capable of achieving the best European standards.
- Complexity – the process must be easy to operate without excessive staff numbers, and with clearly understood operating and maintenance costs.
- The process shall deal with all Jersey's solid residual waste, and where output streams are produced, sustainable outlets must exist for these.
- The process shall recover value as efficiently as possible from Jersey's residual waste, in line with the Solid Waste Strategy and the European Waste Hierarchy.

Capability of the supplier and their financial strength are also key factors in selection, but this report has not considered these. The intention is to determine which technology is best suited for Jersey, and then consider which of the various suppliers are able to deliver the solution at the next stage, prior to drawing up the final short list of tenderers.

2) The following types of technology have been considered:

- EfW - Conventional Incineration
- EfW - Fluidised Bed Combustor
- EfW - Gasification and Pyrolysis
- Steam Autoclaves
- Anaerobic Digestion
- Mechanical Biological Treatment
- Plasma Gasification
- Bio-Ethanol Production
- Liming Process

3) EfW - Conventional Incineration

- Conventional energy from waste, i.e. incineration, using either a grate or a kiln, will dispose of all Jersey's residual waste, producing electricity and heat if required. Some material will remain, most of which is inert and suitable for reuse as secondary aggregate, with residues amounting to about 5% of the input material requiring secure landfill as hazardous waste.
- The net electrical conversion efficiency of the plant will be about 23%, that is 23% of the input energy in the waste will be exported from the plant as electricity.

- 8 suppliers have been considered, all of which have significant reference plants and the capability to deliver the project for Jersey.
- Of these eight, at least four have expressed an interest in the project, and it is recommended that they should be included on the short-list to be considered for tendering.

4) EfW - Fluidised Bed Combustors

- There are examples of large scale fluidised bed combustors processing treated residual waste in Europe.
- There are at least four suppliers capable of supplying such plants.
- Fluidised beds are very sensitive to over-sized material, metal and stones. To operate successfully, intensive pre-treatment is required, with rejection of significant amounts of unsuitable material. Fluidised bed combustors are normally used to process a refuse derived fuel from which 20-50% of the incoming material has been removed. This makes the overall plant costs more expensive and also leaves a waste stream requiring further treatment or landfill. This technology is therefore not considered as being the correct choice for an island with no landfill, such as Jersey.

5) EfW - Gasification and Pyrolysis

- There are very few reference plants for successfully operating gasification or pyrolysis plants in Europe. Many of these are very small scale, only treating parts of the waste stream.
- The environmental performance of most gasifiers is similar to conventional energy from waste plants, but the energy recovery efficiency is generally lower.
- 20 gasifier or pyrolyser suppliers have been reviewed. Of these, only one is considered to have adequate references for the type of plant proposed for Jersey. In terms of technology, it is recommended that it should be considered further for inclusion on the short-list of tenderers.

6) Steam Autoclaves

- Steam Autoclaves are a pre-treatment process, whereby the residual waste stream is split into a number of separate output streams. Each of these streams requires further treatment. The biggest stream is the fine organic stream, which is about 60% of the incoming waste. Whilst further treatment, such as combustion of this “fuel” or composting for use as landfill restoration material, are proposed, none of these is suitable for Jersey, as this method of combustion of the fuel would be less efficient than conventional incineration, and there is no landfill requiring the application of the restoration material.
- Whilst there are no such plants currently operating in Europe, the process is relatively simple. There are at least three suppliers proposing to supply such equipment in the UK, and some authorities are proposing to use this type of technology.
- However, due to the requirement for additional facilities to treat the outputs, this technology is not suitable for Jersey’s residual waste.

7) Anaerobic Digestion

- There are a number of anaerobic digestion plants operating throughout Europe, treating either separately collected kitchen waste, or mechanically separated mixed organic waste.
- Six reputable European suppliers have been considered.

- Anaerobic digestion can only treat organic waste, and significant amounts of residual waste material such as plastics and wood are not processed. As separation facilities, together with additional facilities to treat the rejects would be required, this solution is not seen as the most suitable option for Jersey.

8) Mechanical Biological Treatment (MBT)

- There are a number of MBT plants operating in Europe. These all pre-treat the waste by separating it into a number of different streams – recyclables such as aggregates and metals, refuse derived fuel (RDF), organic material which can be further composted, and rejects.
- 13 suppliers of such systems have been considered. Several of these are considered sufficiently capable and experienced to supply an MBT plant to Jersey.
- As this process is an intermediary one, and additional disposal facilities (including an energy from waste plant) would be needed, it is not considered that this technology is the most suitable option for the Island.

9) Plasma Gasification

- This is an advanced technology where significant amounts of energy are used to convert the material into its elements. Due to the intense heat, much of the material will form an inert glassy material considered safe for disposal.
- The pollutants which have been released still require capture and cleaning, and the technology is only considered suitable for small amounts of hazardous material, not for the complete residual waste stream.

10) Bio-Ethanol Production

- This is a process under development, whereby organic material can be treated to produce ethanol, for use as a chemical feedstock or for fuel. The process only converts the organic fraction of waste.
- The process is not operating commercially in Europe and will not treat all of the residual waste stream It is, therefore, not considered suitable for Jersey.

11) Liming Processes

- This is a process under development in France, where lime is added and the lime/organic material separated for use on land.
- Plastics and other rejected material will still require disposal, probably in an energy from waste plant.
- There is no identified use for large quantities of lime based mixed waste organic material in Jersey.
- The process is therefore not seen as the most suitable option for Jersey, as there would still be a need for an EfW plant, and there would be no security that the large quantities of lime-based organic material could be disposed of to land on a continuous basis.

3 DESCRIPTION OF DIFFERENT TECHNOLOGIES

3.1 EfW - Conventional Incineration

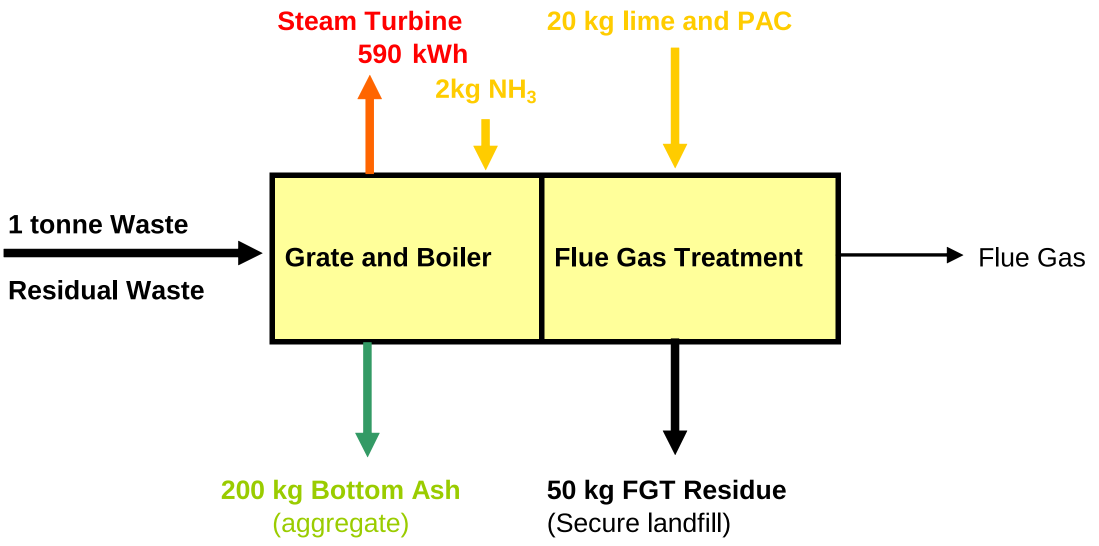
Conventional incineration systems, also known as “mass-burn” have been used worldwide for many decades. There are several hundred such plants operating throughout Europe. These types of plants are by far the most developed. Contrary to public perception, this type of technology is not out of date – it has been developed to a mature level where technical risks are low and costs are well understood. Such plants easily achieve the low emission levels required by the Waste Incineration Directive and convert the energy left in the residual waste in an efficient manner into a useful form, normally as electricity, but also if required as heat, thereby displacing fossil fuels.

Countries with advanced waste management systems and high recycling rates, such as Germany, Holland or Sweden, continue to install new plants of this type to reduce the amount of waste going to landfill.

These plants are based upon grate or rotating kiln systems where largely untreated waste is fed and burnt under controlled conditions. Steam is then generated in a boiler and the flue gas is cleaned using a flue gas treatment plant.

Figure 1 shows typical mass flows of the solids for a conventional plant, together with the electricity generated.

Figure 1 : Conventional Energy from Waste



Numbers are approximate for illustrative purposes only, and dependent on actual supplier and waste composition

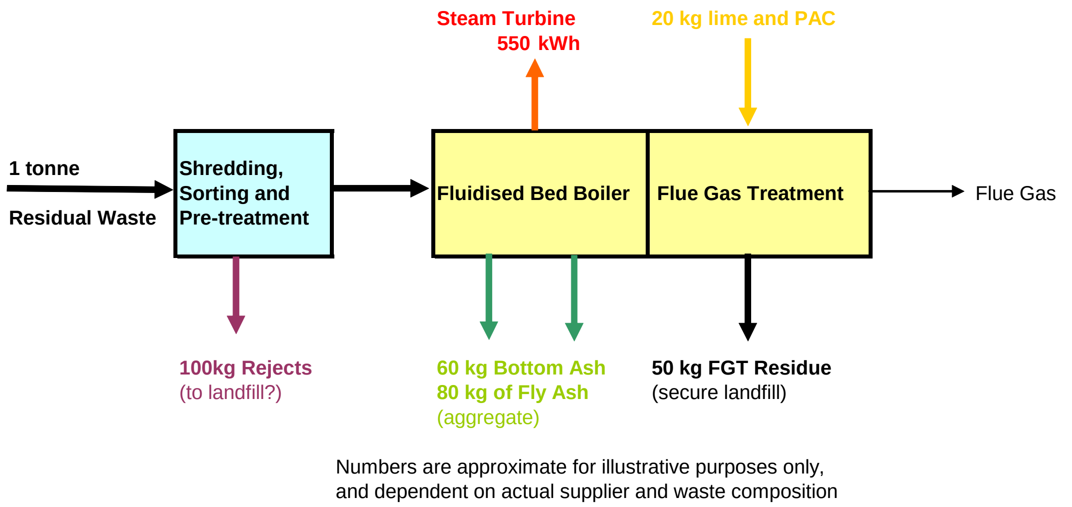
3.2 EfW - Fluidised bed combustion systems

In a fluidised bed, fuel or waste is fed to a mass of hot material (the bed) suspended by air, normally sand, where it burns well due to the mixing of the bed. The hot flue gases are then used to generate steam and are cleaned in a similar manner to that used in a conventional system.

Fluidised beds are commonly used for the combustion of fuels such as coal, sludge or biomass. The use of fluidised beds to burn residual waste is more limited. This is because fluidised beds are sensitive to particle size and dense material such as glass and metal, which does not burn. Whilst there are examples of fluidised beds burning Refuse Derived Fuel, the requirement to pre-treat the residual waste means that the application of fluidised beds is limited to specific applications, where a suitable pre-treated fuel is available.

Figure 2 shows the typical mass balance for a fluidised bed plant.

Figure 2 : Fluidised Bed Energy from Waste



3.3 EfW - Pyrolysis and Gasification

Pyrolysis is thermal degradation of a substance in the absence of oxygen. Gasification is partial thermal degradation of a substance in the presence of oxygen but with insufficient oxygen to completely oxidise the fuel (sub-stoichiometric). The main combustible components of the resulting gaseous product ("syngas") in either case are methane, carbon monoxide and hydrogen. Gasification of coal, oil (and its refined fractions), and natural gas is widely used to produce Syngas which in turn is used as a chemical feedstock or in the production of steam and electricity.

The distinction between pyrolysis and gasification is often blurred by the fact that in an industrial installation it is virtually impossible to have sealing that is good enough to completely exclude air from the process.

Producing electricity in a large-scale, natural gas-fired, combined cycle power plant utilising gas and steam turbines can be much more efficient than a conventional power plant with a steam turbine only. Because of this, there is interest in developing the gasification and pyrolysis techniques to turn solid fuels and wastes into syngas for power generation.

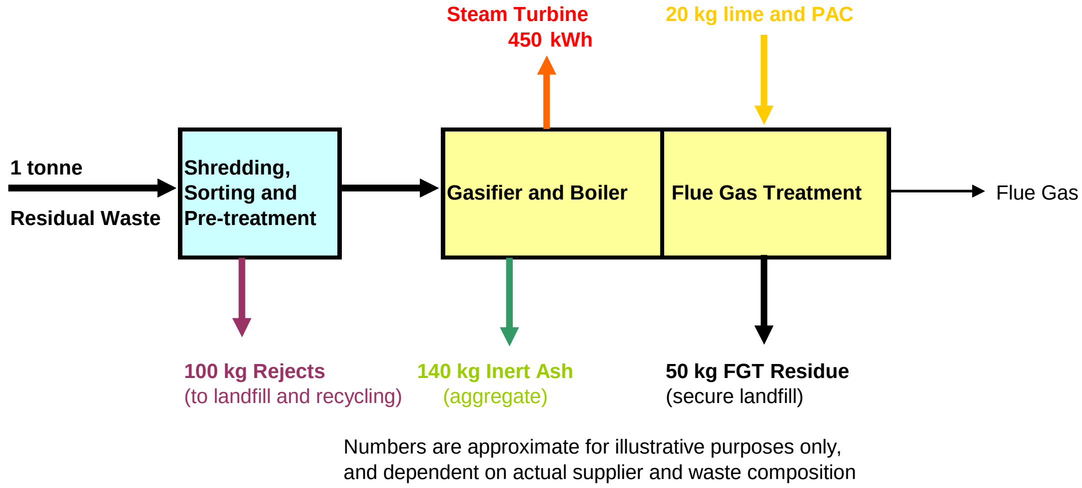
In the UK, the Government has tried to assist the development of these so called "Advanced Technologies" by allowing them to qualify for Renewable Obligation Certificates, whereas modern waste incinerators do not qualify as these are considered to be commercially mature. The Renewables Obligation Certificate increases the electricity revenue by up to £30/MWh (Megawatt hours), so it is a considerable incentive and this has led to a number of suppliers actively entering the market.

Contrary to much that is written, there is no clear evidence that the pyrolysis or gasification of waste is cleaner than conventional techniques. In the UK and Europe, processes using incineration, pyrolysis and gasification of waste are all regulated under the same Directive and with similar limits. The evidence from most existing gasification processes is that emissions from these plants are quite similar to emissions from modern mass burn incinerators.

There are only a limited number of such plants operating throughout the world, with few of any significant size.

Figure 3 shows a typical mass balance for a basic gasification process. It should be noted that there are a large number of variants of gasification and pyrolysis processes.

Figure 3 : Simple Gasification Process



The total amount of residues generated in a pyrolysis or gasification process is largely similar to that from a conventional incineration process. The quantity of residues is largely dependent on the amount of ash present in the waste stream, and all thermal processes should be capable of reducing the incoming waste to the non-combustible ash in an efficient manner. Claims of low residue quantities are normally due to a low assumption of the ash content of the waste, or because the front-end rejects are excluded from the overall balance.

It can also be noted from the above diagram that the net efficiency of pyrolysis and gasification processes has to date been low, significantly less than from conventional combustion processes.

3.3.1 Pyrolysis

The general characteristics of pyrolysis are as follows:

- No oxygen is present (or almost no oxygen) other than any oxygen present in the fuel;
- Temperatures vary from 400°C to 800°C;
- Products are gas, liquid, and char (material which is not completely oxidised);
- Lower temperatures with longer residence times tend to result in more char;
- Higher temperatures with short residence times (<1 second) tend to result in more liquid (up to 80%);
- Typical net calorific value (NCV) of the medium energy gas produced is 15 to 20 MJ/Nm^3 (Megajoules per cubic metre at normal temperature and pressure). For comparison, the NCV for natural gas is about 38 MJ/Nm^3.

3.3.2 Gasification

The general characteristics of gasification are as follows:

- Oxygen is present either as pure oxygen or in air;
- Temperatures tend to be above 750°C;
- NCV of the gas produced will be lower than for pyrolysis as product is partially oxidised;
- Typical NCV of the gas from gasification in the presence of oxygen is 10 to 15 MJ/Nm^3;
- Typical NCV of the low energy gas from gasification in the presence of air is 4 to 10 MJ/Nm^3.

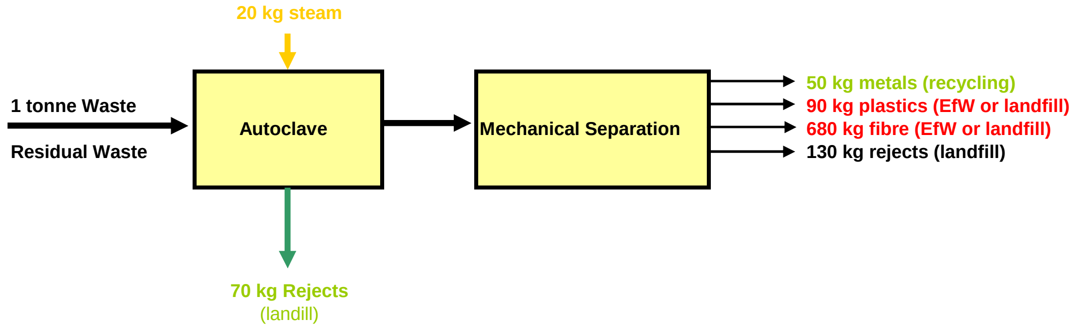
3.4 Steam Autoclaves

In these facilities, waste is loaded into a drum and heated by injecting steam. The tumbling action, together with the steam, breaks the organic material down into a fibre. The resulting material can then be mechanically separated into different output streams, such as metal, plastics, fibre and rejects. Several uses for the fibre have been suggested, such as refuse derived fuel, compost or landfill restoration material. The process is a pre-treatment one and it is necessary to ensure disposal routes exist for each output. Due to the addition of water to the process, the amount of waste actually increases unless the fibre is thermally dried.

There are a few examples of such plants which have operated worldwide.

Figure 4 shows a typical mass balance for a system based upon a steam autoclave. As noted, there are several solid waste outputs which will require additional facilities, but these facilities are not pictured on the figure. The process is a net consumers of energy, requiring electricity for the mechanical equipment and heat to produce the steam.

Figure 4 : Steam Autoclave



Numbers are approximate for illustrative purposes only,
and dependent on actual supplier and waste composition

3.5 Anaerobic Digestion (AD)

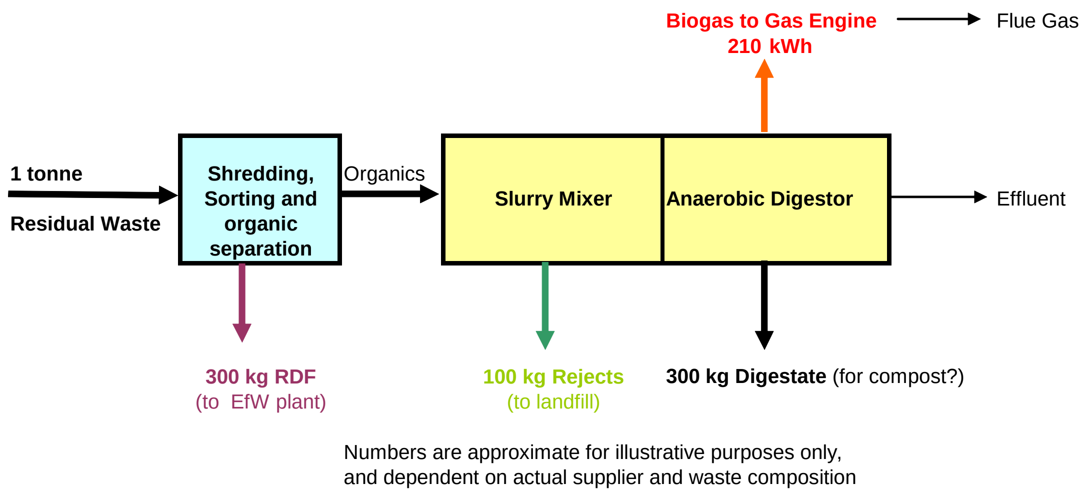
Anaerobic digestion is a well established technique for the decomposition of organic slurries, such as sewage or farm slurries. Jersey PSD operates a digester at the sewage treatment plant at Bellozanne. Organic material is mixed into a slurry, and bacteria are used under anaerobic conditions, that is without the presence of oxygen, to decompose the waste and produce methane gas. The methane gas can be used to generate electricity in gas engines or to produce heat.

It is possible to separate out the organic fraction of municipal waste and to digest it anaerobically. There are examples of such plants in Europe, normally operating on source separated streams such as kitchen waste. There are also a number of plants processing separated mixed municipal solid waste (MSW).

Where mixed MSW is treated, it is still necessary to dispose of the remainder of the waste, typically more than half, which cannot be processed in the digester. In addition, a digestate is produced which must also be disposed of. Whilst such plants do generate some electricity, the net efficiency is low, typically about one third of that of a conventional energy from waste plant.

Figure 5 shows a typical mass balance for an anaerobic digestion system. Some of the outputs (the RDF and the digestate) require additional treatment facilities to process all the waste, which are not shown in the diagram.

Figure 5 : Anaerobic Digestion



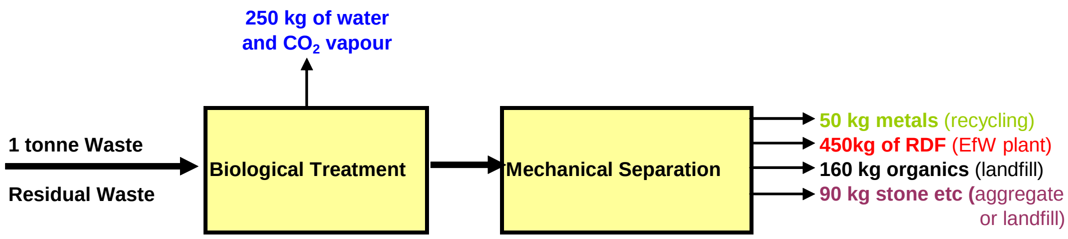
3.6 Mechanical Biological Treatment (MBT)

Residual waste can be treated using a combination of mechanical sorting and biological treatment. Such MBT plants split the raw waste stream into a number of products, typically refuse derived fuel, organic material, glass/stones and metal. Some of the material is lost to the atmosphere, although this is mainly water with some decomposition of carbon and hydrogen. This type of plant is not a complete solution and it is necessary to ensure sustainable offtake routes exist for all the output streams.

There are many examples of this type of plant operating throughout Europe, and the technology can be considered mature.

Figure 6 shows the mass balance for a typical MBT system. As a pre-treatment process, several of the output streams need to be processed in additional treatment facilities, which are not shown in the diagram.

Figure 6 : Mechanical Biological Treatment Plant



Numbers are approximate for illustrative purposes only, and dependent on actual supplier and waste composition

The process is a net consumer of electricity, required to power the mechanical equipment, with typically 70-100 kWh electricity /tonne of waste consumed. The process requires no external heat, as the heat in the process is provided from the waste itself.

3.7 Other Technologies

Various other technologies have been considered to determine whether these would be suitable for Jersey. These include:

- Plasma gasification, where waste is processed at high temperatures
- Bio-ethanol or diesel production, where organic material can be processed to make a chemical feedstock, for example for production of fuels
- Treatment of organic waste with chemicals, such as lime, to produce fertilisers.

4 CONVENTIONAL ENERGY FROM WASTE

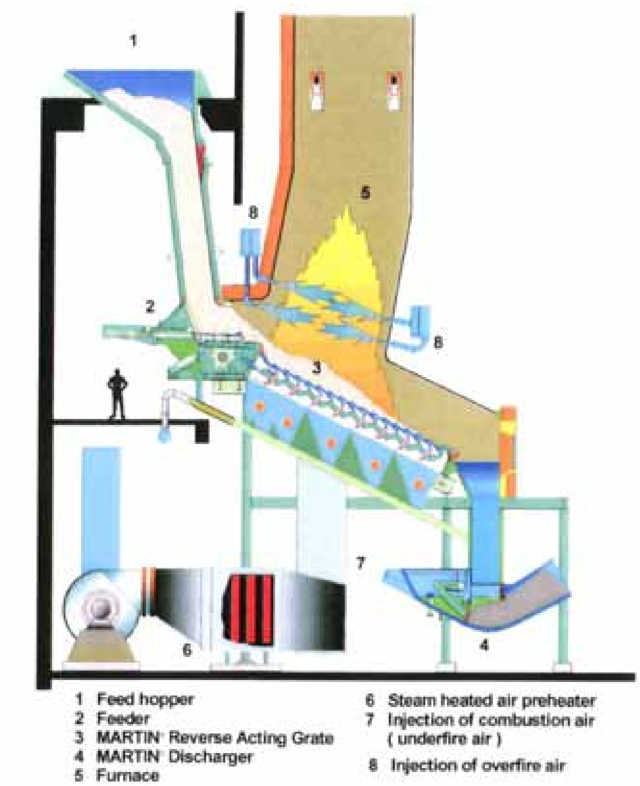
4.1 CNIM / Martin

Process Overview

1) Untreated waste is fed onto the CNIM/Martin "reverse-acting" grate where it combusts;
2) Combustion gases pass through a waste heat boiler to produce steam at high temperature and pressure;
3) The steam passes through a steam turbine to generate electricity for supplying the plant's internal load, with excess power exported to the Grid;
4) NO_x (oxides of nitrogen) is controlled by injecting ammonia solution at the top of the furnace (that is, by Selective Non-Catalytic Reduction SNCR);
5) Flue gases are cleaned using a fabric filter to remove particulates, plus injection of lime and activated carbon to remove other pollutants. Cleaned gases are exhausted to atmosphere via a stack;
6) Ferrous and non-ferrous metals are separated from furnace bottom ash. The metals are recycled and the remaining bottom ash is used as secondary aggregate or sent to non-hazardous landfill.

The majority of the CNIM plants produce electricity, with a net electrical efficiency of 22-24%. Some plants also produce heat for domestic or commercial use. Municipal waste contains 20-25% inert material, and the majority of this material leaves the process as inert material which can be used as aggregates. About 5% of the mass of the incoming material is captured in the bag filter and is classified as hazardous waste, mainly due to the irritant nature of the lime added, requiring secure disposal.

Martin reverse acting grate (picture from Martin)



Reference Plants

CNIM, operating as Martin Engineering Systems (MES) in the UK, is the leading European supplier of conventional combustion technology for residual MSW.

The Martin grate, upon which the CNIM plants are based, is used in over 300 plants worldwide, incorporating over 600 units. Plants supplied by CNIM range from small units processing 20,000 tonnes per annum (tpa) of waste, to very large plants with multiple units and capacities up to 400,000 tpa.

There are five operational MES-CNIM Plants in the UK: SELCHP in London (420,000 tpa), Sinergy in Stoke-on-Trent (200,000 tpa), GEM in Dudley (90,000 tpa), WREN in Wolverhampton (105,000 tpa) and Chineham (90,000 tpa). A further three plants are under construction at Southampton, Portsmouth and Sheffield.

Suitability for Jersey

A possible solution for Jersey because of the following:

- Proven technology for thermal treatment of residual MSW;
- Many reference plants in the UK and Europe;
- Track record for delivering EPC (Engineering, Procurement and Construction) contracts for energy-from-waste plants.

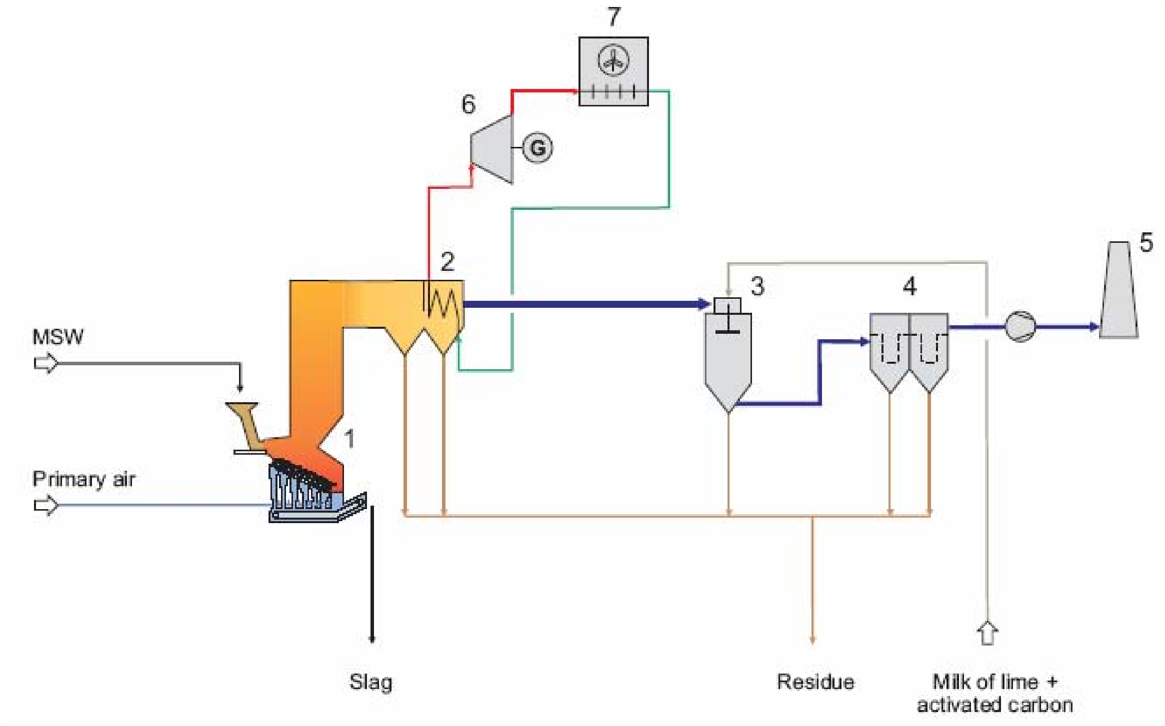
4.2 Lurgi

Process Overview

1) The untreated waste is combusted on either a reciprocating or roller-type grate;
2) High pressure/temperature steam is raised in a waste heat boiler;
3) The steam is used to generate electricity in a steam turbine generator;
4) Flue gas treatment is provided using lime and activated carbon, plus a fabric filter. SNCR is used for NO_x control;
5) Metals are separated from the furnace bottom ash, with inert materials used in construction aggregates, and any residual material sent to landfill.

Most Lurgi plants produce electricity, with a net electrical efficiency of 22-24%. Some plants also produce heat for domestic or commercial use. Municipal waste contains 20-25% inert material, and the majority of this material leaves the process as inert material which can be used as aggregates. About 5% of the mass of the incoming material is captured in the bag filter and is classified as hazardous waste, requiring secure disposal.

Plant Portrait (from Website), Kirklees, Huddersfield



1 Reciprocating grate
2 Boiler
3 Spray absorber
4 Fabric filter
5 Stack
6 Steam turbine
7 Air condenser

Reference Plants

Lurgi has supplied this type of plant for many years, using both roller grates, where the grate consists of several rotating drums which allow the waste to tumble down the outside of each roller, and reciprocating grates where grate bars oscillate backwards and forwards to push and mix the waste lying on the grate.

Lurgi have about 30 references for both their roller grate and reciprocating grate designs, and for complete design and build projects burning residual MSW. Plant sizes vary from small units of around 20,000 tpa of waste up to large multiple unit plants of 400,000 tpa. European examples include Huddersfield (136,000 tpa); Madeira, Portugal (128,000 tpa); Ludwigshafen (180,000 tpa), Offenbach (240,000 tpa) and Wuppertal (375,000 tpa) in Germany; Budapest (340,000 tpa).

Lurgi were the preferred bidder for the Guernsey project before the decision was taken to review the project.

Suitability for Jersey

A possible solution for Jersey because of the following:

- Proven technology for thermal treatment of residual MSW
- Reference plants in the UK and Europe.
- Track record for delivering EPC contracts for energy-from-waste plants.

4.3 Earth Tech with Cyclerval

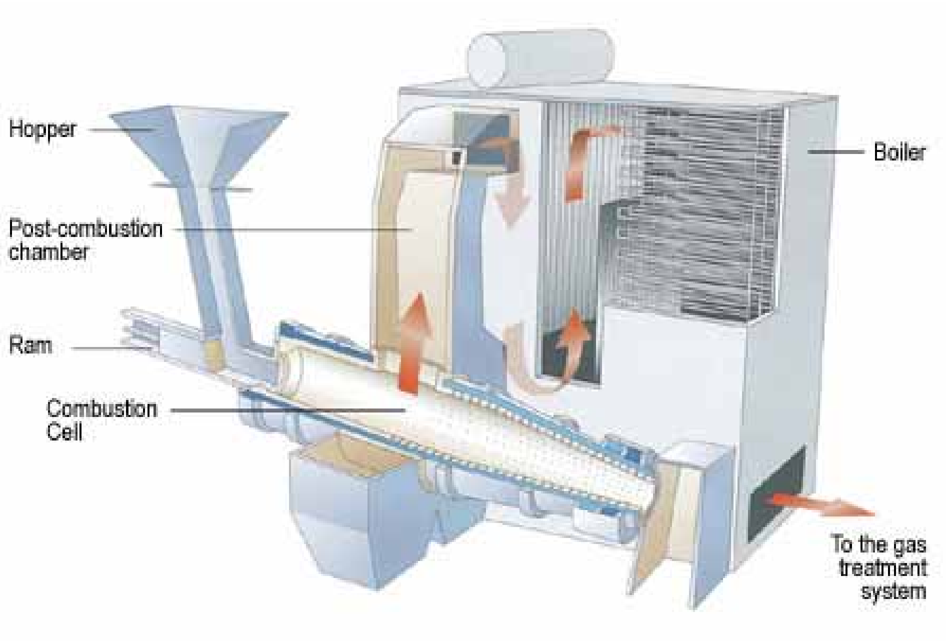
Process Overview

1) Untreated waste is combusted using Cyclerval's oscillating kiln technology;
2) The combustion gases are used to raise steam in a waste heat boiler;

3) The steam is passed to a steam turbine for the production of electricity;
4) SNCR is used for NO_x reduction;
5) Flue gases are cleaned using injected lime and activated carbon, plus a fabric filter;
6) Ferrous and non-ferrous metals are removed from the bottom ash, with the remainder typically used in construction aggregates or sent to landfill. Boiler ash and flue gas residues (fly ash) are sent to hazardous landfill.

The Cyclerval plants produce electricity, with a net electrical efficiency of 22-24%. Municipal waste contains 20-25% inert material, and the majority of this material leaves the process as inert material which can be used as aggregates. About 5% of the mass of the incoming material is captured in the bag filter and is classified as hazardous waste, requiring secure disposal.

Cyclerval reciprocating kiln (picture from Cyclerval)



Reference Plants

Cyclerval's kilns are limited in size due to their large diameter. The processing range of these kilns can vary from 4-10 t/h of waste.

Earth Tech, using the Cyclerval's oscillating kiln, was the EPC contractor for the Newlincs energy from waste facility at Grimsby. The plant incinerates around 56,000 tonnes of municipal waste per year, and was commissioned in 2004.

Earth Tech is an established waste management contractor in the UK. Cyclerval has over ten similar reference plants in France and Belgium, with sizes ranging up to 160,000 tpa.

Suitability for Jersey

Possible solution for Jersey because of the following:

- Proven technology for municipal waste incineration
- European reference plants, including one in the UK;
- Experience of delivering EPC contracts for energy-from-waste plants.

4.4 Stone & Webster with Keppel-Seghers

Process Overview

1) Untreated waste is burnt on the Seghers air-cooled grate.
2) High pressure/temperature steam is raised in a waste heat boiler;
3) The steam is used to produce electricity in a steam turbine generator;
4) Flue gas treatment is provided using lime and activated carbon, plus fabric filter. SNCR is used for NO_x control;
5) Metals are separated from the furnace bottom ash, with inert materials typically used in construction aggregates, with any residual material sent to landfill.

The majority of the Seghers plants produce electricity, with a net electrical efficiency of 22-24%. Some plants also produce heat for domestic or commercial use. Municipal waste contains 20-25% inert material, and the majority of this material leaves the process as inert material which can be used as aggregates. About 5% of the mass of the incoming material is captured in the bag filter and is classified as hazardous waste, requiring secure disposal.

Picture from Website

WTE plant – Antwerp, Belgium – 2 x 60,000 ton

Reference Plants

Stone & Webster, now part of the Shaw group are an established design and build contractor in the process and power industries. Seghers technology has been used in about 20 plants worldwide burning MSW, including the Isvag and Indaver plants in Belgium, (2 x 80,000 tpa and 190,000 tpa respectively) and various plants in Asia and the Far East. Seghers plants vary in capacity from 15,000 to 200,000 tpa.

Suitability for Jersey

Possible solution for Jersey because of the following:

- Proven technology for thermal treatment of residual MSW;
- Reference plants in Europe;
- Experience of delivering EPC contracts for energy-from-waste plants.

4.5 Von Roll Inova

Process Overview

1) Untreated waste is burnt on the Von Roll reciprocating grate.
2) High pressure/temperature steam is raised in a waste heat boiler;
3) Steam is used to produce electricity in a a steam turbine generator;
4) SNCR is used for NO_x reduction;
5) Flue gas treatment is provided using lime and activated carbon, plus a fabric filter;
6) Metals are separated from the furnace bottom ash, with inert materials typically used in construction aggregates, and any residual material sent to landfill. Boiler ash and flue gas residues are sent to secure landfill.

The majority of von Roll plants produce electricity, with a net electrical efficiency of 22-24%. Some plants also produce heat for domestic or commercial use. Municipal waste contains 20-25% inert material, and the majority of this material leaves the process as inert material which can be used as aggregates. About 5% of the mass of the incoming material is captured in the bag filter and is classified as hazardous waste mainly due to the irritant nature of the lime added, requiring secure disposal.

Picture of Nuremburg waste incineration plant (from Von Roll Inova Website)

Entered service: 2001, Capacity: 3 × 10.5 Mg/h

Reference Plants

Von Roll has supplied over 300 plants worldwide since 1954, mostly burning MSW - none in the UK although Stream 3 at Bellozanne was delivered by von Roll. Examples of recent European plants include Thun, Switzerland (150,000 tpa); Alkmaar, Netherlands (3 x 150,000 tpa plus 1 x 225,00 tpa); Perpignan, France (2 x 85,000 tpa); Nuremberg (3 x 85,000 tpa); MHKW Pirmasens, Germany (2 x 100,000 tpa).

Suitability for Jersey

Possible solution for Jersey because of the following:

- Proven technology for thermal treatment of residual MSW;
- Reference plants in the UK and Europe;
- Experience of delivering EPC contracts for energy-from-waste plants.

4.6 Babcock & Wilcox Vølund

Process Overview

1) Untreated waste is burnt on a Vølund air-cooled, reciprocating grate.
2) High pressure/temperature steam is raised in a waste heat boiler;
3) Steam is used to produce electricity in a steam turbine generator;
4) Flue gas treatment is provided using lime and activated carbon, plus a fabric filter. SNCR is used for NO_x reduction.
5) Metals are separated from the furnace bottom ash, with inert materials typically used in construction aggregates, and any residual material sent to landfill.

The majority of the Vølund plants produce electricity, with a net electrical efficiency of 22-24%. Some plants also produce heat for domestic or commercial use. Municipal waste contains 20-25% inert material, and the majority of this material leaves the process as inert material which can be used as aggregates. About 5% of the mass of the incoming material is captured in the bag filter and is classified as hazardous waste mainly due to the irritant nature of the lime added, requiring secure disposal.

Picture of Cleveland plant, UK (from Website)

Reference Plants

Vølund is a Danish based company, with over 300 waste-to-energy plants supplied worldwide over a period of 70 years. Babcock Wilcox of the US took the company over in recent times. Recent European projects utilising an air-cooled grate include Charleroi, Belgium (65,000 tpa); Esbjerg, Denmark (190,000 tpa), and Nevers, France (1 x 50,000 tpa). There are two operating UK plants at Cleveland (2 x 110,000 tpa) and Slough Heat & Power (100,000 tpa). Cleveland was built by Sir Robert MacAlpine, and Slough Heat and Power by Agra Birwelco (AMEC) with Vølund as the boiler and grate supplier.

Suitability for Jersey

Possible solution for Jersey because of the following:

- Proven technology for incineration of residual MSW;
- Reference plants in the UK and Europe.

However, Babcock Wilcox Vølund is currently not bidding for full turnkey projects, and even appears to be reluctant to offer its grate and boiler together with a main contractor.

4.7 Fisia Babcock Environment

Process Overview

1) Untreated waste is burnt on an air- or water-cooled grate
2) High pressure/temperature steam is raised in a waste heat boiler;
3) Steam is used to produce electricity in a steam turbine generator;
4) Flue gas treatment is provided using lime and activated carbon, plus fabric filter. SNCR is used for NO_x reduction;
5) Metals are separated from the furnace bottom ash, with inert materials typically used in construction aggregates, and any residual material sent to landfill.

The majority of the Fisia Babcock plants produce electricity, with a net electrical efficiency of 22-24%. Some plants also produce heat for domestic or commercial use. Municipal waste contains 20-25% inert material, and the majority of this material leaves the process as inert material which can be used as aggregates. About 5% of the incoming material is captured in the bag filter and is classified as hazardous waste, requiring secure disposal.

Tyseley Energy from Waste Plant, Birmingham, England. (source Onyx)

Reference Plants

Fisia Babcock has numerous worldwide and European references. The company has supplied plants ranging from 30,000 tpa of waste up to 400,000 tpa. The company owns the Babcock, Steinmuller and Noell technologies and can offer either roller or reciprocating grates. Recent European new plant references include Århus, Denmark (water-cooled grate, 140,000 tpa); Isle of Man (Noell water-cooled grate, 65,000 tpa, plant built by Kvaerner); and Rambervillers, France (air-cooled grate, 50,000 tpa). The most recent UK reference plant is at Tyseley, Birmingham which has a capacity of 2 x 180,000 tpa.

Suitability for Jersey

Possible solution for Jersey because of the following:

- Proven technology for recovering energy from residual MSW;
- Reference plants in the UK and Europe.

Babcock Borsig Power went into receivership in 2001 and was subsequently bought by Fisia of Italy to create Fisia Babcock Environment. Due to this, the company was not active for some time, but this has now changed.

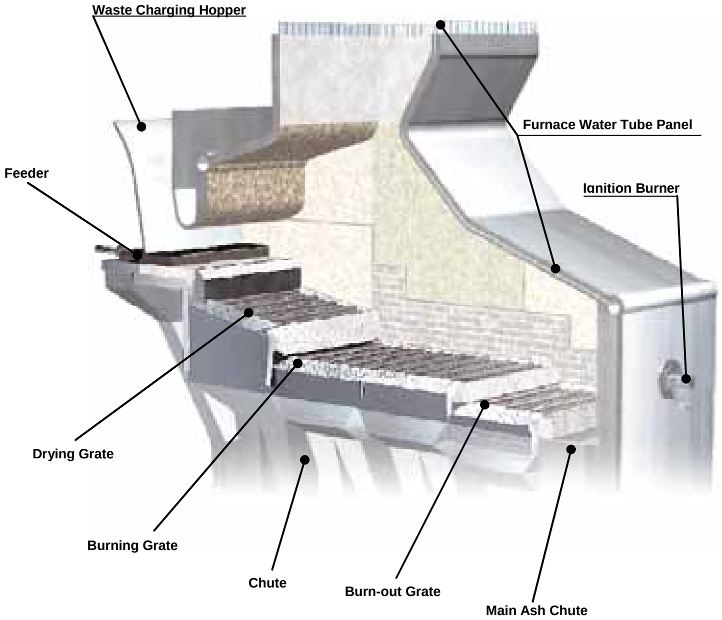
4.8 Itochu with Takuma

1) Untreated waste is fed onto the Takuma sliding grate, with individual speed control on each section;
2) NO_x is controlled through the injection of ammonia solution at the top of the furnace (SNCR);
3) Combustion gases are used to raise high pressure steam in a waste heat boiler;
4) A steam turbine generator produces electricity from the steam;
5) Waste flue gases are cleaned with the injection of lime and activated carbon, plus a fabric filter to remove particulates.

6) Metals are separated from the furnace bottom ash, with inert materials typically used in construction aggregates, and any residual material sent to landfill.

Most Itochu/Takuma plants produce electricity, with a net electrical efficiency of 22-24%. Some plants also produce heat for domestic or commercial use. Municipal waste contains 20-25% inert material, and the majority of this material leaves the process as inert material which can be used as aggregates. About 5% of the mass of the incoming material is captured in the bag filter and is classified as hazardous waste, requiring secure disposal.

Illustration from Takuma



Reference Plants

There are many reference plants in Japan and the Far East ranging in size from 30,000 tpa of waste to over 400,000 tpa. Itochu / Takuma are currently constructing the 430,000 tpa Lakeside Energy-from-Waste project at Colnbrook, near Slough, which will be the first European reference plant, and should be operating by late 2007.

Suitability for Jersey

Possible solution for Jersey because of the following:

- Proven technology for incineration of residual MSW;
- Many reference plants worldwide;

However, Lakeside, due for completion in 2007, is the first plant built by the consortium in Europe.

5 EFW - FLUIDISED BED COMBUSTION

5.1 Austrian Energy

Austrian Energy & Environment (AEE) are part of the same group as von Roll.

Process Overview

1) Mechanical pre-treatment of raw waste is used to produce refuse derived fuel (RDF) suitable for combustion in a fluidised bed boiler;
2) The treated waste is combusted in a bubbling or circulating-type fluidised bed of sand, through which combustion air is blown.
3) Steam at high pressure and temperature is generated in a waste heat boiler;
4) Production of electricity from the steam using a steam turbine;
5) Flue gas cleaning is provided using lime and activated carbon, plus a fabric filter to remove particulates.

The AEE plants produce electricity, with a net electrical efficiency of 20-25%. Some plants also produce heat for domestic or commercial use. RDF contains 12-20% ash, and the majority of this material leaves the process as inert material, some of which can be used as aggregates. About 5% of the incoming material is captured in the bag filter and is classified as hazardous waste mainly due to the irritant nature of the lime added, requiring secure disposal.

Picture of Niklasdorf RDF-Plant, Austria (from Website)

Reference Plants

The main reference plant for bubbling bed (Ecofluid) plants burning Refuse Derived Fuel (RDF) is the Niklasdorf plant in Austria, including waste handling and treatment facilities. This has an electrical output of 7.5 MW and also supplies steam to a paper mill.

Suitability for Jersey

AEE fluidised beds are not considered suitable for Jersey because significant pre-treatment of raw waste is required prior to combustion. Fluidised beds are very sensitive to over-sized material, glass, metals or stones and these must be separated prior to combustion. Such a solution would therefore require a preparation facility which would create a reject stream requiring disposal, plus additional staff and operating costs, for no identified benefits.

5.2 Foster Wheeler

Process Overview

1) Mechanical pre-treatment of raw waste is used to produce refuse derived fuel (RDF) suitable for combustion in a fluidised bed boiler;
2) The treated waste is then combusted in a circulating-type fluidised bed (CFB) boiler;
3) Steam at high pressure and temperature is generated in a waste heat boiler;
4) Eelectricity is produced from the steam using a steam turbine;
5) Flue gas cleaning is provided using lime and activated carbon, plus a fabric filter to remove particulates. SNCR is not normally required.

FW plants produce electricity, with a net electrical efficiency of up to 25%. RDF contains 12-20% ash, and the majority of this material leaves the process as inert material, some of which can be used as aggregates. About 5% of the mass of the incoming material is captured in the bag filter and is classified as hazardous waste mainly due to the irritant nature of the lime added, requiring secure disposal.

Picture of Lomellina RDF-fired plant, Italy (from FW Website)

Reference Plants

FW supplied the Lomellina waste-to-energy plant in Parona, Italy which processes about 120,000 tpa of RDF and is currently being expanded. The plant is designed to recover material and energy from MSW. About 60 % of the MSW can be converted into RDF, following separation of aluminium, ferrous materials, glass and compost from the raw waste. The fuel is then fed into the CFB boiler and burnt at temperatures between 850 and 900°C.

Suitability for Jersey

FW fluidised beds are not considered suitable for Jersey because significant pre-treatment of raw waste is required prior to combustion. Fluidised beds are very sensitive to over-sized material, glass, metals or stones and these must be separated prior to combustion. Such a solution would therefore require a preparation facility which would create a reject stream requiring disposal, plus additional staff and operating costs, for no identified benefits.

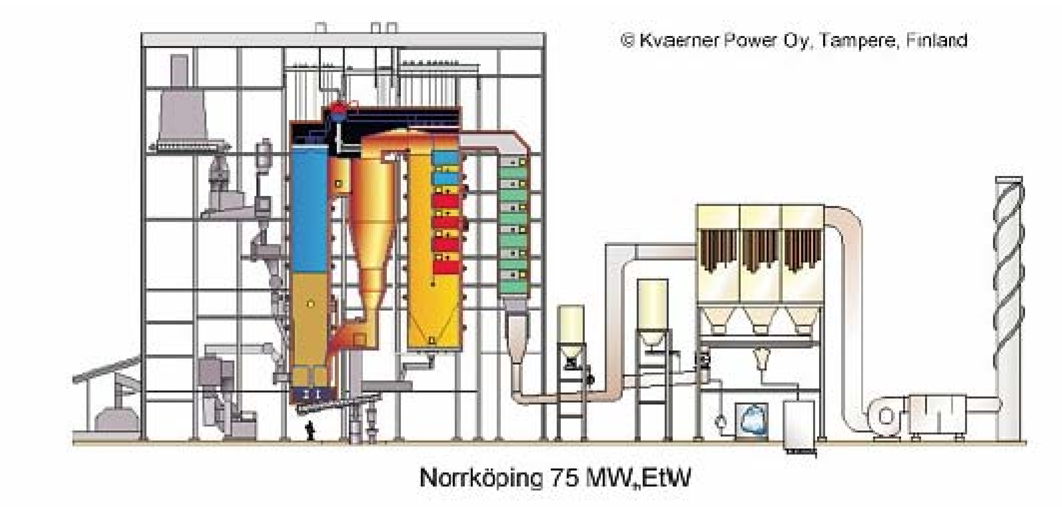
5.3 Kvaerner

Process Overview

1) Mechanical pre-treatment of raw waste is used to produce suitable fuel (RDF) for combustion in a fluidised bed boiler;
2) The treated waste is combusted in a bubbling or circulating-type fluidised bed of sand, through which combustion air is blown;
3) Steam at high pressure and temperature is generated in a waste heat boiler;
4) Electricity is produced from the steam using a steam turbine;
5) Flue gas cleaning is provided using lime and activated carbon, plus a fabric filter to remove particulates.

Kvaerner plants produce electricity, with a net electrical efficiency of about 25%. Some plants also produce heat for domestic or commercial use. RDF contains 12-20% ash, and the majority of this material leaves the process as inert material, some of which can be used as aggregates. About 5% of the mass of the incoming material is captured in the bag filter and is classified as hazardous waste, requiring secure disposal.

Kvaerner Norrköping CFB Boiler plant [from The Finnish Environment report: "Finnish Expert Report on best available techniques in energy production from solid recovered fuels"]



Reference Plants

There are some reference plants burning refuse-derived fuel (RDF) / solid recovered fuel (SRF), including:

- Norrköping, Sweden burning assorted municipal solid waste in a fuel mix with industrial waste, sewage sludge, rubber chips and demolition waste wood. Capacity 75 MW_{th} plant

- Sogama plant in North West Spain processing 650,000 tpa of MSW to 400,000 tpa of solid recovered fuel, for firing in CFB boilers and subsequent electricity generation.
- Baldovie waste-to-energy plant, Dundee burning mainly treated municipal waste in two 17 MW_{th} bubbling fluidised bed boilers. The steam raised is used to generate electricity in a single condensing turbine generator with up to 8.3 MW being exported to the national electricity network. The plant is designed to treat 120,000 tpa of waste.

Suitability for Jersey

Kvaerner fluidised beds are not considered suitable for Jersey because significant pre-treatment of raw waste is required prior to combustion. Fluidised beds are very sensitive to over-sized material, glass, metals or stones and these must be separated prior to combustion. Such a solution would therefore require a preparation facility which would create a reject stream requiring disposal, plus additional staff and operating costs, for no identified benefits.

5.4 Lurgi

Process Overview

A typical fluidised bed process will include:

1) Mechanical processing of waste including at least a reduction in size to below 300mm;
2) Combustion of treated waste in the Rowitec® fluidised bed;
3) Generation of steam at high pressure and temperature in a waste heat boiler;
4) Production of electricity using a steam turbine;
5) Flue gas cleaning using lime and activated carbon, plus a fabric filter to remove particulates.

Lurgi plants produce electricity, with a net electrical efficiency of up to 25%. Some plants also produce heat for domestic or commercial use. RDF contains 12-20% ash, and the majority of this material leaves the process as inert material, some of which can be used as aggregates. About 5% of the mass of the incoming material is captured in the bag filter and is classified as hazardous waste, requiring secure disposal.

Mulhouse, France (170,000 tpa) (Picture from Lurgi Lentjes Website)

Reference Plants

There are several European references for Rowitec® CFB boilers burning municipal solid waste as part of waste mixture. Plants include:

- Madrid, Spain: 400,000 tpa plant processing municipal waste.
- Gien, France: 75,000 tpa of municipal, commercial, hospital wastes, plus sludge;
- Mulhouse, France: 170,000 tpa of municipal waste and sewage sludge;
- Macomer, Italy: 45,000 tpa municipal plus hospital waste.

The Rowitec® technology has also been selected for the 500,000 tpa Allington Quarry plant in the UK, which will include material recovery facilities for pre-treatment of waste prior to combustion. This plant is under construction and should be operational in 2006.

Suitability for Jersey

Lurgi fluidised beds are not considered suitable for Jersey because significant pre-treatment of raw waste is required prior to combustion. Fluidised beds are very sensitive to over-sized material, glass, metals or stones and these must be separated prior to combustion. Such a solution would therefore require a preparation facility which would create a reject stream requiring disposal, plus additional staff and operating costs, for no identified benefits.

6 EFW - GASIFICATION AND PYROLYSIS

6.1 Austrian Energy - Von Roll

Austrian Energy & Environment (AEE) and von Roll are part of the same company.

Process Overview

AEE has a new RCP (Recycled Clean Products) process. It includes pyrolysis and controlled high-temperature melting with oxygen injection to yield an immediately usable raw material for the construction industry. Slag is vitrified in the RCP process, with extraction of heavy metals in the slag refinement step.

Reference Plants

None known.

Suitability for Jersey

The technology is not considered suitable for Jersey because there are no reference plants with residual MSW.

6.2 British Gas - Lurgi

Process Overview

This gasification process uses an oxygen blown gasifier to produce a medium calorific value fuel gas was developed to process coal.

Material is fed to a fixed bed gasifier and heat and oxygen used to produce a gas.

The gas can be used in processes, or burnt to generate steam in a boiler, or in a gas turbine.

The process also requires an air separation plant to provide the oxygen required for the process.

Reference Plants

Schwarze Pumpe BG-Lurgi gasifier

There is an operating plant at Schwarze Pumpe, Germany, where RDF and commercial waste are gasified, together with some coal.

Suitability for Jersey

The process is not considered suitable, as the process requires RDF, not residual waste, and additional fuel such as coal. In addition, the requirement for an air separation plant means that the process is complicated and requires additional land space.

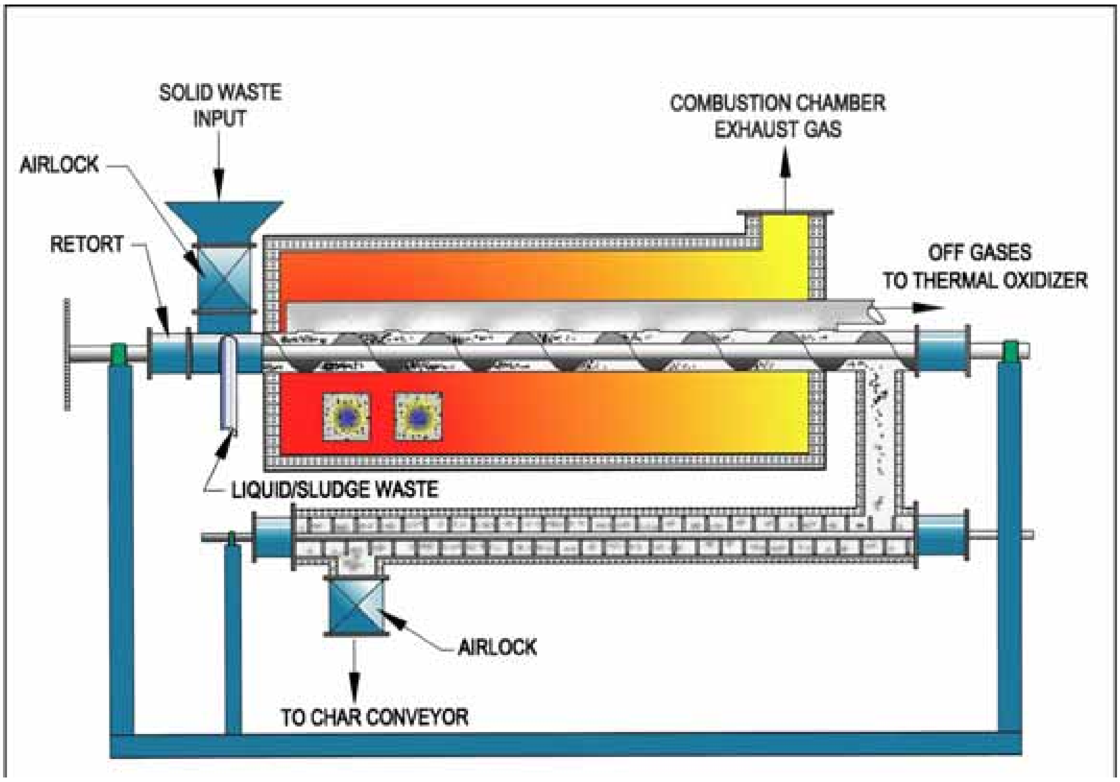
6.3 Bowen Worldwide Developments

Process Overview

Bowen describe their process as follows:

- Raw waste is first separated by manual picking. The separated waste is then shredded, dried and pelletised. Material such as glass, metal and stones are rejected.
- The process pyrolyses waste using indirect heat.
- The resulting gases are then burnt in a secondary chamber.
- The hot flue gases are used to generate steam which is used to produce electricity in a steam turbine.
- The flue gases are then cleaned using a wet scrubber.

Schematic taken from Bowen Worldwide presentation to Jersey PSD



Reference Plants

None identified. We understand there is a small thermal oxidiser unit operating in America, but no details of size or waste type treated have been provided.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- No suitable reference plants have been identified.
- Staffing requirements – according to Bowen, 60 staff are required for a 50,000 tpa unit.

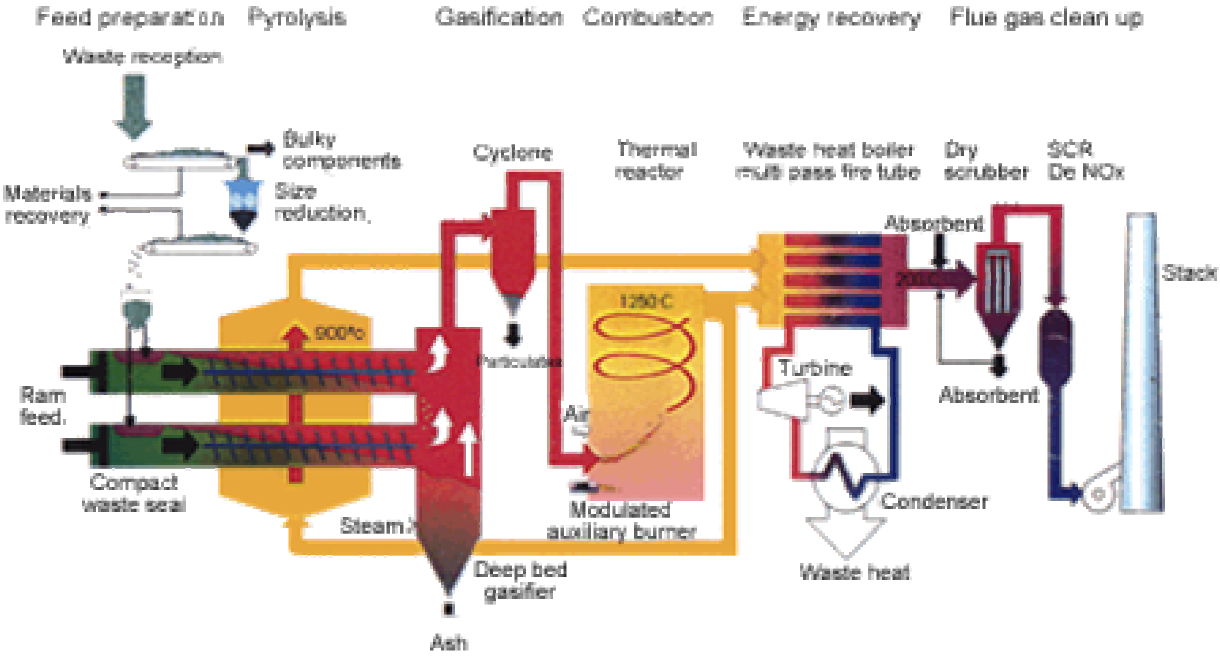
6.4 Compact Power

Process Overview

1) Materials recovery facility is used for taking out bulky materials and recyclables;
2) Pyrolysis is carried out at 800°C in externally heated screw tube pyrolysers;
3) Gasification of residues follows with air & steam;
4) Thermal oxidation (combustion) of the syngas (from the pyrolysis and gasification processes) with air at high temperature (>1250°C for 2 seconds) converts the gas to hot flue gases.
5) Steam is then generated in a waste heat boiler;
6) Power is generated from the steam via a steam turbine;
7) Flue gas cleaning is provided with a bag filter with sodium bicarbonate injection, and selective catalytic reduction (SCR) with ammonia for NO_x reduction. .

The estimated net electrical efficiency of the process is only about14%. The process will create similar amounts of residues (or perhaps slightly more) as a conventional incineration process.

Picture from Compact Power Website



Reference Plants

Compact Power has a single reference plant operating commercially at Avonmouth, with a capacity of 6,000 tpa. The plant was tested using residual municipal solid waste (RMSW) but normally burns clinical waste.

Suitability for Jersey

Not considered suitable for Jersey because:

- There are no reference plants of sufficient capacity;
- The suitability of ash for use as secondary aggregate is unclear due to higher potential amounts of unburnt material;
- The process has a low electrical efficiency of less than 20%.

6.5 Enerkem / Novera

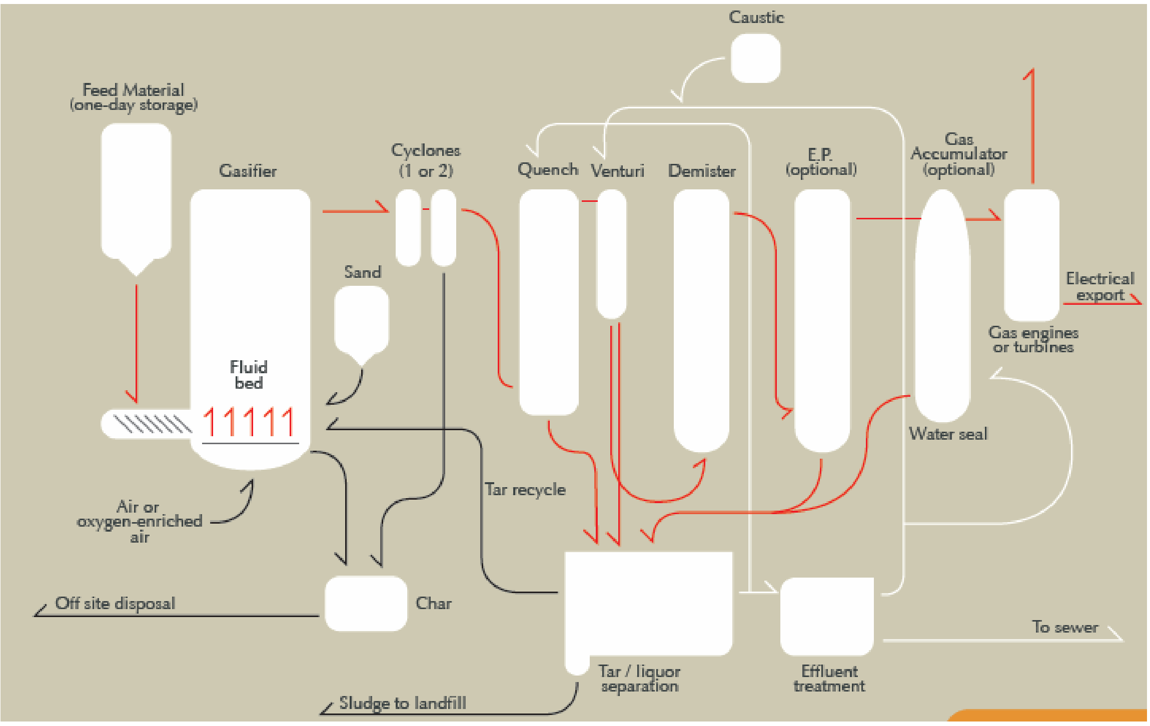
Enerkem gasification technology is marketed under licence by Novera Energy in the UK for MSW application.

Process Overview

The proposed process includes the following steps:

1) Feedstock reception, pelletisation and storage;
2) Gasification in a bubbling fluidised bed with silica alumina as the fluidising medium. The quantity of air, or optionally oxygen, fed into the fluidised bed represents about 30% of the stoichiometric amount required for complete combustion of the organics in the feedstock;
3) Removal and disposal of coarse char particles from hot syngas via cyclones;
4) Gas cleaning and cooling with gas quench tower, venturi scrubber, demister, electrostatic precipitator and dehumidification to produce a clean syngas suitable for use in gas engines or turbines;
5) Power generation using either a conventional steam cycle, or gas engines / turbines. The estimated net electrical efficiency is only 15% with a conventional steam cycle. This is estimated to rise to 22% in a gas engine, although this has yet to be tested with MSW.

Picture from Enerkem website



Reference Plants

A single reference plant in Castellon, Spain using gas engines for power generation. The feedstock for the reference plant was plastics with a high calorific value in the order of 38 MJ/kg.

Suitability for Jersey

Not considered suitable for Jersey because there are no reference plants of sufficient capacity or with experience of processing MSW.

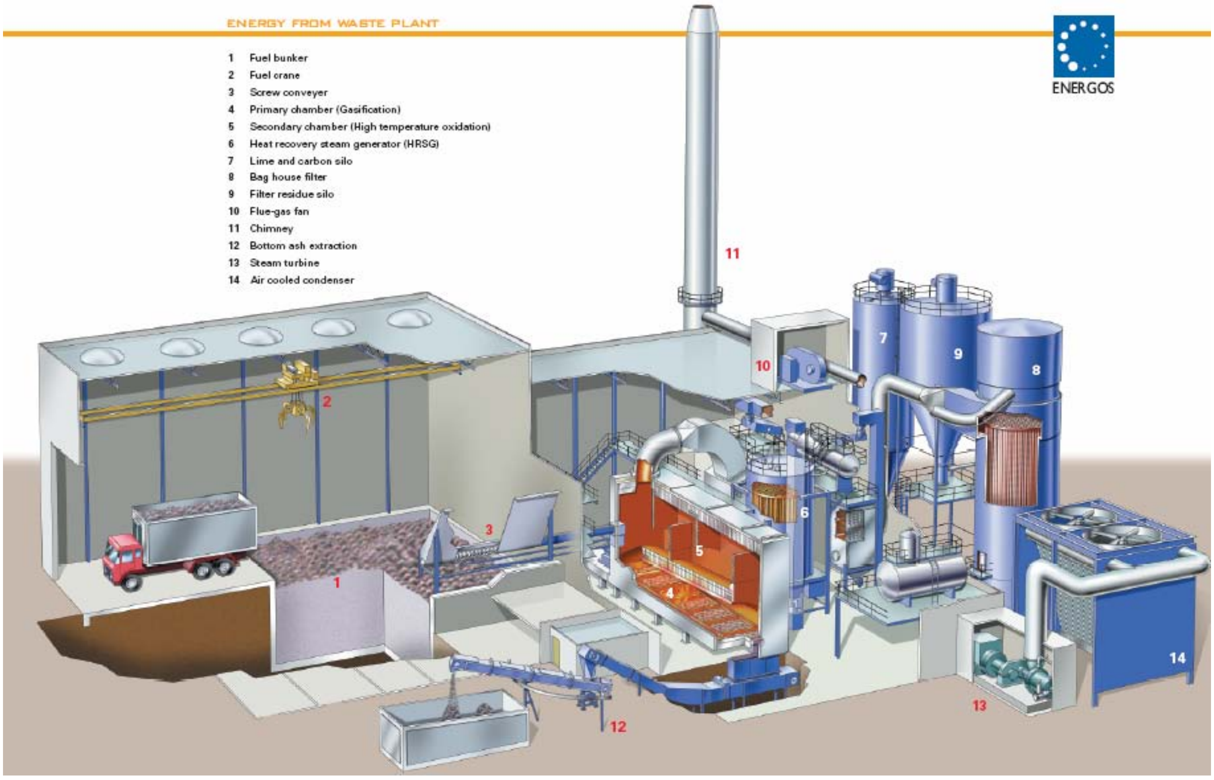
6.6 Ener-G / Energos AS

Process Overview

1) Feed preparation (shredding) is required to increase surface area of waste;
2) Static grate gasifier with combustion chamber directly above grate burns the processed waste;
3) Each module can process around 35,000 tpa of raw waste. Additional capacity is achieved with multiple modules;
4) Steam generation is carried out in a boiler, and the steam used to generate electricity in a turbine;
5) Flue gas cleaning by fabric filter with lime and carbon injection.

Energos plants produce electricity, with a net electrical efficiency of about 18%. Some plants also produce heat for domestic or commercial use. Municipal waste contains 20-25% ash, and the majority of this material leaves the process as inert material, some of which can be used as aggregates. About 5% of the incoming material is captured in the bag filter and is classified as hazardous waste mainly due to the irritant nature of the lime added, requiring secure disposal.

Picture from EnerG Website



Reference Plants

Six plants are operating commercially (five in Norway, one in Germany), for between 2 and 7 years, processing MSW, commercial, and industrial wastes. Plant capacities range from 10,000 tpa to 75,000 tpa.

Energos ceased to trade in 2002 and was taken over by EnerG, who own the Isle of Wight energy from waste plant.

Suitability for Jersey

This is considered a possible solution for Jersey because of the following:

- Proven technology for thermal treatment of residual MSW;
- Reference plants in Europe.

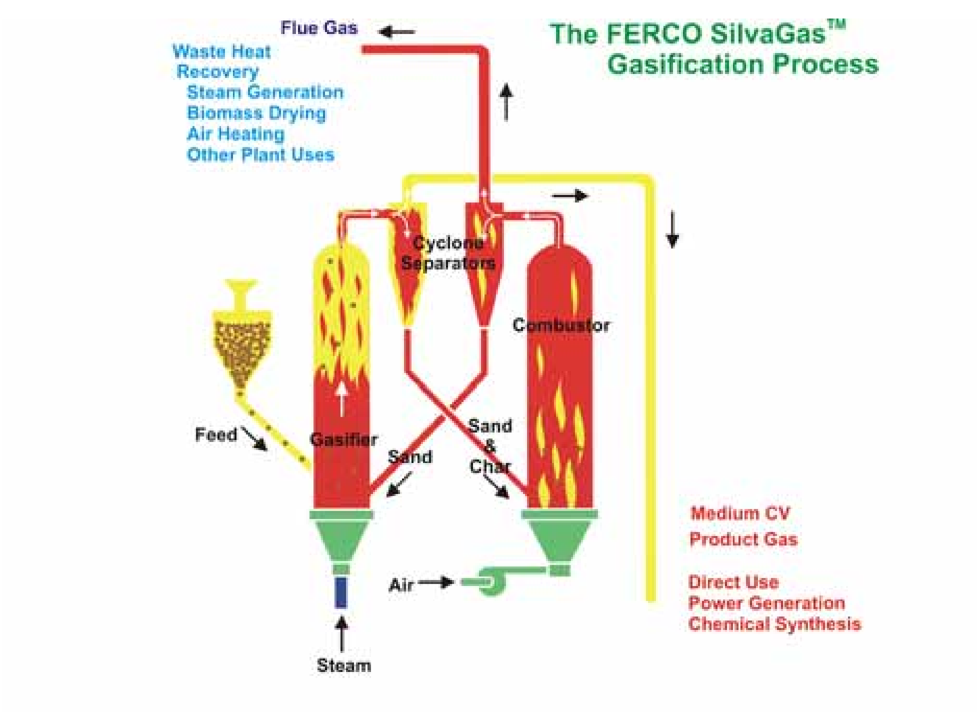
6.7 Ferco

Process Overview

The Ferco SilvaGas™ gasification process is specifically designed for processing biomass, and the organic fraction of MSW. The process incorporates the following:

1) Fuel drying;
2) Gasification in a circulating fluidised bed;
3) Steam gasification to produce syngas. Char combustion takes place in a second fluidised bed to provide heat to the sand carried over from the gasifier. This hot sand is recycled back into the gasifier to provide heat for the chemical reactions;
4) Syngas from demonstration plant has been used in a power station but FERCO intends to burn the gas in a gas turbine. Some testing of syngas in a very small (200kW) Solar Spartan gas turbine has been undertaken at the pilot plant.

FERCO process – illustration supplied by FERCO



Reference Plants

Single demonstration plant in Vermont (USA) processing biomass. The syngas was exported for co-firing at an existing conventional power plant. MSW has not been tested at the demonstration plant but RDF has been tested for a short period in a small pilot plant.

Suitability for Jersey

The technology is not considered suitable for Jersey because there are no commercially operating plants processing MSW. In addition, the process is not tolerant of raw MSW. MSW requires extensive preparation and drying prior to gasification. If the syngas is to be used in a gas turbine, this would require extensive testing due to the high risk of damage to the gas turbine blades with a dirty gas.

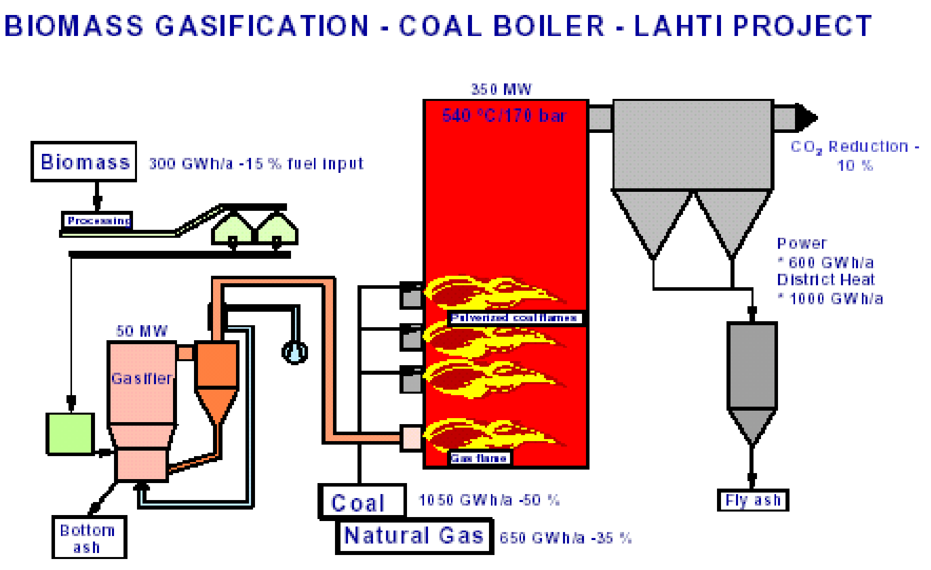
6.8 Foster Wheeler

Process Overview

The proposed process includes:

1) Gasification of prepared RDF in a circulating fluidised bed at atmospheric pressure using air;
2) Flue gas clean-up;
3) Use of syngas in a power station or industrial process.

Diagram from Foster Wheeler



Reference Plants

The main reference plant is a demonstration plant at Lahti, Finland processing recycled fuel containing plastics, paper, cardboard, and wood. Fuel input is 60 MW_{th}. The syngas is co-fired in a conventional power station**.** Foster Wheeler is targeting the gasifier for processing of RDF to produce syngas for use in power stations, which would require significant pre-processing of MSW. There are also four smaller Finnish plants supplied between 1983 and 1986 to the pulp and paper industry use bark and waste wood as the feedstock.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- The technology is more suited to gasification of biomass and RDF, not raw MSW which would need significant pre-processing to produce RDF.

- The main FW concept is based upon producing gas for use in a power station or similar process, and no such process exists in Jersey;
- The requirement for pre-processing of MSW would require additional staff over existing levels.

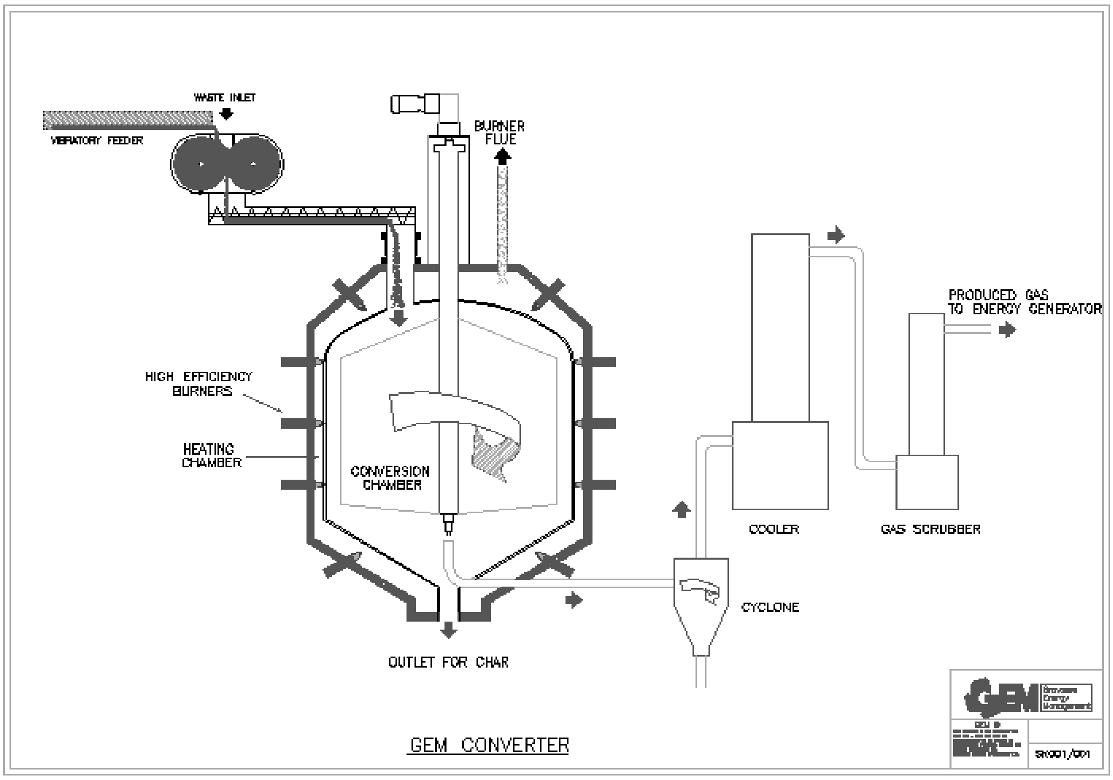
6.9 GEM (Graveson Energy Management)

Process Overview

The proposed Gem process includes the following:

1) Three-stage pre-treatment comprising: (i) removal of metals, glass and ceramics, (ii) shredding into small flakes, (iii) thermal drying to around 5% moisture
2) Continuous feed and fast pyrolysis in an externally heated stirred reactor;
3) Hot gas filtration;
4) Syngas cooling in a heat exchanger cooled with atomised mineral oil coolant;
5) Syngas compression and after cooling. Syngas is then fired in a gas engine, with an estimated net electrical efficiency of about 24%.

GEM Converter – illustration supplied by GEM



Reference Plants

GEM's small test plant at Bridgend normally flared the syngas. The plant supplying the waste fuel was dismantled in 2004 and the gasifier has not operated for several years. A gas engine was tested on site for about four weeks for trials but it is not clear how many operating hours were achieved. There are no commercially operating plants.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

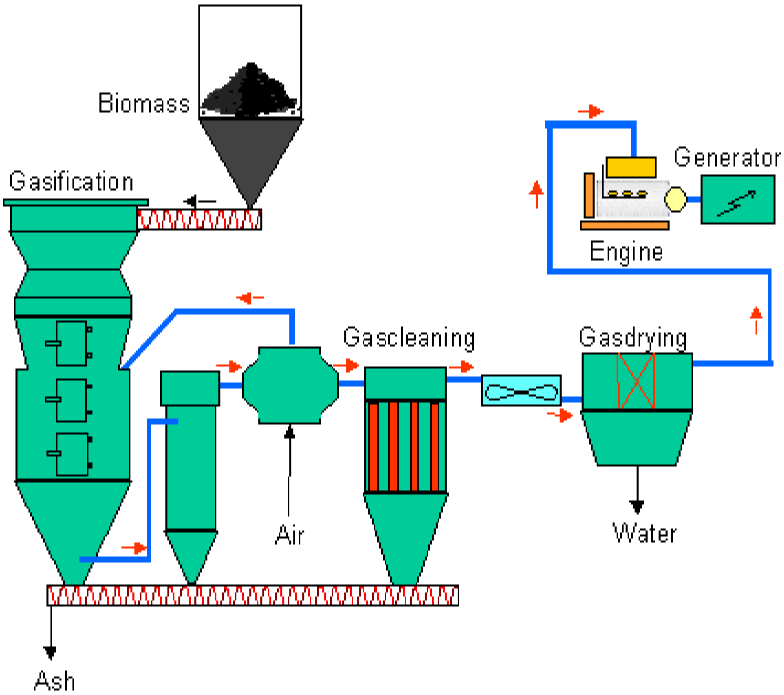
- There are no reference plants operating commercially.
- Pre-sorting and significant pre-treatment of the waste stream is required. The gasifier cannot accept any broken glass, and waste must be dried to a low moisture content of only a few percent, prior to gasification.

6.10 Gibros / Marick

Process Overview

The company is dedicated to the development and sale of commercially viable small scale gasification plant with CHP, ranging from 25 kW to 500 kW electricity.

Illustation from Marick website



Reference Plants

No significant references known.

Suitability for Jersey

Not suitable for Jersey because:

- There are no commercial plants in operation processing similar wastes;
- The process appears to be designed for biomass, rather than raw MSW;
- The proposed scale of the plants is too small to meet the required waste throughput at Jersey

6.11 IET / Entech

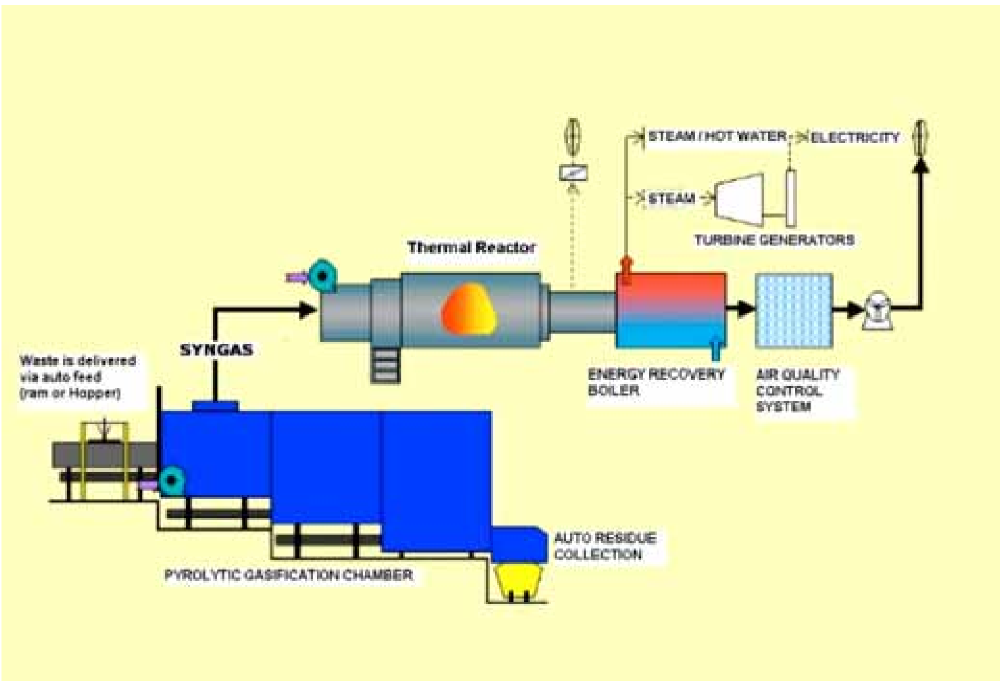
Process Overview

The Entech system is marketed by IET Energy in the UK. The process is as follows:

1) Continuous feeding of waste into stepped hearth;
2) Syngas combustion in a thermal reactor with flue gas recirculation (FGR) and SNCR for NO_x reduction;
3) Power generation using boiler and steam turbine. Estimated net electrical efficiency is about 20%;
4) Flue gas cleaning system consisting of bag filter with reagent injection for VOC control and packed tower for acid control. IET/Entech will offer to guarantee compliance with WID;
5) Recovery of ferrous and non-ferrous metals and glass from the gasifier residues.

Minimal or no waste pre-treatment is necessary but pre-treatment to recover recyclables is not precluded.

IET/Entech Process - illustration supplied by IET Energy



Reference Plants

Around 145 reference plants processing a variety of waste including 11 plants processing MSW with capacities up to 130 tonnes per day (c.40,000 tpa). Only one plant in Europe (Poland), with a capacity 5 tonnes of clinical waste per day, with steam vented to atmosphere, i.e. no energy recovery.

Suitability for Jersey

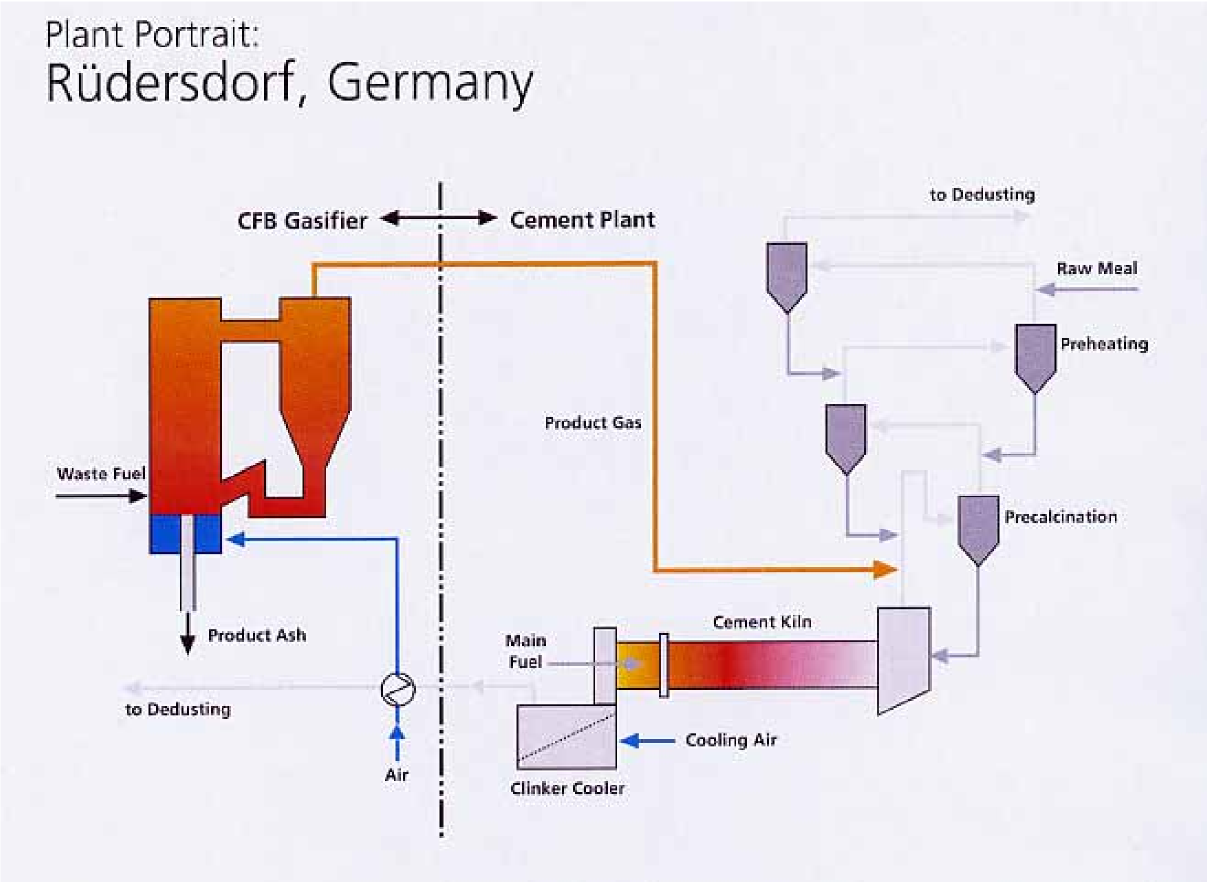
There are a number of plants in the Far East. However, the plants reviewed were of a smaller scale and the proposed feeding systems would not be suitable for the much larger tonnages in Jersey. It has not been possible to establish sufficient confidence in the applicability of this solution.

6.12 Lurgi

Process Overview

The process is based upon:

1) Gasification in circulating fluidised bed;
2) Ash discharge, cooling, and transportation to raw mill on cement manufacturing plant;
3) Syngas fired in calciner of cement plant.



Reference Plants

One reference plant at Rüdersdorf in Germany utilising various types of RDF for the production of syngas and char for use in a cement kiln. This plant is based on fluidised bed technology.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- Lurgi have now withdrawn from the waste gasification market;
- MSW would require pre-treatment to obtain a suitable RDF fuel for gasification, and disposal routes for the non-gasified waste would need to be found.

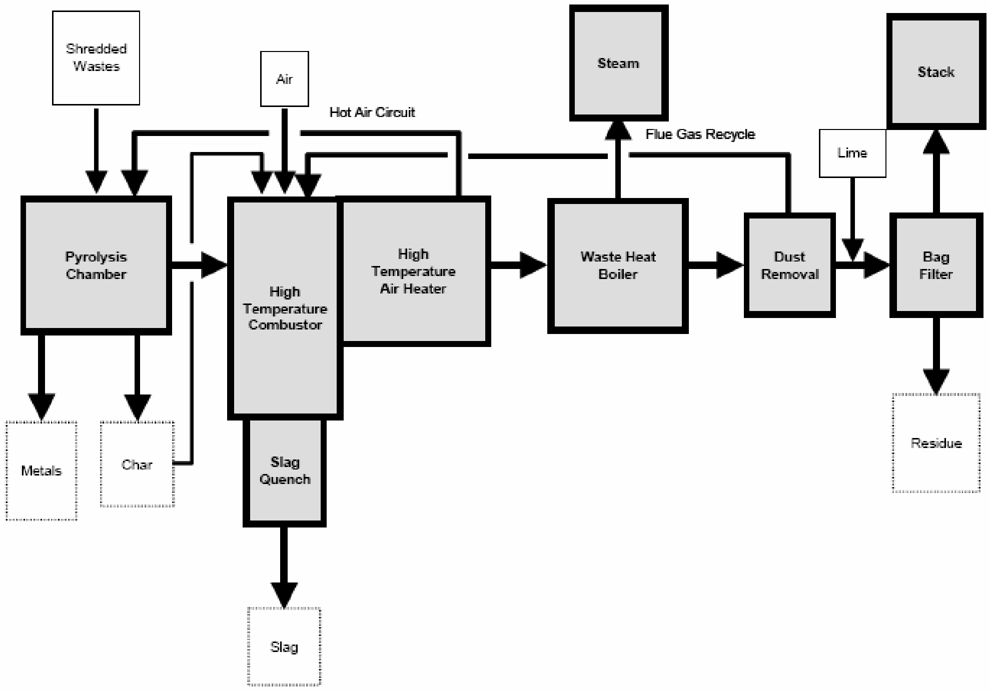
6.13 Mitsui Babcock

Process Overview

Mitsui-Babcock market the Mitsui Engineering and Shipbuilding Pyrolysis process which is based on the R21 process developed by Siemens (who have since withdrawn from the gasification market). The Mitsui-Babcock process is designed to process municipal household and commercial waste, and comprises:

1) Sorting, possibly manual, of bulky waste for recovery of large recyclables;
2) shredding of the residual MSW before delivery to the storage pit;
3) pre-sorting of MSW, if required, to remove glass and metals;
4) low temperature pyrolysis at below 450°C in rotary kiln that is indirectly heated by hot air;
5) metals recovery from char;
6) combustion of the syngas and char from the pyrolysis process at over 1300°C in an ash-melting furnace;
7) power generation via a steam cycle
8) collection of fly ash in a bag filter for recycling to the main combustion chamber;
9) collection of lime-based flue gas treatment residues to be sent to landfill.

Source: website



Reference Plants

There are six plants in Japan operating on MSW and commercial waste with capacities between approximately 40,000 and 120,000 tonnes per year. No plants are operating outside Japan.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- There are no operating European plants;
- The process has a low electrical efficiency of around 15%.
- Pre-treatment of waste streams will be required.

6.14 Nathaniel Energy

Process Overview

The process includes:

1) A fuel preparation system to produce fuel pellets from processed municipal waste;
2) A gasification stage where the waste is heated and gasified using controlled air flows;
3) A secondary combustion chamber where the gases are burnt;
4) A boiler to convert the heat in the flue gas to steam;
5) A flue gas cleaning system, using a wet scrubber (or potentially dry cleaning);
6) A steam turbine to generate electricity from the steam.

The plant is therefore quite similar in make-up to a conventional incineration plant.

Reference Plants

Gasifier unit (source Nathaniel Energy web-site)

Two small units, processing around 1.5 t/h of pellets produced from RDF, were commissioned in Cologna Veneta, Italy in early 2005.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- Limited reference plant and none at the capacity required for Jersey;
- The reference plant processes RDF. As this is then converted into pellets at the site, the process would not be suitable for raw MSW.

6.15 PKA / Toshiba

Process Overview

The process is based upon the following steps:

1) Separation of glass and metals and preparation of the incoming waste;

2) The remaining material then goes through a size reduction process. Drying to below 15% moisture is recommended, but not mandatory

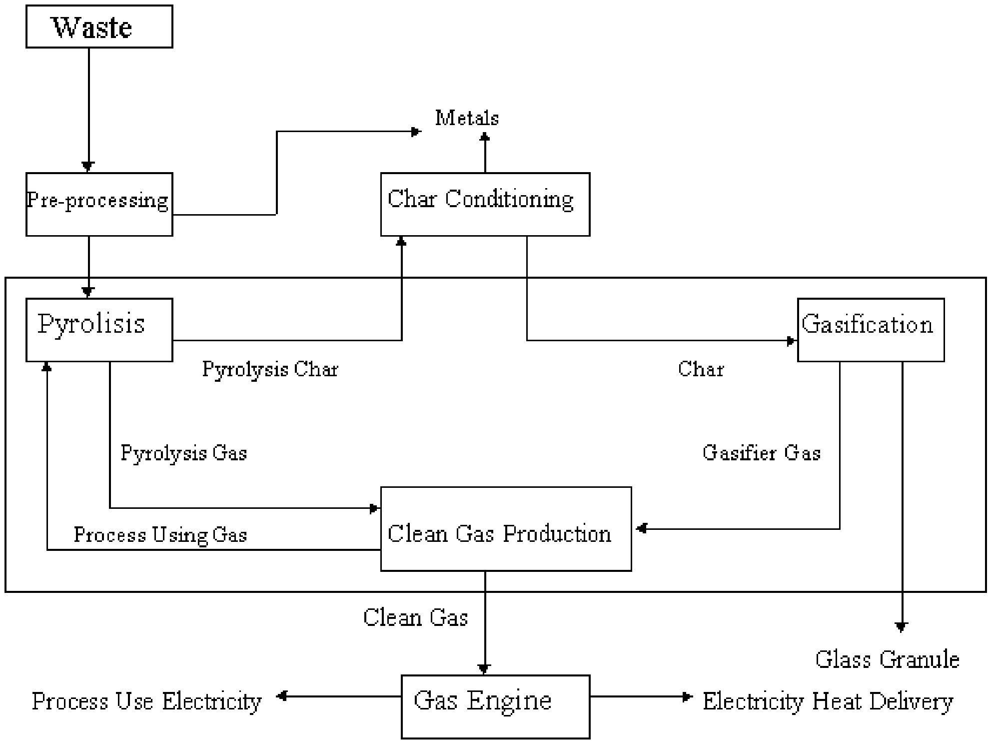
3) The prepared waste is fed to an externally-heated rotary kiln for pyrolysis / gasification at 500-600°C;

4) The product gases and vapours are transferred to a gasification chamber where they are cracked at around 1000°C into lighter components;

5) The gases are transferred to a gas cleaning system, which removes chlorides and sulphur, leaving a clean reusable gas.

6) The metal residue from the kiln can be reused. The pyrolytic char can be supplied to a secondary gasification device to produce additional syngas, which is mixed with the syngas from the pyrolysis process.

Diagram from Web



Reference Plants

A PKA facility in Aalen, Germany, has been operating on a blend of MSW, commercial waste, and sewage sludge since 2001. The plant has a capacity of around 25,000 tonnes per year.

PKA also has a plant processing approximately 30,000 tpa at Freiberg, Germany, where high aluminium content industrial waste is pyrolysed for recovery of the aluminium.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- There are limited reference plants and none at the capacity or processing the type of waste required for Jersey
- The process is a relatively complex plant with pre-treatment of waste, pyrolysis, gasification and power generation plant.

6.16 Thermoselect

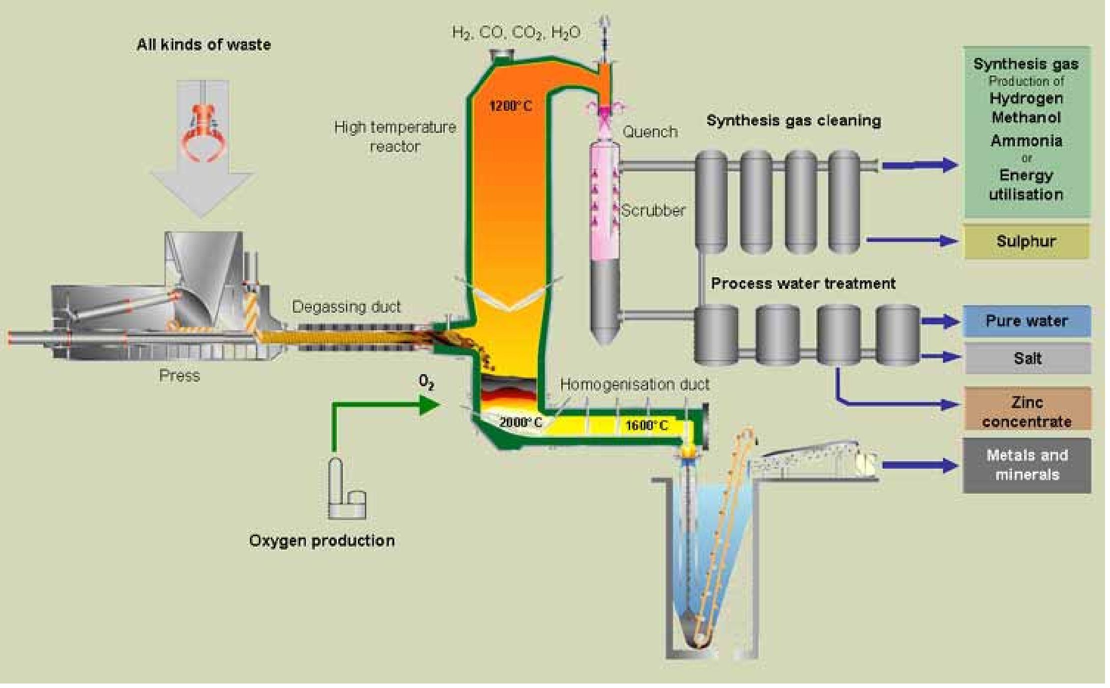
Process Overview

The process is based upon the following:

1) Pyrolysis in externally heated tubes with waste feeding by ramming;
2) High temperature (2,000°C) gasification using oxygen as the gasification medium;
3) Melting of ash into slag at high temperatures;
4) Solidification of metals and minerals by quenching with water;
5) Magnetic separation of metals from the mixed slag;
6) Syngas held at over 1,100°C for at least 2 seconds before quenching down to 90^{o}C;
7) Water condensed from syngas cooling is treated for re-use as cooling water;

If the syngas is used for electricity generation using a gas engine, the estimated net electrical efficiency of the plant is only about 13%.

Illustration from Thermoselect website



Reference Plants

There were three plants in commercial operation processing a range of domestic and industrial wastes:

- One plant (3 streams x 75,000 tpa) in Karlsrühe, Germany, operational since 1999.

- Two plants in Japan: one at Chiba in Greater Tokyo (2 x 50,000 tpa) operational since 1999; and a second c.40,000 tpa plant at Mutsui.

Thermoselect tried to market this process in the UK two years ago but it is considered as extremely complicated and no projects have been established. The Karlsruhe plant has had a series of problems and we understand it is no longer operating.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- The main European reference plant is closed.

- It is a very complex process including oxygen production, syngas cleaning and water treatment, likely to require significant additional staff.
- The stated electrical conversion efficiency of less than 14% is very low.
- Thermoselect is no longer actively marketing in the UK.

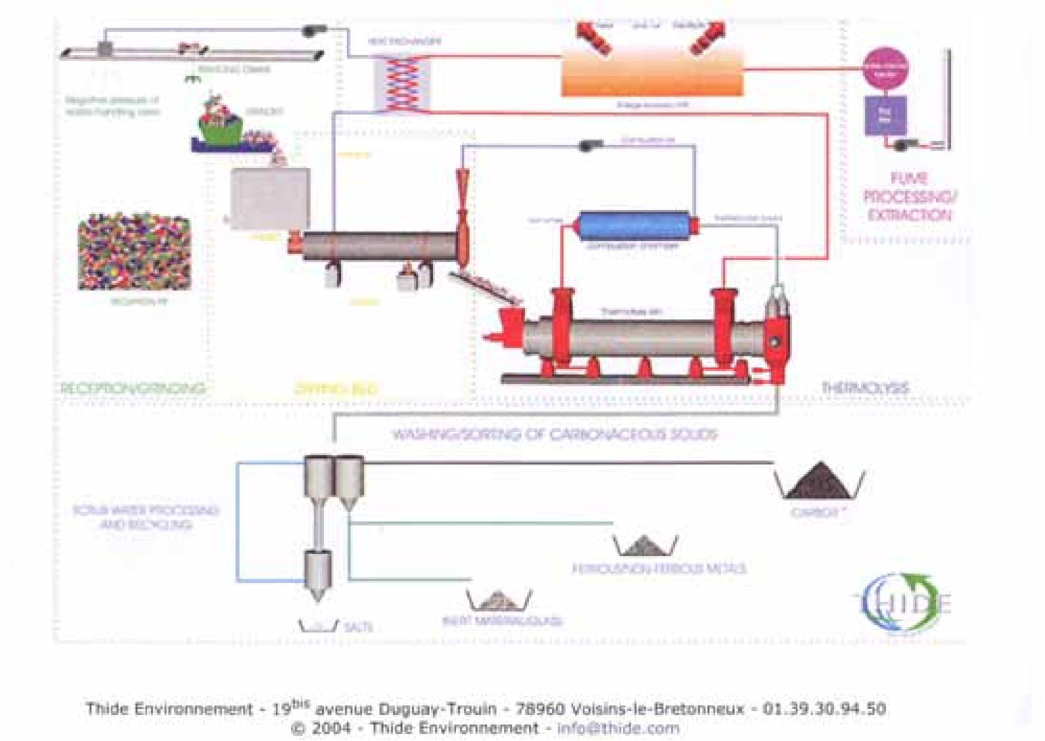
6.17 Thide

Process Overview

The process consists of the following steps:

1) Fuel preparation including grinding, screening and metals removal;
2) Drying of the waste to 10-15% moisture using a rotary hot air dryer, with hot gases supplied from the gasifier;
3) Gasification of the waste in a rotary tube, heated to 450-700°C using the combusted syngas from the gasification process;
4) Energy recovery from the hot flue gases for hot water, steam or electricity production;
5) Flue gas treatment with activated carbon injection, plus a bag filter;
6) Scrubbing, sorting and processing of the carbonaceous solids from the gasifier to separate coke/coal substitute (Carbor®), ferrous and non-ferrous metals, glass and inerts, and chloride salts.

Picture from www.thide.com:



Reference Plants

There are three operating reference plants:

- One plant in France operated by Thide Environment. Capacity of 50,000 tpa, processing household and small business waste, with steam exported to a local plant.
- Two plants in Japan at Izumo and Itoigawa built under licence by Hitachi:

Izumo: Capacity 70,000 tpa of household waste. Outputs are electricity and Carbor® vitrified on site.

Itoigawa: Capacity 25,000 tpa of household waste. Hot water output, with Carbor® used for combustion in a local cement plant.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- There are no clear disposal routes for all the by-products from the post-gasification processing, including salts, Carbor® (a coal/coke substitute), metals, glass and inerts, plus salts.
- The process is not sufficiently proven, and is only one European reference plant.
- There is a low electrical conversion efficiency as the process does not convert all the available heat in the waste.

6.18 TPS Termika

Process Overview

The process includes the following stages:

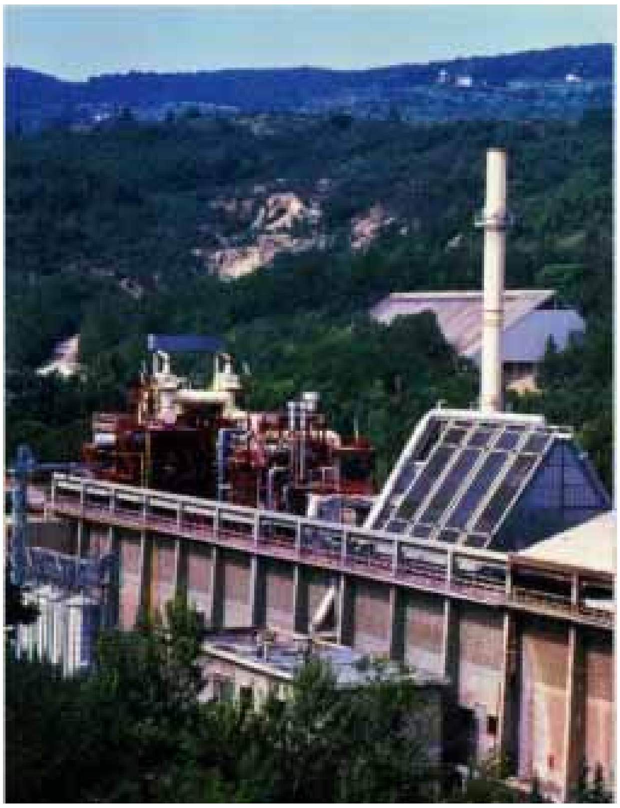
1) RDF reception, storage, and feeding;
2) Gasification using a circulating fluidised bed;
3) Syngas combustion;
4) Power generation via steam cycle;
5) Flue gas treatment.

Reference Plants

One reference plant processing RDF in Italy.

The Arbre project in the UK used biomass fuel as the feedstock and intended to generate power using a combined gas and steam turbine cycle. The project failed to get past the commissioning phase due to problems with cleaning of the syngas and has been abandoned.

Plant Greve-in -Chianti, Italy (from www.tps.se)



Suitability for Jersey

The technology is not considered suitable for Jersey because:

- There are no reference plants processing MSW.
- The Arbre project in the UK was unsuccessful and raises questions over the capability of the company and the technology. Some of the lessons learned from the Arbre project are also relevant to other similar processes where production of sticky tars can lead to rapid fouling of surfaces.

6.19 Wastegen / Techtrade

Process Overview

The process steps are as follows:

1) Pyrolysis in rotary kiln with lime addition;
2) Syngas combustion;
3) Generation of electricity via steam cycle.;
4) SNCR for NO_x control;
5) Flue gas cleaning by fabric filter with sodium bicarbonate and activated carbon injection.

The estimated net electrical efficiency is about 20%.

Picture of Pyrolysis rotary kiln (from www.wastegen.com)

Reference Plants

The Techtrade technology is marketed in the UK by Wastegen. One reference plant in Burgau, Germany, has been in operation since 1984 based on a standalone configuration, with a capacity of 35,000 tpa using two rotary kilns, with electricity production (2.2 MW_e max). The residues contain 26% carbon. A carbon recovery unit (probably based on a rotary kiln or fluidised bed technology) is being considered for future standalone configurations;

There is a more recent reference plant at Hamm-Uentrop, Germany, which is based on firing of the syngas and char produced in the pyrolyser in a conventional coal fired power station. Whilst this is an interesting concept, Jersey has no equivalent power station.

Suitability for Jersey

The technology is not considered suitable for Jersey because of the following:

- There are limited reference plants – the configuration of the Hamm plant, providing gas for a power plant, would not be suitable for Jersey, because there is no equivalent power station operating in Jersey;
- The electrical conversion efficiency is low;
- The pyrolyser residue contains large amounts of unburnt material making it unsuitable as secondary aggregate. This would require further treatment.

6.20 Wellman Process Engineering

Process Overview

Wellman is a supplier of low pressure, updraft, fixed bed gasifiers for coal and wood feedstocks, and has designed and built an ‘Integrated Fast Pyrolysis Plant’ to produce 223 kg/hr of pyrolysis liquid from biomass feedstock.

Integrated Fast Pyrolysis Plant from www. wellman-process.co.uk

Reference Plants

None for residual MSW.

Suitability for Jersey

The technology is not considered suitable for Jersey because there are no reference plants processing residual MSW.

7 STEAM AUTOCLAVES

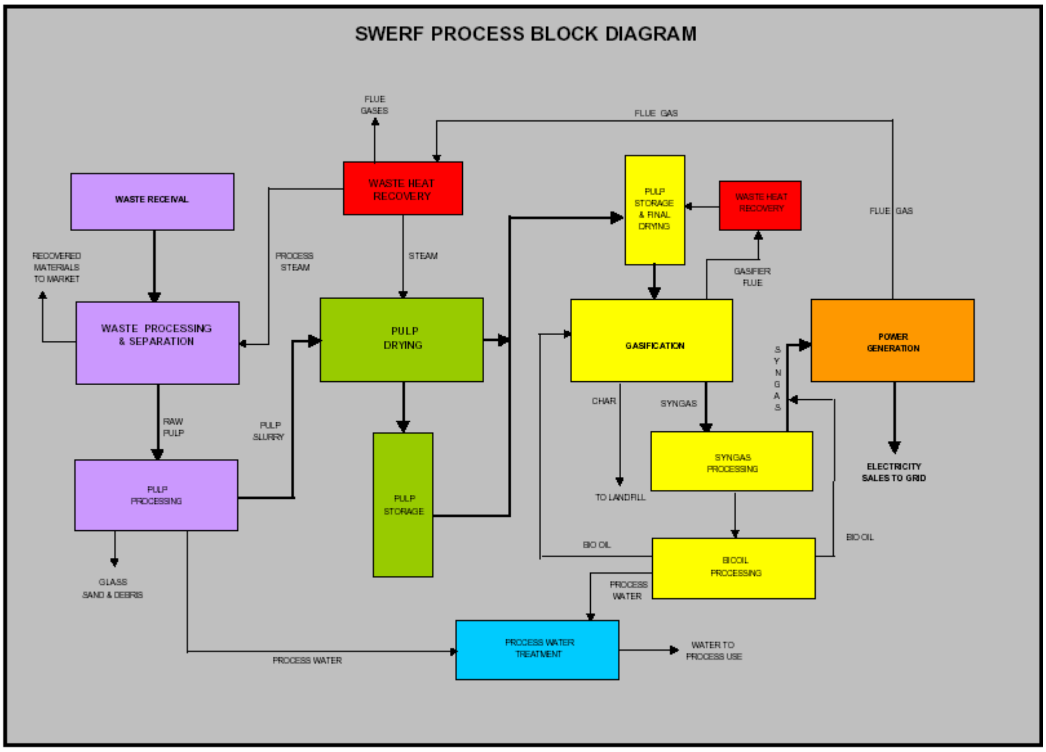
7.1 Brightstar Environmental - SWERF process

Process Overview

The process includes the following stages:

1) Waste sterilisation in rotating steam autoclave at temperatures between 130°C to 150°C;
2) Recovery of recyclables from cooked waste in materials separation plant;
3) Drying of residual waste using steam;
4) Fuel storage;
5) Pyrolysis in series of externally heated pipe coils to produce syngas and liquid fuel;
6) Syngas cooling and cleaning;
7) Power generation using gas engines;
8) Char (containing 35% to 40% carbon) is intended to be landfilled;
9) Liquid fuel used for steam production and heating of pyrolyser.

SWERF Process (diagram from Brightstar)



Reference Plants

There is a single demonstration plant commissioned in 2001 in Australia but still operating intermittently with a capacity of 25,000 tpa compared to the design capacity of 100,000 tpa.

Gas engines are employed for power generation. but exhaust gases do not meet Waste Incineration Directive (WID) limits. WID does not apply in Australia;

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- There are no suitable European reference plants

- Despite significant marketing in the UK, Brightstar has not been able to develop any projects since its backers stated that they would not provide further development money to ensure that the Australian demonstration plant operated satisfactorily.

7.2 Estech Europe

Process Overview

The Fibrecycle™ process: incorporates the following

1) Untreated waste is fed into the autoclave where it is sterilised with high temperature steam, and broken down into organic and inorganic fractions;
2) Primary screening of processed waste is carried out to separate the fine fraction which includes organic material, plus denser elements such as grit, glass, and small metal objects. The fine fraction is then passed to an air classifier which separates the organic fraction from the denser elements.
3) Ferrous and non-ferrous metals are separated from the oversize fraction using over-band magnets and eddy current separator, the metals being baled for sale and re-use. The remaining residues are mainly plastics which are conveyed to the plastics recovery station for final separation, baling and onward shipment.
4) Rejected material from the fines and from the oversize have no value and are normally landfilled.

The process is therefore a pre-treatment process, and each of the output streams requires either recycling markets or further treatment. As water is added to the process, the total tonnage removed from the system is greater than the incoming waste. The biggest output fraction is the fine organic fraction for which several uses have been proposed:

- After drying, as a fuel;
- After composting, as a “compost”, although because it has been derived from mixed waste this will not achieve compost standards. The material may be suitable for use on landfills or for restoration of contaminated sites.
- For use in fibreboards or other construction materials.

Steam Autoclave (pictures from www.estecheurope.com)

Materials Separation equipment

Reference Plants

A 25,000 tpa pilot plant operated for three years at Bridgend in South Wales and is now being relocated. Estech Europe also have a one twentieth scale Mobile Demonstration Plant.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- Further processing or disposal routes is required for the recycled materials, i.e. organic fraction (e.g. to a composting plant to produce material for restoration of landfill sites), ferrous and non-ferrous metals, plastics, inert material, and residual fraction streams. The process does not deal with the waste, it simply splits it into various streams.
- There are no plants currently operating.

7.3 Fernwood

Process Overview

The process stages are:

1) Removal of oversize objects from incoming MSW;
2) Thermal treatment of the waste with steam in an autoclave for a period of around one hour to transform pulp and paper materials to cellulose-based product, reducing the volume of pulp, paper and plastics, and sterilising the MSW
3) Removal and treatment of gaseous products;
4) Screening of the treated waste in a rotary trammel to separate the cellulose-based fraction, from which contaminants (e.g. glass, plastics, metals) are removed by a “stoner” or air classifier.
5) Further separation of the metals, plastics and inerts using appropriate equipment;
6) Sorting of non-screened waste to remove recyclables.

Photographs of autoclaves from www.fernwood.co.uk

Reference Plants

There is a demonstration plant at Alabama University. It is understood that a commercial installation in Anaheim, California (with a capacity of up to 160,000 tpa of MSW) is currently under construction.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- There are no commercially operating reference plants;
- Disposal routes or further processing are required for the cellulose fraction and all other separated fractions

7.4 Thermsave / RCR

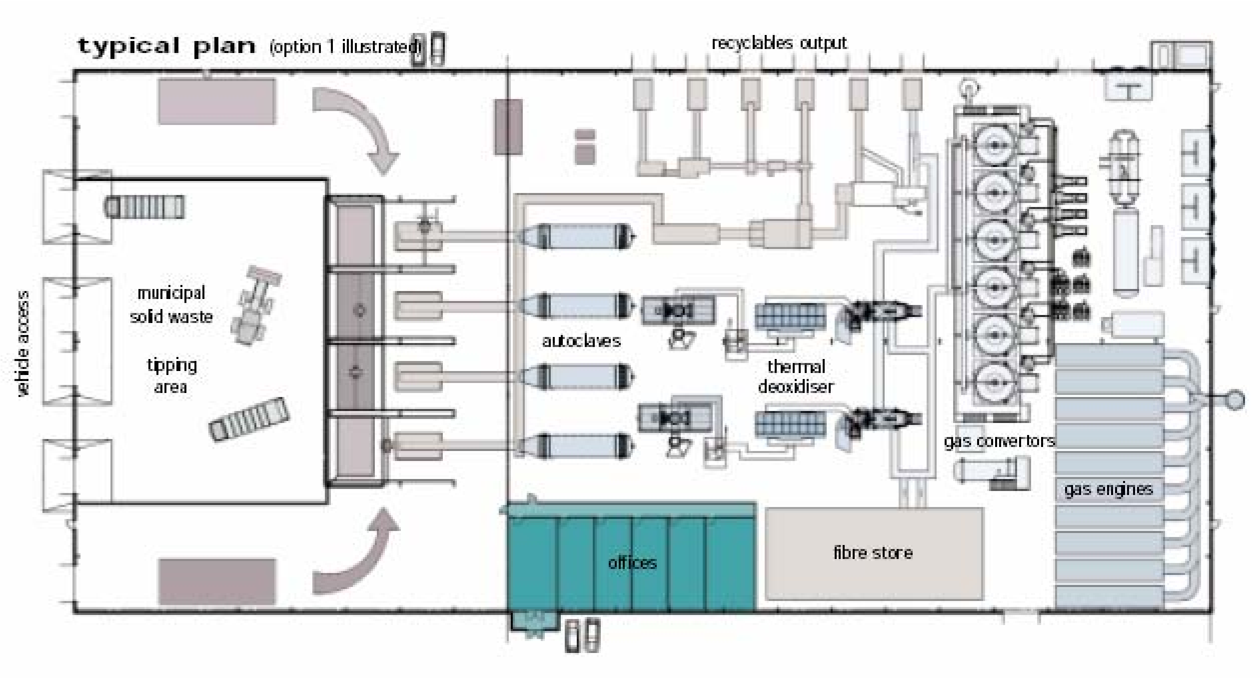
Process Overview

Incoming waste is treated with dry saturated steam at 160°C in a rotating autoclave to sanitise it, reduce the biomass content to its fibrous form, de-lacquer and de-label all containers. The processed material is then screened and separated in density separators to produce several output streams, consisting of organic material (fibre), ferrous and non-ferrous metals, plastics and rejects. The fibre is a relatively homogenous feedstock which it is proposed can be used as:

- Gasification feedstock;
- Refuse derived fuel for use in conventional boilers;
- Feedstock for anaerobic digestion to produce compost and methane;
- Substitute wood- product when combined with plastics;
- Further composting prior to use as landfill restoration material.

As with other steam autoclave processes, this is a pre-treatment process which produces a greater mass output than the amount of incoming waste. Each of the separated output streams must find recycling routes, or be further treated prior to disposal.

Illustration from RCR Website, showing typical plant layout.



Reference Plants

No operating commercial reference plants have been identified. Thermsave has used the Bridgend plant as a reference (see above on Estech), but this plant no longer operates. It is believed that Thermsave has recently been appointed, as technology supplier to the main contractor Sembcorp Simon-Carves, who are the preferred bidder for the Glasgow waste disposal plant. The organic material produced by the process will be further composted for use as landfill restoration material. This plant is not yet under construction and it is also possible that the autoclaves will not be supplied by RCR/Thermsave.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- There are no suitable reference plants;
- The system is only a partial solution, requiring additional processing (including either gasification, combustion or anaerobic digestion) in order to fully treat Jersey's waste.

8 ANAEROBIC DIGESTION

8.1 BTA

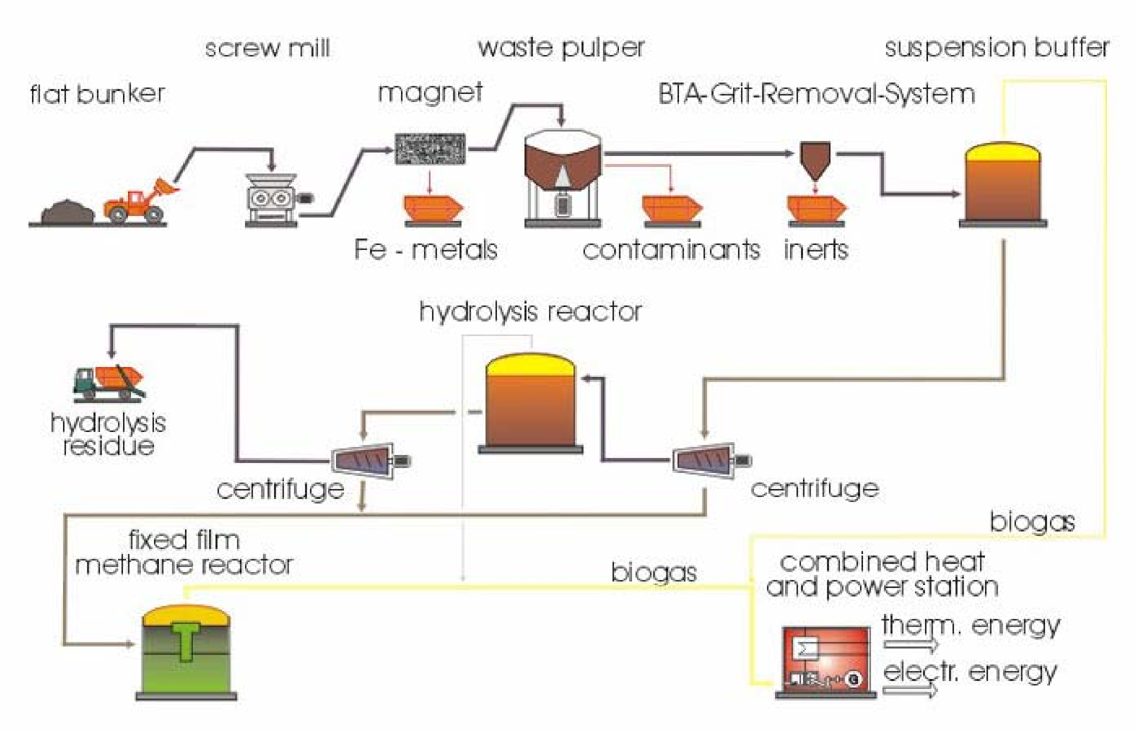
Process Overview

The process includes the following steps:

1) Organic waste is crushed in a screw mill, and ferrous metal contaminants are removed by overhead magnet.
2) Material is mixed with recycled process water to produce a pulp from which grit and contaminants are separated.
3) Pulp is separated into a solid and liquid phases using a dewatering aggregate: The liquid is pumped to a reactor for a methanisation period of 2 days; the dewatered solid material is mixed again with water before being fed to a hydrolysis reactor for 4 days before being dewatered again with the liquid fed into the methane reactor.
4) Methane gas can be combusted to produce heat and electrical energy.
5) Solid waste can be composted using an aerobic treatment of 1-3 weeks.

For the treatment of food waste an additional sanitisation step is required.

Process Diagram from BTA website



Reference Plants

There are over 20 operating plants using BTA equipment or components, including Ypres, Belgium (50,000 tpa biowaste); Villacidro, Italy (45,000 tpa mixed waste including sewage sludge); and Mülheim, Germany (22,000 tpa biowaste and commercial waste).

Suitability for Jersey

The technology is not considered suitable for Jersey because it is only suitable for processing the organic fraction of municipal waste, and would therefore require upstream mechanical separation plant. Non-organic waste would require another disposal route.

8.2 Greenfinch

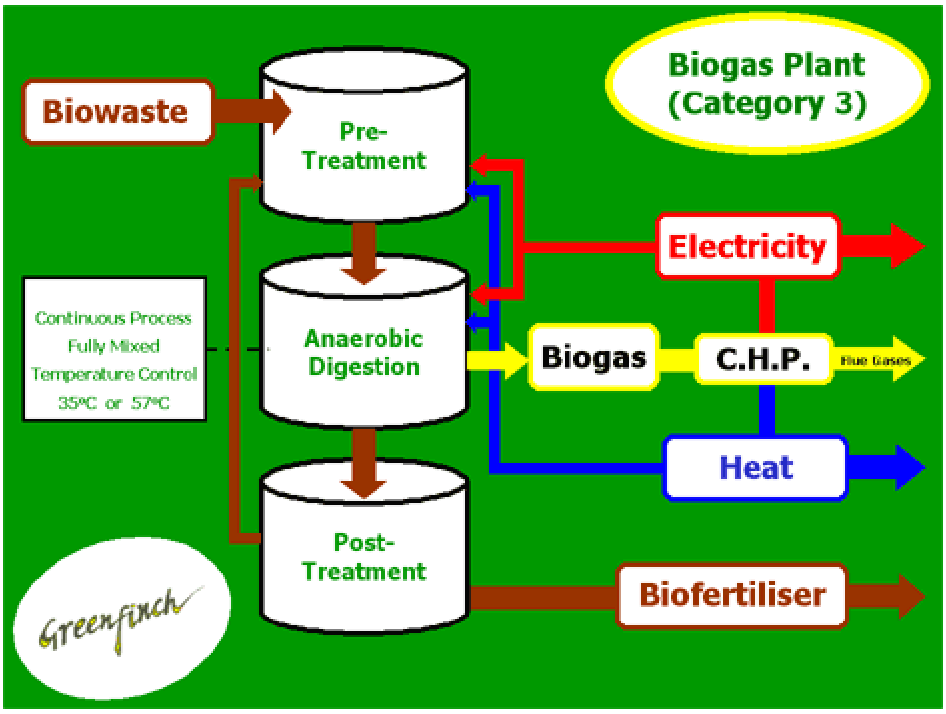
Process Overview

The process stages are as follows:

1) Pre-treatment of kitchen and garden waste, including homogenisation, particle size reduction to less than 12 mm, and pasteurisation at 70 °C for a period of one hour.
2) Anaerobic digestion of the treated waste carried out in the absence of air and at a temperature either in the mesophilic range (35 °C) or in the thermophilic range (55 °C), producing biogas.
3) Storage of liquid digestate before its application to farmland. A more sophisticated digestate treatment involves flocculation and pressing to produce a solid digestate.
4) Combustion of the biogas (which consists of 60% CH_4 and 40% CO_2 with traces of H_2S) for the production of heat and electricity.

Material containing meat contaminated food waste will require a further processing stage prior to application to land.

Diagram from Greenfinch website (www.greenfinch.co.uk)



Reference Plants

A plant is under construction for South Shropshire County Council, which will process 5,000 tpa of source-separated kitchen and garden waste.

Suitability for Jersey

The technology is not considered suitable for Jersey because it is only suitable for processing the organic fraction of municipal waste, and would therefore require upstream mechanical separation plant, or household source separation, plus a composting plant. Additional plant will be required to deal with the non-organic waste..

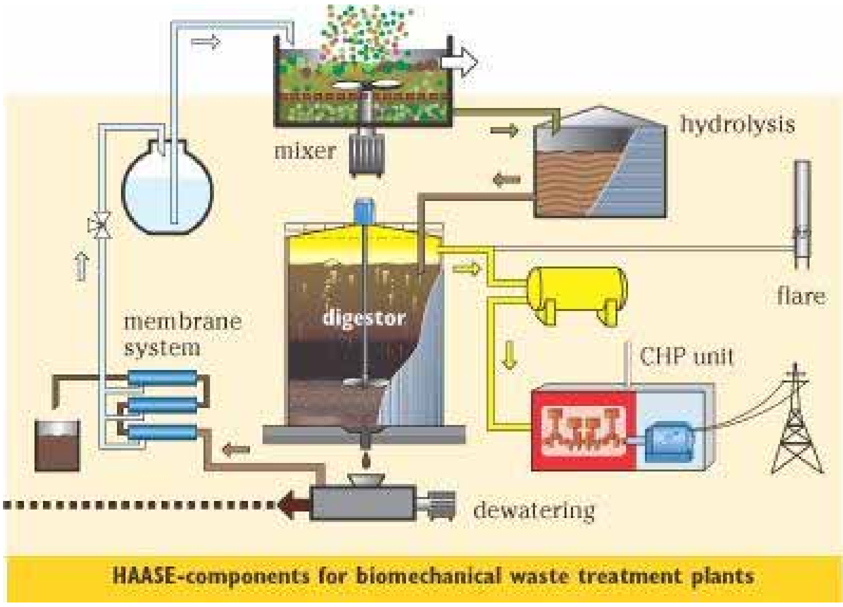
8.3 Haase

Process Overview

The process stages are as follows:

1) Screened / pre-treated waste mixed with water to remove floating and suspended matter;
2) Two-stage wet anaerobic digestion over a period of 10 to 21 days.
3) Biogas production for heat / electricity in a gas engine;
4) Dewatered digestate sent to landfill, or further composted for use.

Illustation from Haase website.



References

There are several operating references for AD plant including Groeden, Germany (110,000 tpa manure and biowaste); Schwanebeck, Germany (49,000 tpa biowaste and manure). Plants at Léon, Spain, Lübeck, Germany and Lauchhammer, Germany are being commissioned in 2005 processing mixed and residual MSW.

Suitability for Jersey

The technology is not considered suitable for Jersey because it is only suitable for processing the organic fraction of municipal waste, and would therefore require upstream mechanical separation plant, or household source separation, plus a composting plant. Non-organic waste would need a separate treatment facility.

8.4 Hese-Valorga

Process Overview

The main process steps are:

1) The dilution and mixing of pre-treated organic waste in the form of a thick sludge, with a high dry matter content (20% to 35% depending on the type of waste), giving a reduction in the volumes of fermentation. Heating is provided by steam injection. The mixture is introduced at the bottom of the reactor with a piston pump

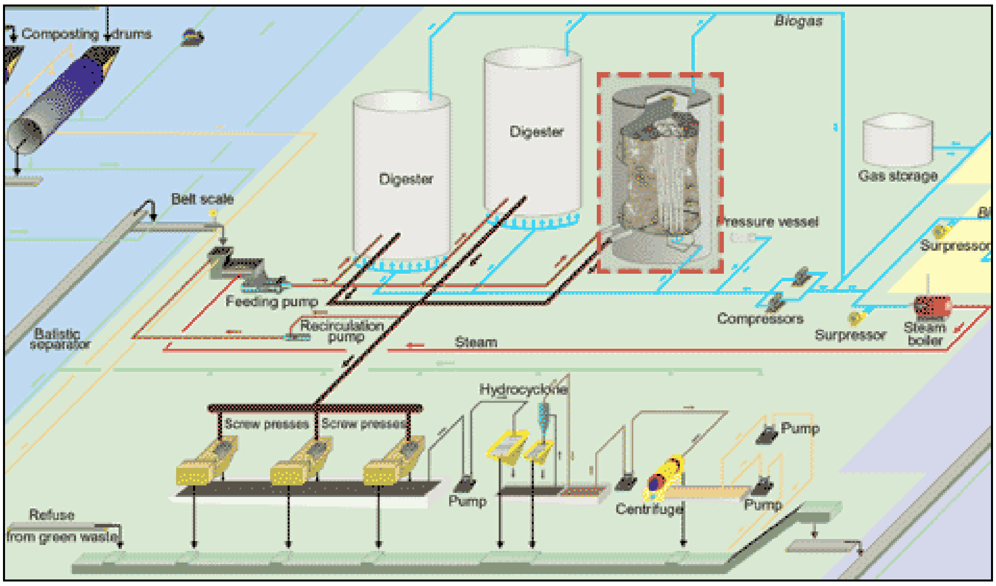
2) Digestion in fermenters under anaerobic conditions, with temperature control in the mesophilic range (~ 40°C) or thermophilic range (~ 55°C) for around 3 weeks, utilising pneumatic mixing by injecting biogas into the reactor under pressure.

3) Gravity extraction and the pressing of the digested matter: the digested product taken out of the digester then undergoes a mechanical pressing process, resulting in a solid fraction and a liquid sludge

4) Sludge treatment in order to separate the suspended solids. A part of the clarified process water is used for dilution of the incoming waste. The remaining part is either discharged into the sewage network or transferred to the excess water treatment unit.

5) The solid fractions are transferred to the aerobic post-treatment unit.

Diagram from Valorga website (www.valorgainternational.fr)



Reference Plants

Valorga anaerobic digestion plants are used at five operating European references including Amiens, France (85,000 tpa mixed household waste), Freiburg (36,000 tpa source-separated kitchen and garden waste (SSKGW) with c. 1 MW electricity production), Engelkirchen (35,000 tpa SSKGW, c. 1 MW electricity production).

Suitability for Jersey

The technology is not considered suitable for Jersey because it is only suitable for processing the organic fraction of municipal waste, and would therefore require upstream mechanical separation plant, or household source separation for garden and kitchen waste. It also requires a composting facility and electrical generating sets for burning biogas. Non-organic waste will require a separate disposal facility.

8.5 Iska

Process Overview

The process stages are as follows:

1) Mechanical processing of residual MSW including i) removal of oversize objects; ii) screening to separate organic-rich matter from a high calorific value (CV) fraction; iii) ferrous metals removal;
2) The organic fraction is directed for biological treatment with the high CV fraction for disposal to landfill or processed and utilised as refuse-derived fuel (RDF);
3) Biological treatment of the organic matter comprises aerobic hydrolysis at 40 to 45°C; separation of the solid phase for dewatering, and anaerobic digestion of the organic-rich liquid;
4) Composting of the solid material from the dewatering process;
5) Utilisation of the biogas produced by the anaerobic digestion process for heat or electricity production.

Model of the Buchen plant (165,000 tpa municipal waste, operational from 2005)

References

A pilot plant started in 2000 at Buchen, Germany with a capacity of around 30,000 tpa and closed in 2003 after the demonstration period. A new 165,000 tpa plant is now constructed at the site which has been treating MSW since June 2005. Other plants at Heilbronn (80,000 tpa, operational 2005) and Sydney, Australia (175,000 tpa of MSW, operational late 2004).

Suitability for Jersey

The technology is not considered suitable for Jersey because it is only suitable for processing the organic fraction of municipal waste, and would therefore require upstream mechanical separation plant, or household source separation, plus a composting plant. Non-organic waste will require a separate disposal facility.

8.6 Linde

Process Overview

The process contains the following steps:

1) Wet preparation of biowaste and pre-treated MSW using pulper and drum screen;
2) Single-stage or two-stage wet digestion processes run in thermophilic or mesophilic depending on the type of input material.
3) The generated biogas can be cleaned to remove H_2S, and then used for heat / electricity production in a gas engine;
4) Digestion residues from wet digestion plants can be used for the production of compost, or sent to landfill.

Mechanical-bilogical waste treatment plant for MSW and separately collected municipal biowaste (from Linde website)

References

Wet AD facilities have been supplied as part of complete facilities processing MSW, for example Ecoparc 1 in Barcelona (150,000 tpa digestion plant capacity from total facility capacity of 300,000 tpa MSW); Madrid (73,000 tpa of total 140,000 tpa MSW), Burgos (40,000 tpa of total 80,000 tpa segregated MSW), and Salto del Negro (75,000 tpa of total 200,000 tpa MSW).

Wet AD equipment has not yet been supplied for a turnkey plant.

Suitability for Jersey

The technology is not considered suitable for Jersey because it is only suitable for processing the organic fraction of municipal waste, and would therefore require upstream mechanical separation plant, or household source separation, plus a composting plant. A separate disposal facility will be required for the non-organic waste fraction.

9 MECHANICAL BIOLOGICAL TREATMENT

9.1 ADAS

Process Overview

ADAS is a former government advisory service for agriculture and horticulture. ADAS operate the largest composting facility in the UK at St Ives, Cambridgeshire, a 17 hectare site, licensed to handle up to 105,000 tpa of organic waste.

In addition to the commercial work, the centre has an area where many Government and commercially funded research projects are run. The ADAS team of specialists based at St Ives is available to provide consultancy to clients on a range of composting and waste management solutions, from planning and licensing for new and existing sites to legislative compliance, waste selection, financial evaluation and technological advice.

ADAS has been awarded a grant under the UK New Technologies programme to develop a process to treat residual waste. It should be noted that to qualify for this grant, the facility cannot be "commercial".

The process comprises Mechanical Biological Treatment followed by in-vessel composting.

References

An MBT plant is under development in Cambridge under the UK New Technologies programme.

Suitability for Jersey

The process is not suitable for Jersey because:

- The MBT process is a pre-treatment process, designed to treat the residual waste and turn it into several output streams, such as refuse derived fuel, organic material for composting, rejects and metals, stone and glass for potential recycling. If adopted for Jersey, additional facilities would be needed for each of these streams.
- There are no operating reference plants.

9.2 Advanced Recycling Technologies (ART)

Process Overview

ART has proposed a facility to sort and separate residual municipal waste into various streams. The steps proposed are:

1) Residual waste is received at the plant;
2) Metals are extracted using magnets and eddy current separators;
3) A dense RDF fraction is separated, consisting mainly of paper and plastics, by screening and density separation;
4) Organic material is separated and can be treated by composting if required;
5) Glass is separated and ground to produce a shard-free material for use as aggregate;
6) A small amount of the waste stream will be rejected, with disposal to landfill.

References

ART have designed facilities for the fuel preparation plant at Slough Heat and Power, and to feed RDF to Ketton cement kiln. The main reference is Slough Heat and Power. However, this facility does not receive residual municipal waste. The facility processes RDF received from municipal, commercial and industrial sources, together with rejects from recycling facilities. The fuel plant, which is the part of the plant which was designed by ART, supplies an energy from waste plant. The energy from waste plant was designed and built by Agra Birwelco, with the boiler supplied by Babcock Wilcox Vølund (see Section 4.6).

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- Any MBT process is a pre-treatment process, designed to treat the residual waste and turn it into several output streams, such as refuse derived fuel, organic material for composting, rejects and metals, stone and glass for potential recycling. If adopted for Jersey, additional facilities would be needed for each of these streams.
- ART references are for only a small part of the process, to produce fuels for further use, and these do not provide a total solution for Jersey.
- Whilst the ART proposal does include additional facilities such as an energy from waste plant, ART has provided no references of such facilities which they have supplied (Slough Heat and Power's energy from waste plant was supplied by Agra Birwelco).

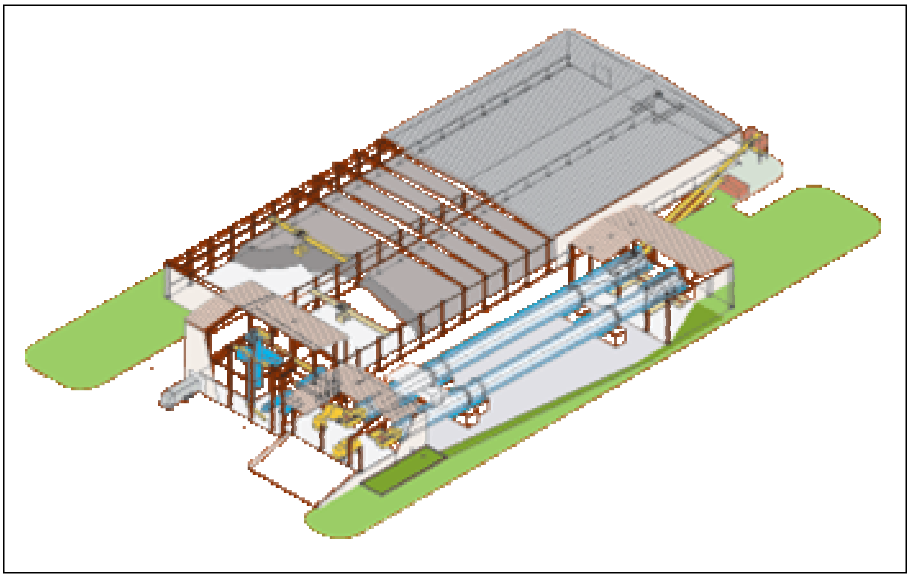
9.3 Bedminster

Process Overview

The Bedminster process consists of the following stages:

1) Removal of large items and shredding of wood, as necessary, from the incoming MSW;
2) Aerobic digestion of treated waste with sewage sludge (which is required to accelerate the bio-degradation processes) in a rotary drum for a period of three days;
3) Mechanical treatment to remove ferrous and non-ferrous metals, and screening to remove the coarse fraction (>25mm), primarily consisting of plastics;
4) Compost maturation of the fine fraction (<25mm) for 3-6 weeks in windrows located within an enclosed building;
5) Further screening to separate particles <10mm which are used as the compost product. The oversize fraction is sent to landfill.

Illustration from Bedminster website



References

There are eleven commercial facilities in USA, Canada, Australia and Japan, all co-composting treated MSW with sewage sludge. Capacities range from 25,000 tpa up to 250,000 tpa of MSW at the Edmonton plant, Canada. There is one demonstration plant in Saitama, Japan processing only MSW to produce a solid fuel. Following combustion of the RDF, the ash is used in cement production.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- The MBT process is a pre-treatment stage, designed to process the residual waste and turn it into several output streams, such as refuse derived fuel, organic material for composting, rejects and metals, stone and glass for potential recycling. If adopted for Jersey, additional facilities would be needed for each of these streams.
- There are no operating facilities in Europe, although significant facilities do exist elsewhere, so this is not considered to be a major issue.

9.4 Eden

Process Overview

Eden proposed the following process:

1) Raw MSW is shredded;
2) The shredded material is fed to an aerobic digestion plant using a composting tower
3) The treated waste is then mechanically separated into metal, plastics and other material;
4) The residual material is then treated in a pyrolysis/gasification plant.

References

Eden gave the CPS Civic plant at Thornley as their reference. However, this plant only pre-treats the waste and does not have a pyrolysis/gasification unit.

Suitability for Jersey

The technology is not considered suitable for Jersey because there are no operating reference plants for the complete process described by Eden. Eden were unable to provide any details of the proposed pyrolysis/gasification system. The reference quoted by Eden would simply pre-treat the waste, leaving similar quantities of output material requiring further treatment.

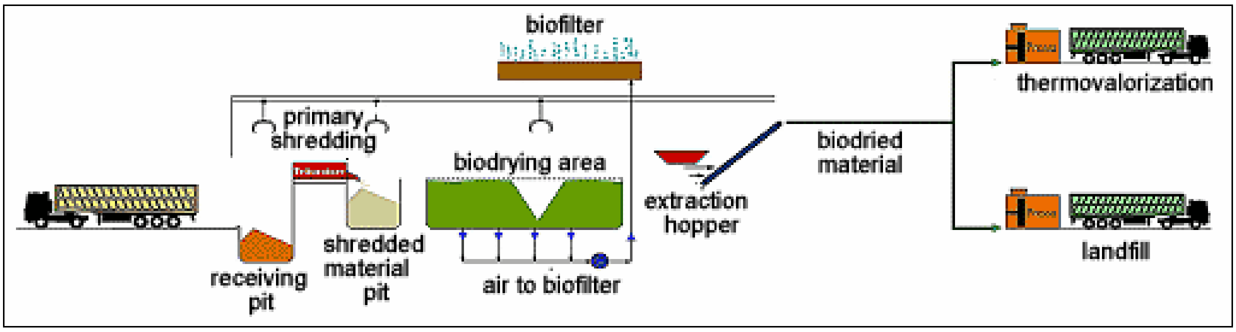
9.5 Ecodeco

Process Overview

The Ecodeco process can be described as follows:

1) MSW is unloaded into a reception pit from where it is transferred to a shredder to reduce the size to 20-30cm;
2) The waste is transferred to a bio-drying area, where it undergoes aerobic fermentation in windrows for a period of 12-15 days at temperatures of 50-60°C, resulting in a reduction in mass of around 25%.
3) The material is transported to the recycling and recovery process area where sieving, metals extraction and weight separation equipment is used to separate the waste into five fractions: Secondary fuel for combustion plant or landfill; ferrous metals; non-ferrous metals; glass and stone; compostible material.

Process diagram from Ecodeco website



References

This MBT concept was developed by Sistema Ecodeco in Italy, and is marketed by Shanks in the UK. There are seven reference plants in Italy including Cortelolona (120,000 tpa MSW) and Biella (120,000 tpa MSW) which have operated for several years. , In the UK two plants, each of capacity 180,000 tpa, are under construction in London and a further plant is being built for Dumfries & Galloway Council (60,000 tpa MSW) which will be operational in 2006.

Suitability for Jersey

The technology is not considered suitable for Jersey because the MBT process is a pre-treatment, designed to process the residual waste and turn it into several output streams, such as refuse derived fuel, organic material for composting, rejects and metals, stone and glass for potential recycling. If adopted for Jersey, additional facilities would be needed for each of these streams.

9.6 Fairport

Process Overview

According to Fairport, the process involves the following:

1) The waste is dried to enable it to be more efficiently separated and hence produce several recyclate streams;
2) The final stage of the separation uses the "Fairport separator". This high efficiency device results in several separation stages on the basis of size and density.
3) Fairport then blend these fractions together with other materials to produce a fuel meeting a pre-defined specification.
4) The energy for the drying stage is from a gas burner. This ensures that the more valuable renewable energy in the feed is not lost from the products.

References

A pilot plant has been built and tested in Lancashire. Fairport is one of the suppliers selected for consideration for grant support under the UK New Technologies programme, although currently their project has yet to start construction.

Suitability for Jersey

The technology is not considered suitable for Jersey because the MBT process is a pre-treatment, designed to process the residual waste and turn it into several output streams, such as refuse derived fuel, organic material for composting, rejects and metals, stone and glass for potential recycling. If adopted for Jersey, additional facilities would be needed for each of these streams.

In addition, there are no commercially operating facilities.

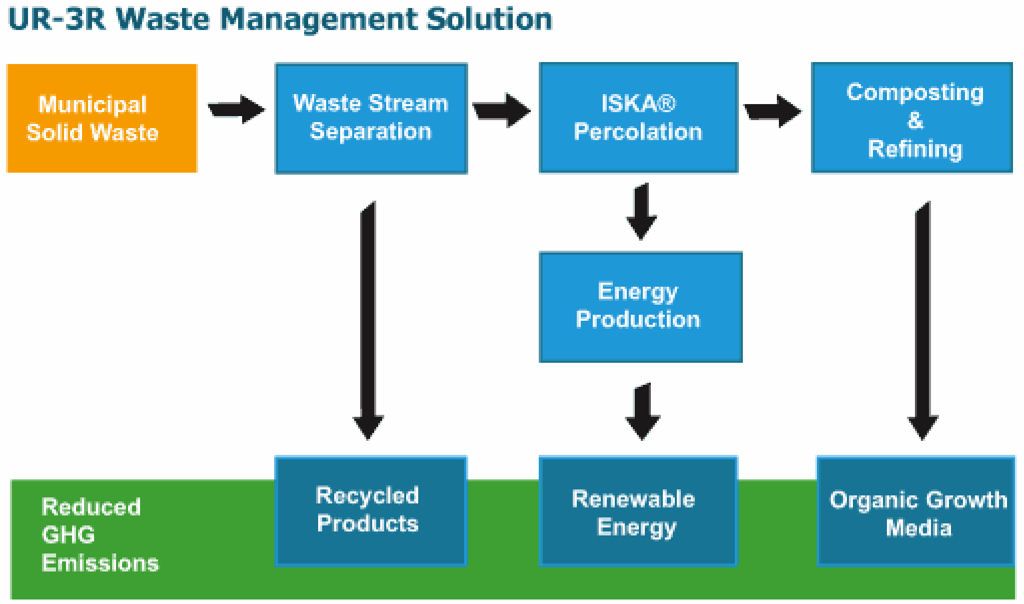
9.7 Global Renewables

Process Overview

According to Global Renewables, the UR-3R (Urban Resource - Reduction, Recovery and Recycling) process comprises:

1) Mechanical pre-treatment of MSW (developed by GRD Miniproc) involving rejection of large items, screening in trommels, hand-picking lines, shredding, and metals separation. Resultant fractions are paper, glass, organics, metals, plastic, other materials.
2) Percolation, involving washing with water under aerobic conditions at a temperature of around 37°C for a period of 2-7 days to remove organic materials in a liquid phase;
3) Anaerobic digestion of the organic-rich liquid using the ISKA process (see 8.5) with the biogas being cleaned before combustion in a gas engine for the production of heat and electricity;
4) De-watering of the solids from the percolation process for composting in an enclosed hall for 3-4 weeks, followed by 2-3 months maturation on aerated pads. The composting technology is provided by SCT.

Process flow diagram from Global Renewables website (www.grl.com.au)



References

The Eastern Creek facility in Sydney, Australia with capacity around 200,000 tpa of MSW which came into operation in 2005. In addition, Global Renewables is the preferred bidder for the Lancashire PFI contract to supply a similar facility.

Suitability for Jersey

The technology is not considered suitable for Jersey because the MBT process is a pre-treatment, designed to process the residual waste and turn it into several output streams, such as refuse derived fuel, organic material for composting, rejects and metals, stone and glass for potential recycling. If adopted for Jersey, additional facilities would be needed for each of these streams.

9.8 Golder Associates

Process Overview

Golder Associates are one of the companies short-listed for the Defra New Technologies Demonstration Programme. Their process is described as MBT / anaerobic digestion, although no detailed description of the process has been reviewed.

References

There are no known references, and the proposed facility will be part of the Defra demonstration programme, which provides UK Government funding. Due to this, the proposed facilities cannot be “commercial”. The proposed plant is not yet under construction.

Suitability for Jersey

The technology is not considered suitable for Jersey because the MBT process is a pre-treatment, designed to process the residual waste and turn it into several output streams, such as refuse derived fuel, organic material for anaerobic digestion, rejects and metals, stone and glass for potential recycling. If adopted for Jersey, additional facilities would be needed for each of these streams.

In addition, no reference plants exist.

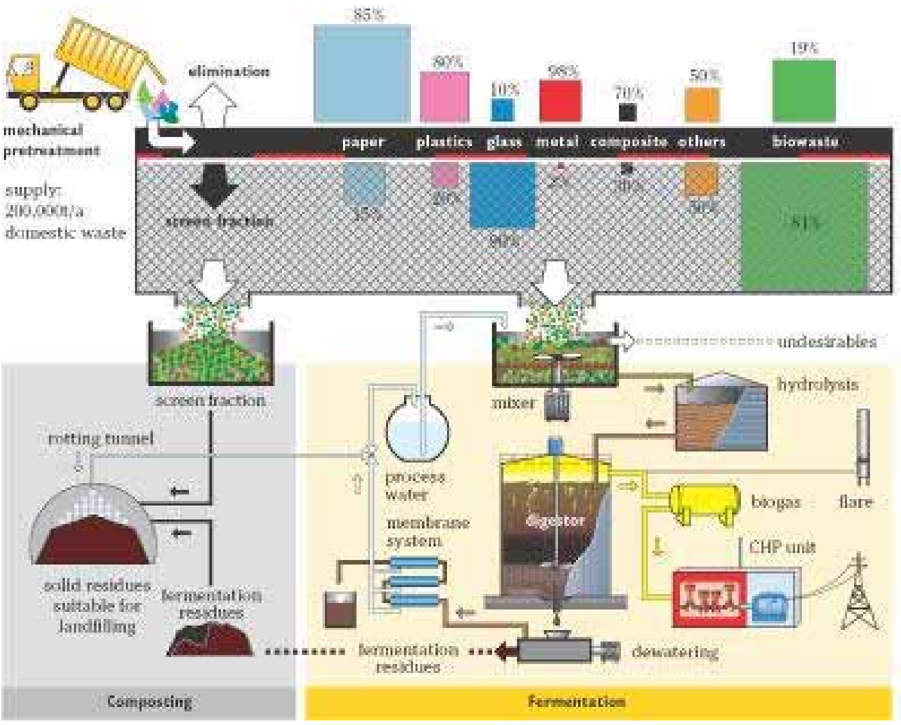
9.9 Haase

Process Overview

This process includes the following stages:

1) Mechanical pre-treatment of incoming MSW, including picking lines to remove recyclables;
2) Part of screened fraction is passed to a tunnel composting facility, with the remainder mixed with water to remove floating matter;
3) Two-stage anaerobic digestion of the wet pulp in Haase's 'biostabilator' process (see 8.3) to produce biogas and digestate;
4) Produced biogas is flared or used in a gas engine / CHP unit for the production of electricity and/or heat;
5) The digestate is de-watered and the solids composted in tunnels, with the waste water treated by reverse osmosis plant.

Illustration from Haase website



References

Haase have a single reference plant in Léon, Spain (200,000 tpa mixed MSW) which is being commissioned in 2005, with plants under construction in Lübeck (150,00 tpa residual waste) and Lauchhammer (50,000 tpa residual MSW) due to be commissioned in late 2005.

Suitability for Jersey

The technology is not considered suitable for Jersey because the MBT process is a pre-treatment, designed to process the residual waste and turn it into several output streams, such as refuse derived fuel, organic material for composting, rejects and metals, stone and glass for potential recycling. If adopted for Jersey, additional facilities would be needed for each of these streams.

9.10 Hese

Process Overview

The Hese process includes the following stages:

1) Mechanical pre-treatment of incoming MSW, to remove recyclables and coarse light material as RDF;
2) Hammer mill to grind material and separate into a coarse and fine (organic) fraction;
3) Anaerobic digestion of the wet pulp to produce biogas and digestate;
4) Produced biogas is flared or used in a gas engine / CHP unit for the production of electricity and/or heat;
5) The digestate is de-watered and the solids potentially composted in tunnels.

References

Hese's main reference plant is the Biffa plant at Leicester in the UK, which treats about 100,000 tpa of MSW and came on line early in 2005. The plant has experienced a major fire and is still being commissioned.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- The process is a pre-treatment stage, designed to process the residual waste and turn it into several output streams, such as refuse derived fuel, organic material for anaerobic digestion, rejects and metals, stone and glass for potential recycling. If adopted for Jersey, additional facilities would be needed for these streams.
- There is a current lack of operating reference plants for non-segregated MSW with sufficient operating experience.

9.11 Horstmann

Process Overview

The process includes the following steps:

1) Incoming MSW is subjected to intensive pre-treatment of waste involving shredding, screening in trommels, density separation using air classifiers, metals separation, and NIR (Near Infra Red) separation for the separation of paper and plastics. The resulting fractions include ferrous and non-ferrous metals, paper, plastics, organic fraction, and residues for disposal to landfill. (Some automated sorting may be replaced by hand-picking lines);
2) Tunnel-composting of the fine organic fraction for a period of 4-7 weeks;
3) Refining of the composted material to remove contaminants such as stones, glass, and oversized particles;

The process can be modified depending on the required output, e.g. compost, RDF, landfill restorative cap.

Picture of tunner composter from Horstmann website

References

Horstmann is a leading supplier of MBT technology. Equipment has been supplied to over twenty plants processing MSW, including two turnkey MBT plants delivered by Horstmann in Madrid, Spain (480,000 tpa MSW) and Onda, Spain (100,000 tpa MSW). Horstmann supplied much of the equipment to the Neath Port Talbot plant owned by HLC, which uses their system to produce RDF for a small energy from waste plant.

Suitability for Jersey

The technology is not considered suitable for Jersey because the MBT process is a pre-treatment, designed to process the residual waste and turn it into several output streams, such as refuse derived fuel, organic material for composting, rejects and metals, stone and glass for potential recycling. If adopted for Jersey, additional facilities would be needed for each of these streams.

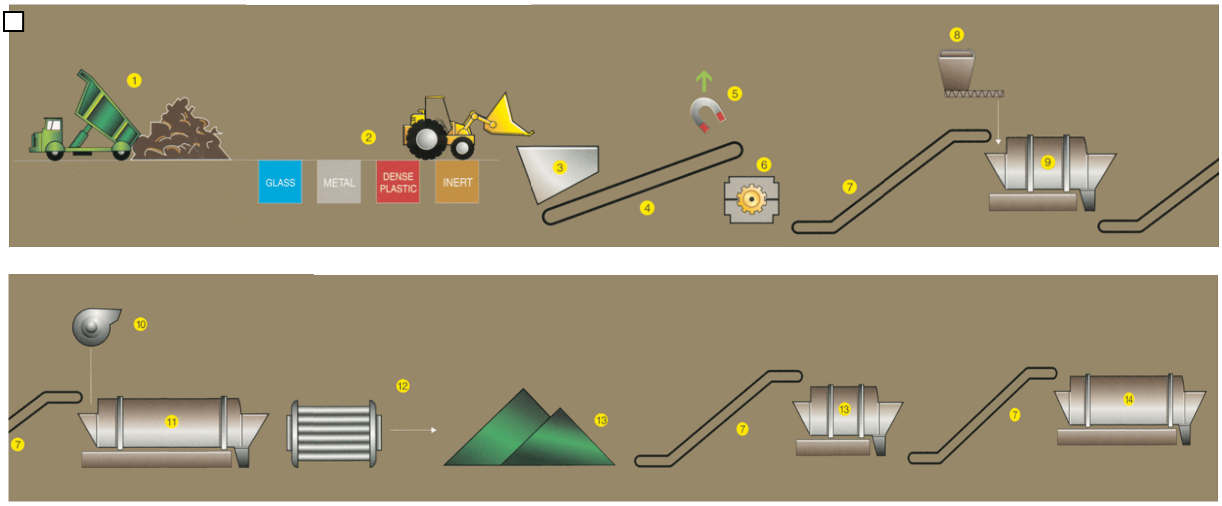
9.12 IWI

Process Overview

The process includes the following steps:

1) MSW is first processed in a material recycling facility to separate glass, metal, paper and plastic as required;
2) Removal of ferrous metals from mixed MSW feed;
3) The separated biodegradable high calorific value waste streams are shredded and put into a blending drum for 8 hours;
4) Processing utilising aerobic digestion in IWI's proprietary 'RAD Drum' for 48 hours to sanitise the waste and reduce the moisture content to below 30% to produce 'Green Coal' fuel. Fuel mass is around 50% of the incoming MSW.
5) The Green Coal can be made into pellets and dried further to produce a substitute fuel for cement kilns, power plant, , etc.
6) IWI propose burning the "Green Coal" fuel in purpose built fluidised bed boilers on the Island (see also Section on fluidised beds).

Process illustration from IWI website (www.iwiuk.com)



1) Municipal Waste	8) Sewage Sludge Feed Conveyor (Optional)
2) Materials Recycling Facility	9) Blending Drum
3) Waste Reception Hopper	10) Water Vapour Extracter
4) Slat Conveyor	11) Main RAD Processing Drum
5) Electro Magnetic Separator	12) Pellet Densifier
6) Shredder	13) Rotary Dryer
7) Chain Conveyor	14) Cement Kiln, Power Station Furnace etc.

References

IWI have provided no references for their process and indicate that a demonstration plant could be operating in the UK in a few months. They also suggest that use of a fluidised bed does not need to be demonstrated as this is a tried and tested technology. Their information does show a photograph of a large drum, which we assume does provide a reference for part of the process.

Suitability for Jersey

The technology is not considered suitable for Jersey because the MBT process is a pre-treatment, designed to process the residual waste and turn it into several output streams, such as refuse derived fuel, organic material for composting, rejects and metals, stone and glass for potential recycling. If adopted for Jersey, additional facilities would be needed for each of these streams.

9.13 Linde

Process Overview

Plant options for the treatment of MSW comprise either

1) Mechanical treatment + wet anaerobic digestion + in-vessel composting:

- Mechanical sorting / picking of incoming waste to remove recyclables and reject material
- Mechanical sieving of pre-treated waste to fine and coarse fractions, from which metals are then separated, with RDF made from the coarse fraction.
- Pulping of the small fraction to remove light particles, heavy inerts and sand, followed by wet anaerobic digestion of the organic fraction
- Composting of de-watered digestate from the AD process in tunnels, suitable for disposal to landfill;

- Biogas from the AD process cleaned before combustion in gas engines for the production of electricity and/or heat;

2) Mechanical treatment + in-vessel composting:
   - Shredding of incoming municipal waste;
   - Mechanical sieving of pre-treated waste to fine and coarse fractions, from which metals are then separated, with RDF made from the coarse fraction.
   - Tunnel composting of fine organic fraction for around 4 weeks, plus 2 weeks maturation;
   - Resultant material sent to landfill.

MBT plant, Borken Germany (from Linde website)

References

Linde are a leading supplier of MBT facilities with many references for mechanical pre-treatment equipment, wet and dry anaerobic digesters, and pile and tunnel composting, supplied to turnkey and non-turnkey plants. Operating turnkey plants include Borken, Germany (85,000 tpa MSW with tunnel composting), Al Ain, UAE (270,000 tpa with pile composting). A further eight plants in Europe (for which Linde is supplying pre-treatment, wet AD, pile or tunnel composting equipment) are currently under construction.

Suitability for Jersey

The technology is not considered suitable for Jersey because the MBT process is a pre-treatment, designed to process the residual waste and turn it into several output streams, such as refuse derived fuel, organic material for composting, rejects and metals, stone and glass for potential recycling. If adopted for Jersey, additional facilities would be needed for each of these streams.

10 PLASMA GASIFICATION

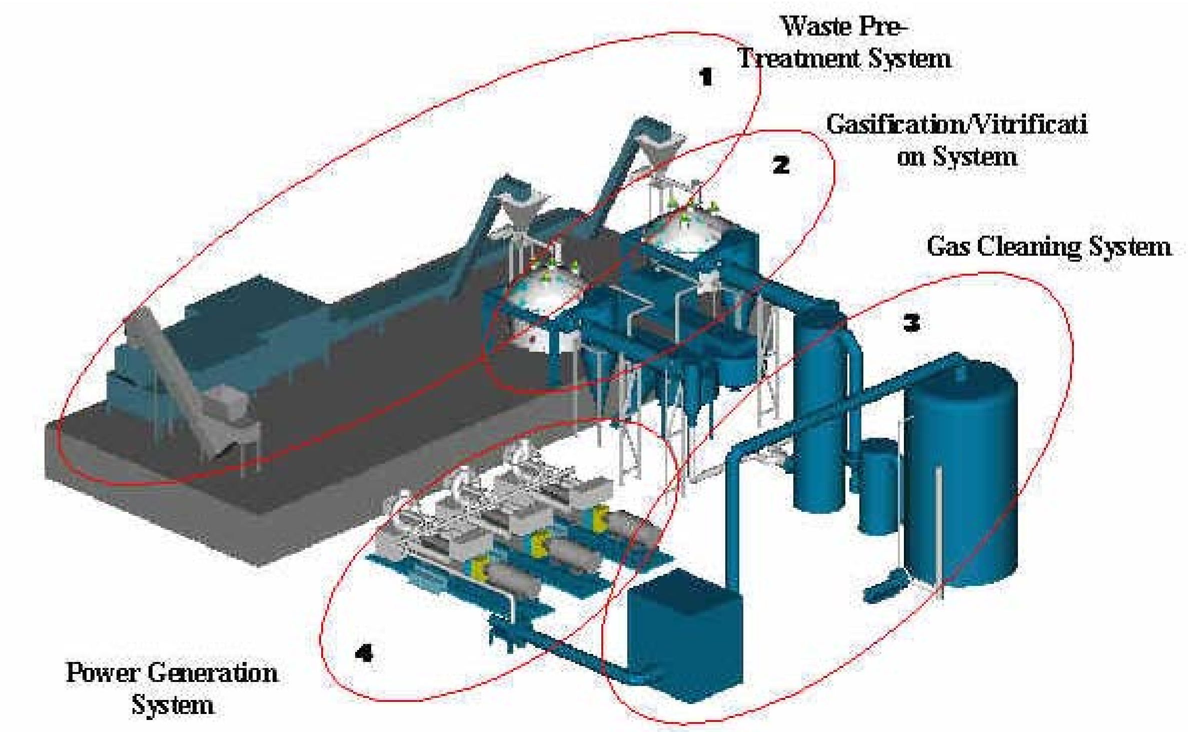
10.1 Verno / Pyrogenesis

PyroGenesis, a Canadian technology company, specializing in the use of plasma arc and thermal processing technology have developed the Plasma Resource Recovery System (PRRS). This includes the following stages:

Process Overview

1) MSW is shredded (and dried if necessary) before being fed into a graphite arc furnace where the organic matter and water are volatilised, and the inorganic fraction (including metals and ceramics) melts;
2) The metal is recovered as ingots, and the ceramic materials recovered as fine vitrified gravel which can be used in construction.
3) The volatilised products are gasified in a plasma-fired furnace that converts the organic matter to synthesis gas (comprising mostly CO and H_2) which is cleaned to remove acid gases, moisture, heavy metals, H_2S, and particulates.
4) The cleaned synthesis gas can be used in an engine to produce electricity.

Picture of conceptual 200 t/day sytem (from www.pyrogenesis.com)



References

A pilot plant has been installed at PyroGenesis' facility in Montreal which PyroGenesis state is suitable for treating a variety of waste types including municipal solid waste. The plant has a capacity of 0.5-2.5 t/day depending on the type of waste and has been treating waste since January 2002. No commercial reference plants are known.

Suitability for Jersey

The technology is not considered suitable for Jersey because there are no commercial reference plants. In addition, the process will require significant amounts of energy leading to low energy recovery, and the concept of releasing much of the incumbent heavy metals in waste by volatilisation would require significant long-term study to confirm whether there was any environmental sense in this approach.

10.2 Pyromex

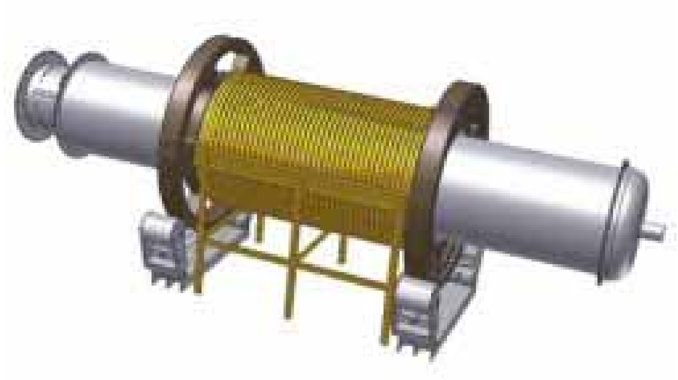
Process Overview

According to Pyromex, the process involves:

1) Pre-processing of MSW consisting of drying, shredding and recovery of recyclables;

2) Ultra-high temperature (1250°C and above) gasification of the pre-treated waste using induction heating. The organic fraction is volatilised to a "pyrogas" that can be combusted in a gas engine to produce electricity. The inorganic fraction is recovered as a sand-like material which can be used as a construction aggregate or as landfill cover.

Illustration of the Pyromex Reactor (from website)



References

A small plant operated in Germany, processing industrial sludge, in 2000, but this is no longer operating. There are no reference plants processing MSW.

Suitability for Jersey

The technology is not considered suitable for Jersey because there are no commercial reference plants processing MSW. In addition, the process will require significant amounts of energy leading to low energy recovery, and the concept of releasing much of the incumbent heavy metals in waste by volatilisation would require significant long-term study to confirm whether there was any environmental sense in this approach.

11 BIO-ETHANOL PRODUCTION

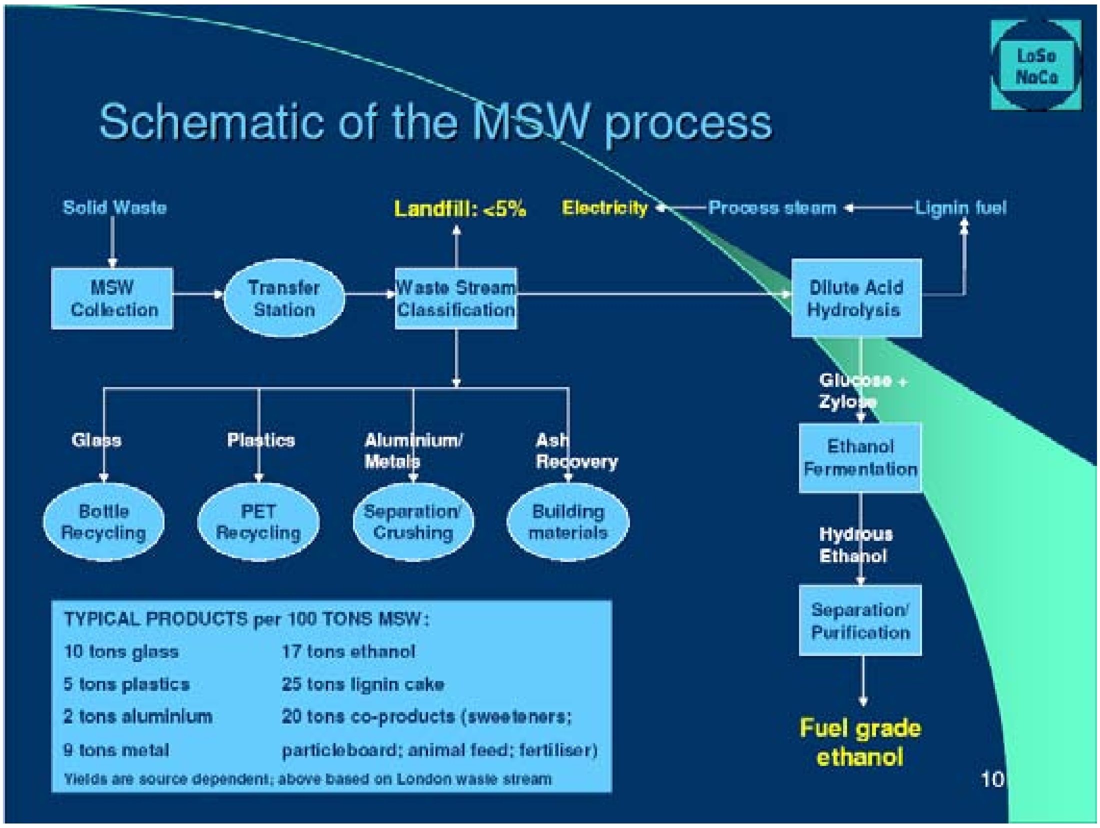
11.1 Losonoco

Process Overview

The Losonoco technology is designed to convert agricultural, municipal and industrial wood wastes into ethanol. According to Losonoco it involves the following steps:

1) Pre-treatment of MSW to remove recyclables (metals, glass, plastics) and other inorganic material to leave the organic fraction of the waste;
2) Dilute acid hydrolysis of the cellulose fraction of the waste to produce sugars plus lignin which is separated by filtration for further processing;
3) Fermentation of the sugars to produce ethanol;
4) Purification of the ethanol prior to combustion in a gas engine to produce process steam and electricity to operate the plant, with any excess exported. Alternatively it can be used as a chemical feedstock or as a fuel to drive specially adapted vehicles.

Diagram from Losonoco presentation



Reference Plants

There are no commercially operating plants. Losonoco have proposals for plants at London Waste, Edmonton; Ince Marshes, Cheshire; County Carlow, Ireland; and Dorset.

Suitability for Jersey

The technology is not considered suitable for Jersey because :

- There are no commercial reference plants processing MSW;

- It is only a partial solution as extensive upstream pre-treatment of waste is required to separate the organic fraction prior to processing, requiring disposal routes for recovered materials. Also a power plant is required if the produced ethanol is not sold;
- The process produces lignin, which would require disposal, or a combustion plant in which to burn it;
- The process is likely to require agricultural wastes such as straw, in combination with the organic fraction of MSW. This would not be suitable for Jersey, with little such material.

12 MECHANICAL TREATMENT / LIMING

This is a novel process where waste is treated by a combination of mechanical separation together with the addition of lime to sanitise the waste.

12.1 Oxalor

Process Overview

The Oxalor process is based on the exothermic chemical reaction of a quick lime-based reagent with water (in the MSW and also added to the process) to produce a dry and sterilised waste.

Glass, plastic and inerts are separated from the treated waste to leave an organic-rich fraction which contains most of the lime from the initial stage. This organic / lime fraction is proposed to be used for soil enhancement in agriculture;

Process diagram from www.upsi-oxalor.com

References

The reference plant in France processing MSW has a projected size of about 30,000 tpa. However, we understand this plant is used as a demonstration plant and is not operated continuously. It has processed about 5,000 tonnes of MSW in the last three years.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- The process is a pre-treatment process. Disposal routes would need to be found for the majority of the oversized and non-organic material which bypasses the process.

- Jersey currently only has a limited demand for lime for agriculture. This process would produce large quantities of lime-based mixed waste organic material on a continuous basis, which would be unlikely to be acceptable to Jersey's agricultural industry, and there would be no long-term security that it could be disposed of to land on a continuous basis.

13 CONCLUSIONS

The Environment & Public Services Committee and the Waste Strategy Steering Group have reviewed all of these technologies with open minds, and continue to monitor developments in technologies. The prime consideration that has been agreed is that the technology chosen for Jersey must be tested and proven, to give a low risk solution, which will provide a long-term secure route for disposal of the solid waste.

The main criteria for the selection of technologies are:

- The technology must be demonstrated, with significant reference plants in operation, preferably in Europe, processing similar waste types. It is essential for a small island such as Jersey, that no significant technology risks are introduced.
- Environmental performance – the technology must be clean, capable of achieving the best European standards.
- Complexity – the process must be easy to operate without excessive staff numbers, and with clearly understood operating and maintenance costs.
- The process should recover value as efficiently as possible from Jersey's residual waste, in line with the Solid Waste Strategy and the European Waste Hierarchy.

1) The following types of technology have been considered, with 60 individual suppliers of such technology investigated:
    - EfW - Conventional Incineration
    - EfW - Fluidised Bed Combustors
    - EfW - Gasification and Pyrolysis
    - Steam Autoclaves
    - Anaerobic Digestion
    - Mechanical Biological Treatment
    - Plasma Gasification
    - Bio-Ethanol Production
    - Liming Process
2) EfW - Conventional Incineration is considered to meet the above criteria, and at least four suppliers have been identified for further investigation prior to inclusion on the short-list of tenderers.
3) EfW - Fluidised Bed Combustors - Fluidised beds are very sensitive to over-sized material, metal and stones. The plants will require pre-treatment, with rejection of some material. As such, it is considered that the technical risks, combined with the failure to provide a complete disposal solution mean that this technology is not considered suitable for Jersey.
4) EfW - Gasification and Pyrolysis – 20 suppliers have been considered and, of these, only one is considered to have adequate reference plants to satisfy the selection criteria for inclusion on the short-list.
5) Steam Autoclaves – This is a pre-treatment process and separates the waste stream into a number of different output streams requiring further processing, including an EfW plant. The additional costs and difficulties involved in a further processing stage mean that this technology is not considered suitable for Jersey.

6) Anaerobic Digestion – Whilst there are a number of operating AD plants, these can only process the organic fraction of MSW. It is necessary to separate the waste, and disposal routes will be required for the non-organic material plus any rejects, together with the digestate from the AD plant. The additional costs and difficulties involved mean that this technology is not considered suitable for Jersey.

7) Mechanical Biological Treatment (MBT) – There are many MBT plants operating in Europe, but these all pre-treat the waste to produce a number of output streams such as RDF, organic material, inerts, metals and rejects. All these streams will require further processing, probably using an EfW plant. The additional costs and difficulties involved mean that this technology is not considered suitable for Jersey.

8) Alternative Processes such as plasma gasification, bio-ethanol production and a liming process have all been considered, but not considered suitable due to a lack of adequate references, lack of proven flexibility to cope with all the incoming waste or doubts about the sustainability of the proposed disposal routes for the various output streams produced.

Appendix A Glossary

AD	Anaerobic Digestion
EfW	Energy from Waste
EPC	Engineering Procurement and Construction
FGT	Flue Gas Treatment
MBT	Mechanical Biological Treatment
MJ/Nm^3	MegaJoule per Normal cubic metre
MRF	Material Recycling Facility
MSW	Municipal Solid Waste
MWh	Megawatt Hour
NCV	Net Calorific Value
NIR	Near Infra-Red
NOx	Oxides of nitrogen
PSD	Public Services Department
RDF	Refuse Derived Fuel
RMSW	Residual Municipal Solid Waste
SNCR	Selective Non-Catalytic Reduction
t	Tonne (always metric)
t/h	Tonnes per hour
tpa	Tonnes per annum
WID	Waste Incineration Directive