STATES OF JERSEY

SOLID WASTE STRATEGY

TECHNOLOGY REVIEW 2008

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MANAGEMENT SUMMARY

This technology review has been carried out as part of the then Environment and Public Services Committee's commitment to the States of Jersey as part of the Solid Waste Strategy. An original review was carried out in 2005 to inform the decision on the companies to be selected for shortlisting for the residual waste treatment facilities to replace the Bellozanne incinerator. This review was updated in late 2007 to ensure that no new entrants to the market had been missed. Following the Juniper review carried out for the Environment Scrutiny panel, the reports have been combined into a single report for States members, and some of the comments from Juniper addressed.

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 residual 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 residual solid waste. In addition, it is essential that the selected technology is demonstrably capable of the disposal of all of Jersey's residual 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 Section 3:

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

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 eight suppliers were identified for further investigation prior to inclusion on the short-list of tenderers.
2) EfW - Fluidised Bed Combustors. Four potential suppliers have been identified, although it is noted that few of these are currently offering this technology to process municipal solid waste. 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 – 25 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) Mechanical Heat Treatment, including 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. Eight plant suppliers have been considered. The additional costs and difficulties involved in a further processing stage means that this technology is not considered suitable for Jersey.

5) Anaerobic Digestion – it must be understood that AD can only process organic wastes, that is it cannot treat the majority of residual solid waste. Seven suppliers of this equipment were reviewed and it is noted that this technology is currently expanding in its use in the UK. 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 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. 15 plant suppliers have been considered. The additional costs and difficulties involved means that this technology is not considered suitable for Jersey.

7) Alternative Processes such as plasma gasification (5 technology suppliers), bio-fuel production (3 technology suppliers), a liming process (one supplier) and plastic extrusion (one supplier) have been reviewed, 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.

Whilst we believe we have reviewed all the potential technologies and the majority of the suppliers of these technologies currently offering solutions in Europe, the suppliers considered are not an exhaustive list. Some suppliers may have been excluded due to a lack of publicly available information. However, we believe that all significant residual waste treatment processes have been considered.

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. Pre-treatment processes have not been rejected without careful consideration. The cost of multiple facilities, together with limited land available and a small workforce, means that these are not considered practical or affordable solutions. This is a decision questioned by Juniper, but we believe our approach has been robust. Where processes require some limited pre-treatment of the waste prior to treatment this has been considered acceptable. However, extensive pre-treatment processes where the waste is split into several different waste streams requiring further treatment facilities, or export from the Island, are unlikely to be acceptable for Jersey due to the additional cost and lack of sustainable disposal routes.

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 was 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 was prepared by Babtie Fichtner for the then Jersey Public Services Department. The report concentrated on residual wastes, that is the waste left over following the various recycling and composting initiatives proposed in the Strategy. This report identified the key technologies and suppliers available to provide a replacement plant for the Bellozanne incinerator. This supported the list of available suppliers which had been identified from the open advertisement placed in the Official Journal of the European Community. This led to a shortlist of suppliers wishing to bid for the plant with an acceptable solution being drawn up.

Prior to tendering for the proposed plant at the end of 2007, a further review of technologies was carried out to ensure that no new supplier had emerged. Despite the two years which had elapsed, no new technology was identified. The tendering process was started with the approved shortlist of four suppliers. The technology report was also reviewed by Juniper Consultancy Services Ltd for the Environment Scrutiny Panel, leading to a number of critical comments.

This report merges the two Babtie Fichtner reports into a single report to assist States members. In addition, the more significant of the Juniper comments are addressed which we believe to be largely misconceptions of the Island's requirements, or due to a lack of clarity in the original reports.

This 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, most of the suppliers included in this list will not tender for a plant on Jersey. The list of suppliers considered is deliberately limited to those offering their solutions in Europe, on the basis that it would not make sense for Jersey to select a technology which is not being built or operated elsewhere on the continent. This is because we believe that if these technologies have a significant role to play in Europe, they would already feature in other larger countries where waste management is more flexible than on a small island, and that the requirement to have access to experienced operators and specialist maintenance staff in nearby countries should not be underestimated.

2 OVERVIEW OF TECHNOLOGIES

Since the 2005 report, there have been no entirely new processes which have entered the market. This is not surprising – the development time to reach commercial operation of waste facilities is long. We are also not aware of any revolutionary technology in the development phase which is likely to change this situation in the next few years.

Any new process needs to go through an initial design and testing phase on the pilot scale. If successful, normally a demonstration plant would then be built and operated to gather information to allow a full-scale plant to be constructed. This would lead to the construction of a commercial scale plant, with construction normally taking of the order of two years. The commercial plant would then operate for an extended period of several years to show that the process works satisfactorily and to allow meaningful data to be established on reliability and long term operating and maintenance costs. The overall process from the conceptual design to a commercially proven design normally takes of the order of ten years.

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 demonstrably proven, 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. Where non-European references only do exist, it is considered a pre-requisite that suppliers are actively bidding their technology in Europe, on the basis that if they are not, it would not be advisable to procure a plant of which they would be the sole European example.
- 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 deal with all Jersey's solid residual waste, and where output streams are produced, sustainable outlets must exist for these. Multiple facility solutions were considered. Facilities which pre-treat the waste were also considered, but in this case the complete disposal route was also taken into account in determining the viability of the solution.
- The process shall recover value as efficiently as reasonably 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 was to determine which technology is best suited for Jersey, and then consider which of the various suppliers were able to deliver the solution, prior to drawing up the final short list of tenderers.

The following types of technology have been considered:

2) 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. It is also easy to export heat to consumers, as a Combined Heat and Power plant, or to a district heating system, if this is required.
- 8 suppliers have been considered, all of which have significant reference plants and the capability to deliver the project for Jersey.
- Of these eight, six expressed a strong interest in the project.

3) 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, although it is noted that not all of these are actively offering such solutions to the European market.
- Fluidised beds are very sensitive to over-sized material, metal and stones. To operate successfully, some 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.

4) EfW - Gasification and Pyrolysis

- There are 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. This would mean that alternative disposal routes would be required for much of the rejected waste, and these do not exist on the Island.
- The environmental performance of most gasifiers is similar to conventional energy from waste plants, but the energy recovery efficiency is generally lower.
- Juniper have suggested that Jersey should consider installing a "slagging" gasifier of which there are several operating examples in Japan, but none in Europe. We strongly disagree with this view, as we can see no advantages for the Island of this technology which has yet to be deployed successfully in Europe despite several attempts. As Juniper note it would be more expensive, and we do not believe that the claimed environmental advantages of an improved ash quality would be significant for the Island.
- 25 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. This supplier, Ener-G, was approved and placed on the short-list of tenderers but withdrew during the tendering process.

5) Mechanical Heat Treatment

- This technology uses heat to pre-treat and break down the waste. This is often in the form of steam, using a "steam autoclave", although it can also utilise a heated rotating drum.

- This is 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 a conventional energy from waste plant, and there is no landfill requiring the application of the restoration material. It would therefore make more economic and environmental sense for Jersey to just install the energy from waste plant.
- These plants are currently just starting to operate in Europe and the process is relatively simple. Eight suppliers proposing to supply such equipment in the UK have been reviewed.
- However, due to the requirement for additional facilities to treat the outputs, this technology is not considered suitable for Jersey's residual waste.

6) 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.
- Seven reputable European suppliers have been considered.
- Separate anaerobic digestion of kitchen waste has been considered independently of this report, although it is considered that a cheaper solution for the Island than anaerobic digestion would be via in-vessel composting of this material. Even this option has shown to be more expensive than a single energy from waste plant.
- Where mixed waste organic material is anaerobically digested, the digestate produced contains most of the contaminants present in the original material. The digestate therefore has very limited land use, usually restricted to the treatment of contaminated land or as restoration material for landfills, neither of which are applicable to Jersey.
- 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 to treat the complete residual waste stream, this solution is not seen as the most suitable option for Jersey.

7) 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.
- 15 suppliers of such systems have been considered. Several of these are considered sufficiently capable and experienced to supply an MBT plant to Jersey.

- This is 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 normally the refuse derived fuel stream, which is about 25-50% of the incoming waste. This material would require an on-Island energy from waste plant in any case, or expensive export to other facilities off the Island. In addition, large quantities of rejects and fine organic material are produced. Whilst further treatment, such as composting for use as landfill restoration material, are proposed in Europe, this is not suitable for Jersey, as there is no landfill requiring the application of the restoration material. It would therefore make more economic and environmental sense for Jersey to just install the energy from waste plant.
- 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 or cost effective option for the Island.

8) 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 has more often been used for the treatment of hazardous material.
- This solution is not considered suitably proven for the treatment of Jersey's residual waste stream.
- This process does not have any commercially operating plants within Europe.

9) 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 will not treat all of the residual waste stream. It is, therefore, not considered suitable for Jersey.

10) Liming Processes

- This is a process under development in France, where lime is added and the lime/organic material is 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.

11) Plastic Extrusion

- The extrusion of waste plastics into lower grade plastic products such as garden furniture is well established. However, it will only work adequately with reasonable quality waste plastics, and produce products with a limited market.
- The process will treat only a small proportion of the residual waste stream after separation. It is, therefore, not considered suitable for Jersey.

3 DESCRIPTION OF DIFFERENT TECHNOLOGIES

3.1 EfW - Conventional Incineration

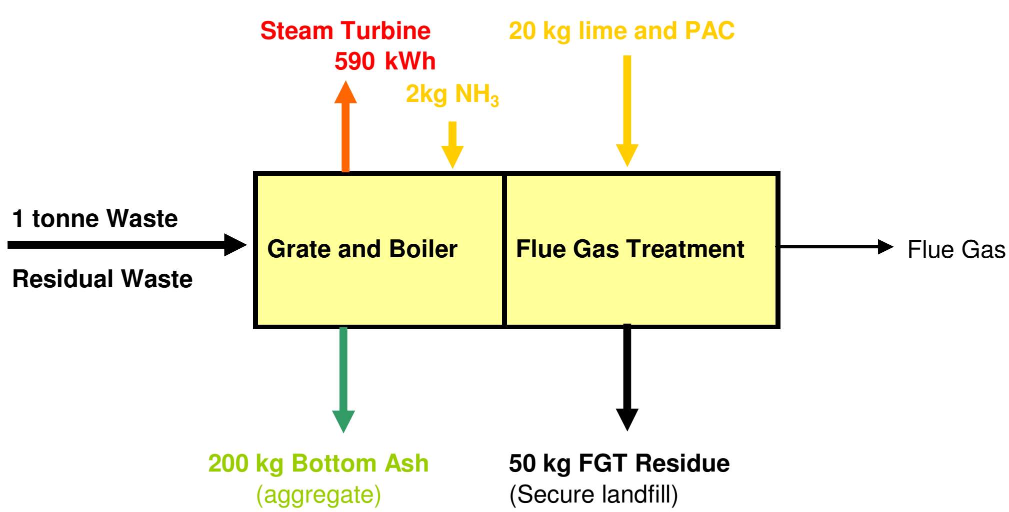
Conventional incineration systems, also known as "mass-burn" have been used worldwide for many decades. There are several hundred such plants operating throughout Europe. These types of plants are by far the most developed. Contrary to public perception, this type of technology is not out of date – it 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

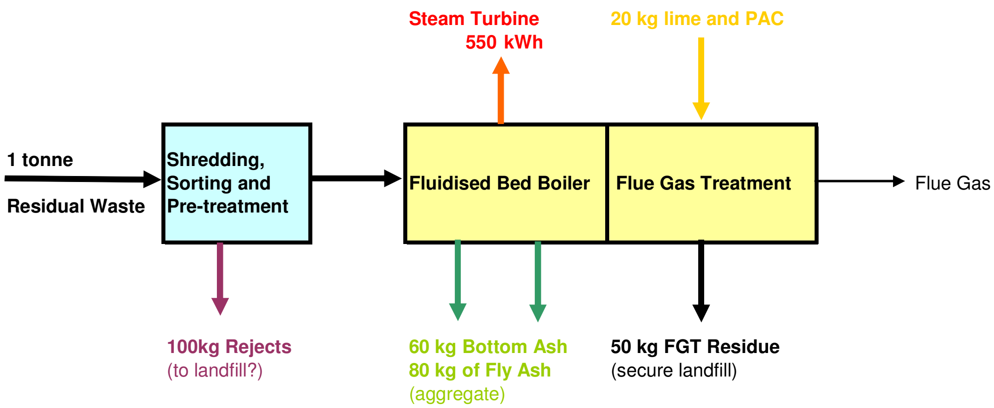
3.2 EfW - Fluidised bed combustion systems

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



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

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.

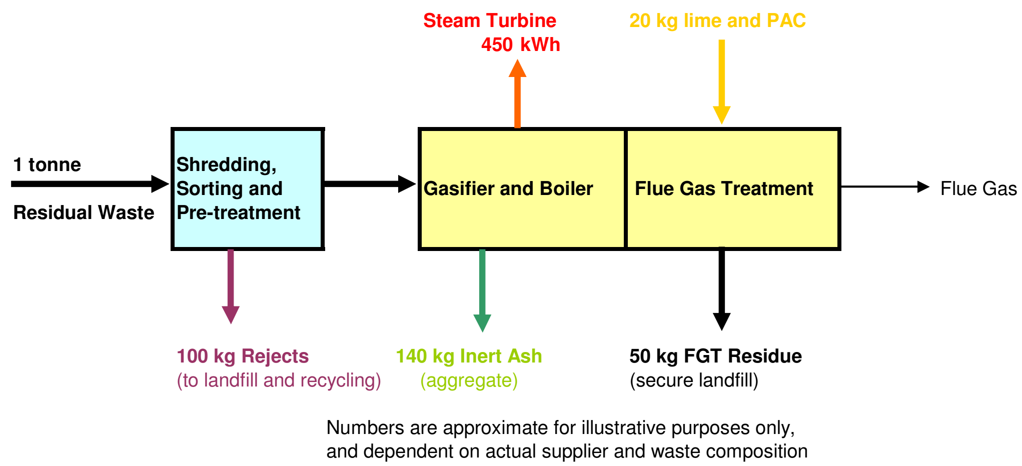
In the UK, the Government has tried to assist the development of these so called “Advanced Technologies” by allowing them to qualify for Renewable Obligation Certificates, whereas modern waste incinerators do not qualify as these are considered to be commercially mature. The Renewables Obligation Certificate increases the electricity revenue by up to £90/MWh (Megawatt Hours), so it is a considerable incentive and this has led to a number of suppliers actively entering the market. This incentive is not available for Jersey.

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.

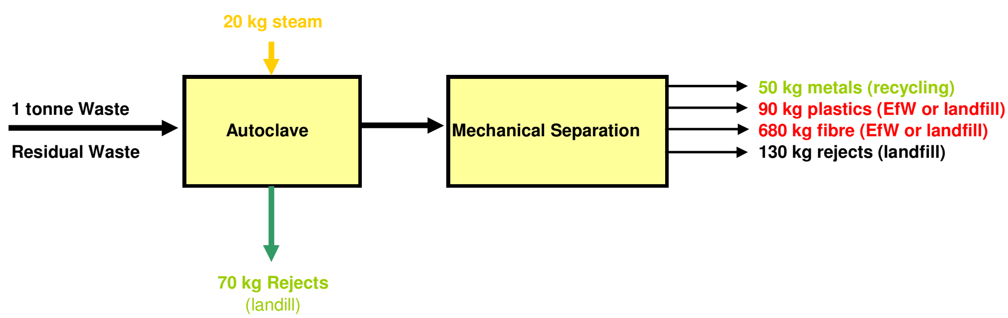
3.4 Mechanical Heat Treatment

In these facilities, waste is loaded into a drum and heated by injecting steam or by separately applying heat. 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 consumer 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)

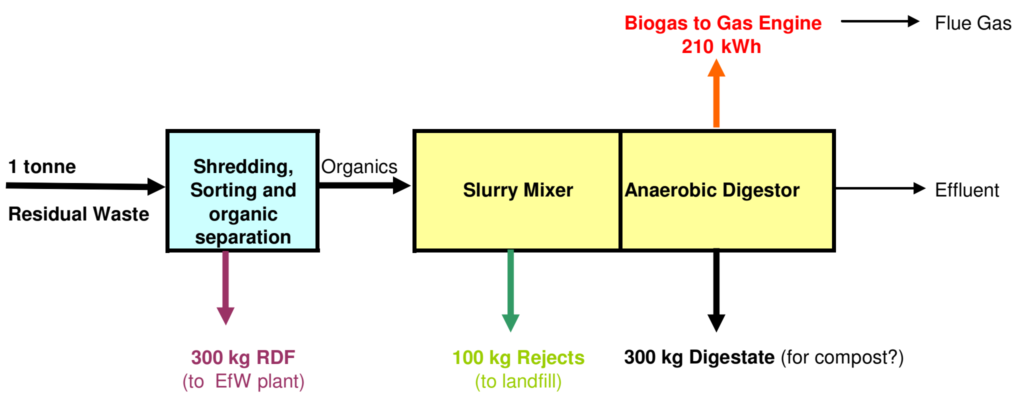
Anaerobic digestion is a well established technique for the decomposition of organic slurries, such as sewage or farm slurries. Jersey PSD operates a digester at the sewage treatment plant at Bellozanne. Organic material is mixed into a slurry, and bacteria are used under anaerobic conditions, that is 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



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

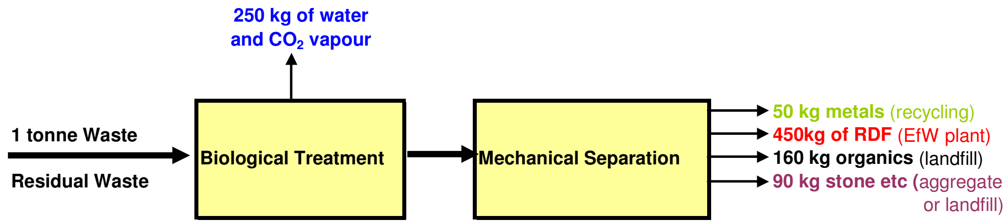
3.6 Mechanical Biological Treatment (MBT)

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.
- Plastic extrusion, where waste plastic is heated and then extruded into low grade plastic products.

4 CONVENTIONAL ENERGY FROM WASTE

4.1 CNIM / Martin

Current Position

CNIM are the preferred bidder for the proposed EfW plants to be built in Rufford and Shropshire. A 220,000 tonnes per annum (tpa) plant in Sheffield was successfully completed on time in 2006, and since then has been operating well.

CNIM are licencees for the well proven Martin grate system, and the vast majority of their plants use this system.

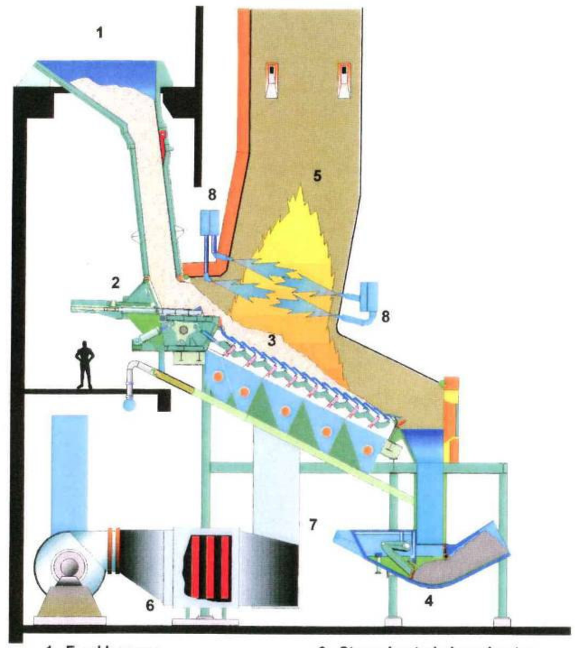
CNIM were invited to tender for Jersey and submitted a proposal in February 2008.

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 tpa of waste, to very large plants with multiple units and capacities up to 400,000 tpa.

There are eight operational 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), Chineham (90,000 tpa), Southampton (160,000 tpa), Portsmouth (160,000 tpa) and Sheffield (220,000 tpa).

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 Lentjes (formerly Lurgi)

Current Position

Lurgi is now trading under the name Lentjes UK Limited. Lentjes were sold by their parent company to Austrian Energy and Environment (AEE) in late 2007. The sale was approved by the European monopolies commission in early 2008. AEE are considered to be an acceptable parent company, with a wealth of experience in waste treatment – AEE also own Von Roll (see 4.5).

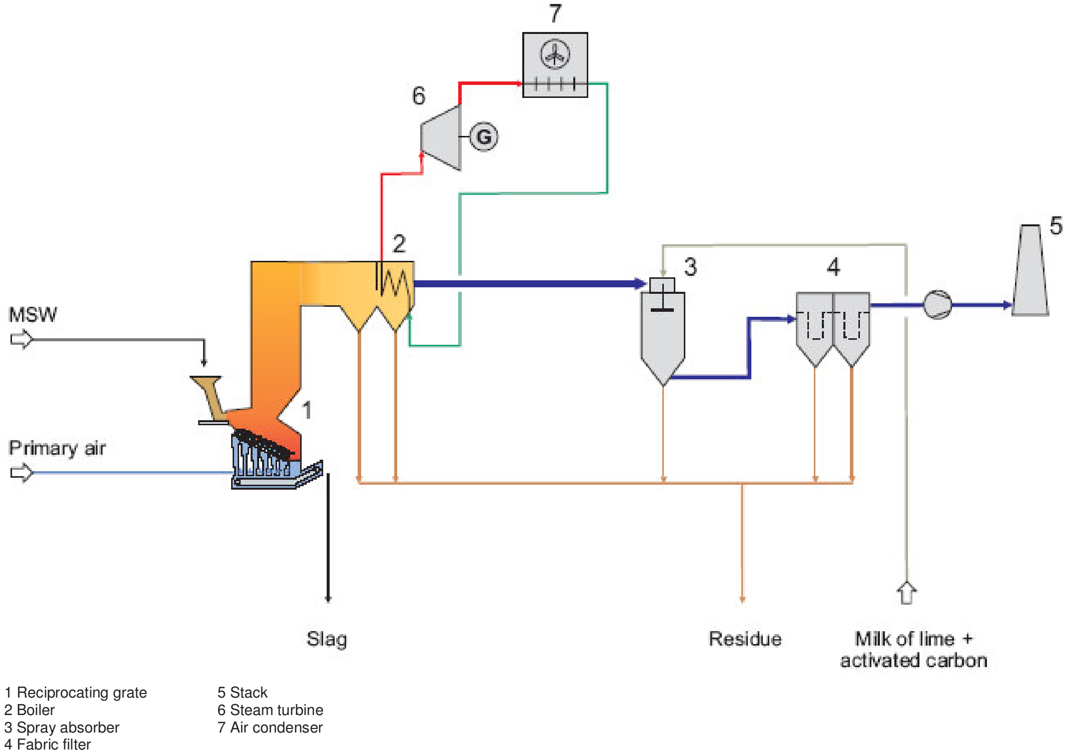
Lentjes were asked to submit a proposal to Jersey in November 2007. Due to the simultaneous acquisition, AEE submitted a proposal utilising both Lentjes and Von Roll experience in February 2008.

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



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 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 Cyclerval

Current Position

Cyclerval are currently involved in the development of a 60,000 tpa MSW facility in Exeter and another facility in Telford.

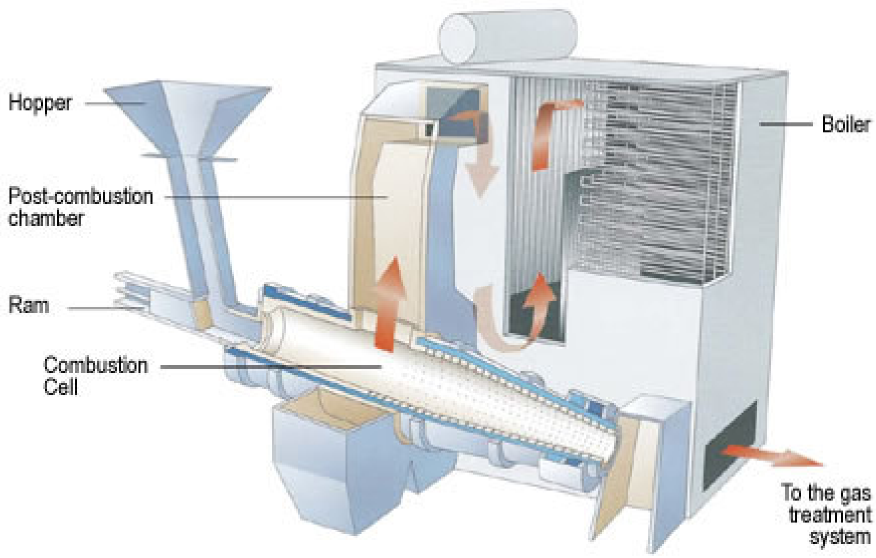
Cyclerval were initially named as Earth Tech's preferred equipment supplier to bid for the Jersey project. Prior to issue of tenders, Cyclerval indicated that they were unwilling to tender for the Jersey plant as they have insufficient resources and wished to pursue their other projects.

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.

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 Keppel-Seghers

Current Position

Keppel Seghers are currently the preferred bidder for a proposed EfW facility to be built for Ineos Chlor in Runcorn.

Keppel Seghers were initially included on the potential bid list but indicated that they had insufficient resources and would be unable to bid.

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

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

Current Position

Von Roll are currently the preferred EPC contractor for Riverside EfW facility, a 670,000 tpa facility targeted to be operational in 2010. They are also involved with the construction of a 130,000 tpa turnkey EfW facility near Vienna, the development of a third line at the Teesside energy from waste facility (135,000 tpa) and the development of the Newhaven EfW facility (225,000 tpa). Von Roll are owned by AEE (see 4.2 above).

When Lentjes were taken over by AEE, some of von Roll's technology was used in submitting the Lentjes/AEE proposal to Jersey.

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 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 225,000 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

Current Position

Since supplying the boiler and grate to Slough Heat and Power as a sub-contractor to Agra Birwelco in 2003, Babcock & Wilcox Vølund have not supplied any other plants in the UK.

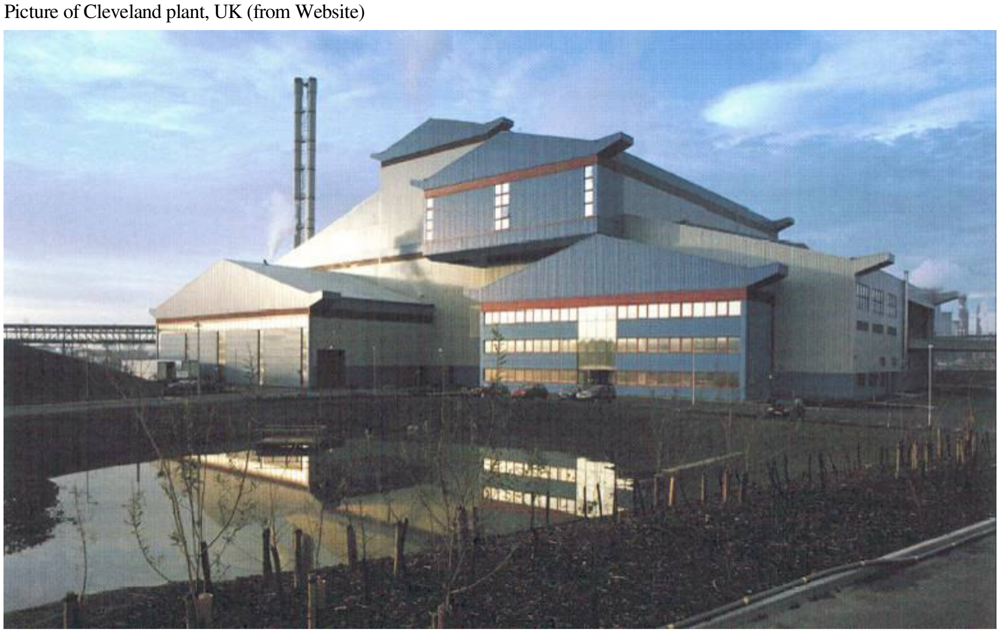
Babcock & Wilcox Vølund were unwilling to submit a proposal for the Jersey contract.

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

Current Position

After a period when Fisia Babcock were unable to bid for projects in the UK, they are now active again. They have made an agreement with Earth Tech which enables Earth Tech to bid for turnkey EPC Contracts using their technology. Fisia Babcock bid together with Earth Tech for the Jersey contract, submitting a proposal in February 2008.

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

Current Position

Takuma are currently constructing the 430,000 tpa EfW plant at Lakeside near Heathrow airport. They are also preferred bidder for the Cornwall PFI contract. Takuma did not indicate any interest in pre-qualifying for the Jersey contract.

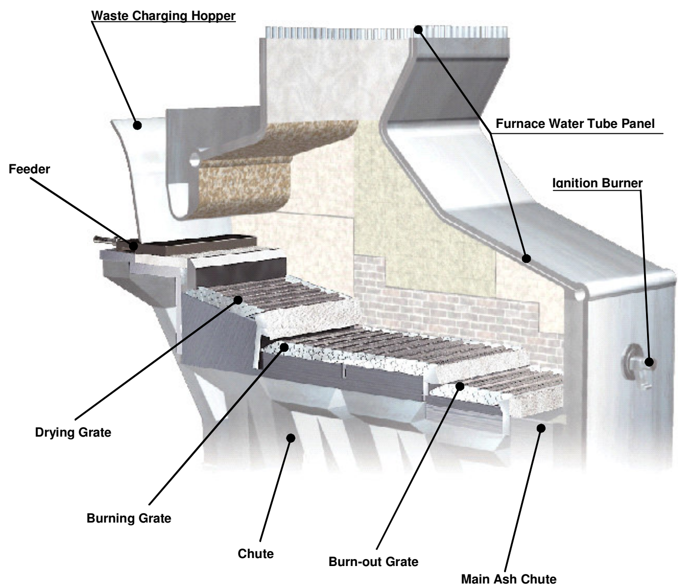
Process Overview

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.

Suitability for Jersey

Possible solution for Jersey because of the following:

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

However, Lakeside 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 and acquired Lentjes this year.

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.

AEE fluidised beds are in operation in Europe successfully burning refuse derived fuel (see also section 9). However, this would require the installation of a MBT plant to produce the refuse derived fuel and a significant amount of rejected material, with no clear disposal route. An energy from waste plant would therefore still be required. Even though this would be smaller in capacity, the overall cost of both facilities, and the need to find disposal routes for a significant quantity of rejected material, means that this is not considered an attractive solution.

5.2 Foster Wheeler

Current Position

FW supply mainly biomass fired boilers worldwide, although they do continue to market and construct refuse derived fuel fired plants. FW are currently installing a third stream at the Lomellina plant in Italy.

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) 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. SNCR is not normally required.

FW plants normally produce electricity, with a net electrical efficiency of up to 25%, or process steam. 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.

FW fluidised beds are in operation in Europe successfully burning refuse derived fuel (see also section 9). However, this would require the installation of a MBT plant to produce the refuse derived fuel and a significant amount of rejected material, with no clear disposal route. An energy from waste plant would therefore still be required. Even though this would be smaller in capacity, the overall cost of both facilities, and the need to find disposal routes for a significant quantity of rejected material, means that this is not considered an attractive solution.

5.3 Kvaerner (now Metso)

Current Position

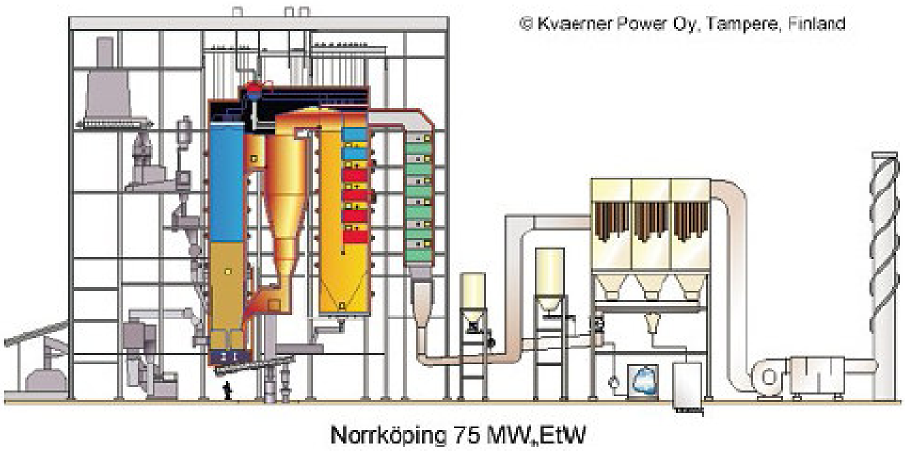
The fluidised bed section of Aker Kvaerner was acquired by Metso in 2007. Metso primarily supply biomass fired fluidised bed boilers, using fuels such as wood. However, they also market refuse derived fuel boilers.

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.

Metso plants normally 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. 75 MW_{th} plant capacity;
- 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

Metso 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.

Metso fluidised beds are in operation in Europe successfully burning refuse derived fuel (see also section 9). However, this would require the installation of a MBT plant to produce the refuse derived fuel and a significant amount of rejected material, with no clear disposal route. An energy from waste plant would therefore still be required. Even though this would be smaller in capacity, the overall cost of both facilities, and the need to find disposal routes for a significant quantity of rejected material, means that this is not considered an attractive solution.

5.4 Lurgi (then Lentjes, now AEE)

Current Position

Lurgi UK were renamed Lentjes UK after their German division. Lentjes has subsequently been acquired by AEE. Lentjes UK are currently constructing the Allington Quarry 500,000 tpa fluidised bed plant in Kent. This project has been delayed following a series of problems. As AEE have their own in-house fluidised bed technology, it is not currently clear if AEE will continue to provide the Lentjes design of fluidised bed. During pre-tendering discussions and the tender process, Lentjes did not indicate that their proposed technical solution for Jersey would be a fluidised bed, and offered a standard grate design instead.

Process Overview

The Lentjes fluidised bed process includes:

1) Mechanical processing of waste including at least a reduction in size to below 300mm. Due to the special, robust design of the fluidised bed, the pre-treatment of the waste is not arduous;
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.

Lentjes fluidised bed plants produce electricity, with a net electrical efficiency of up to 25%, from either pre-treated municipal waste or RDF. 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 used to construct the 500,000 tpa Allington Quarry plant in the UK, which includes material recovery facilities for pre-treatment of waste prior to combustion. This plant is under construction.

Suitability for Jersey

Lentjes fluidised beds are not considered suitable for Jersey because 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 process called RCP (Recycled Clean Products). 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, which 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 heated with oxygen to produce a gas. The gas can be used in processes or burnt to generate steam in a boiler or gas turbine. The process also requires an air separation plant in order to provide the necessary oxygen for gasification.

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 British Gas-Lurgi gasifier is not being marketed for waste disposal in the UK.

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.

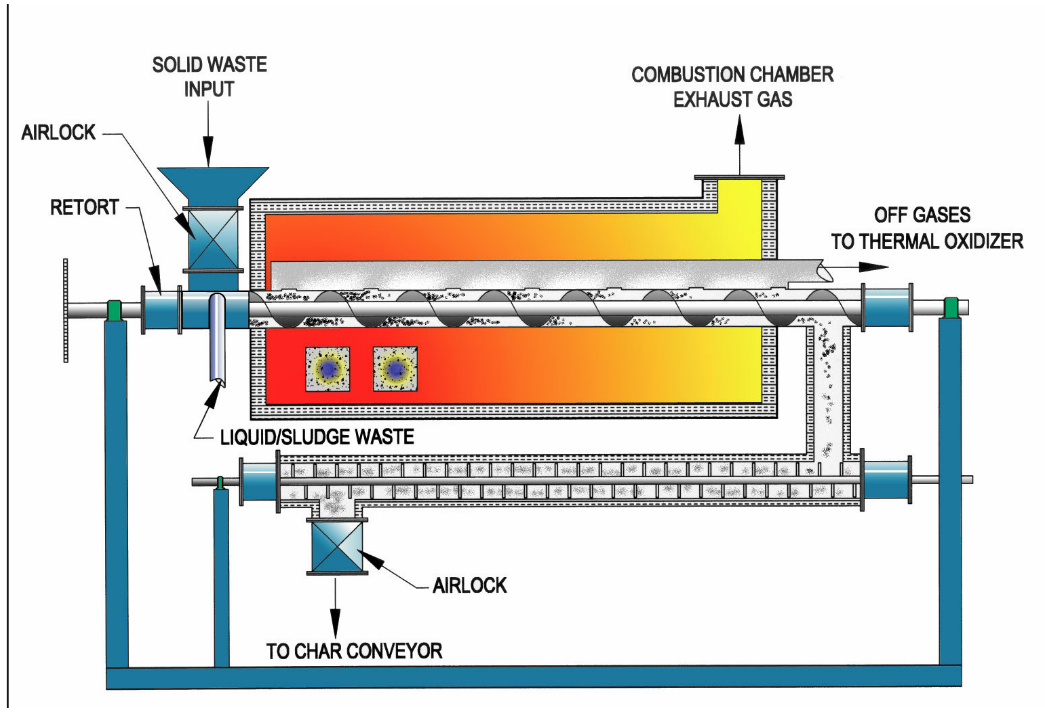
6.3 Bowen Worldwide Developments

Process Overview

Bowen describes 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 (now Ethos Recycling)

Current Position

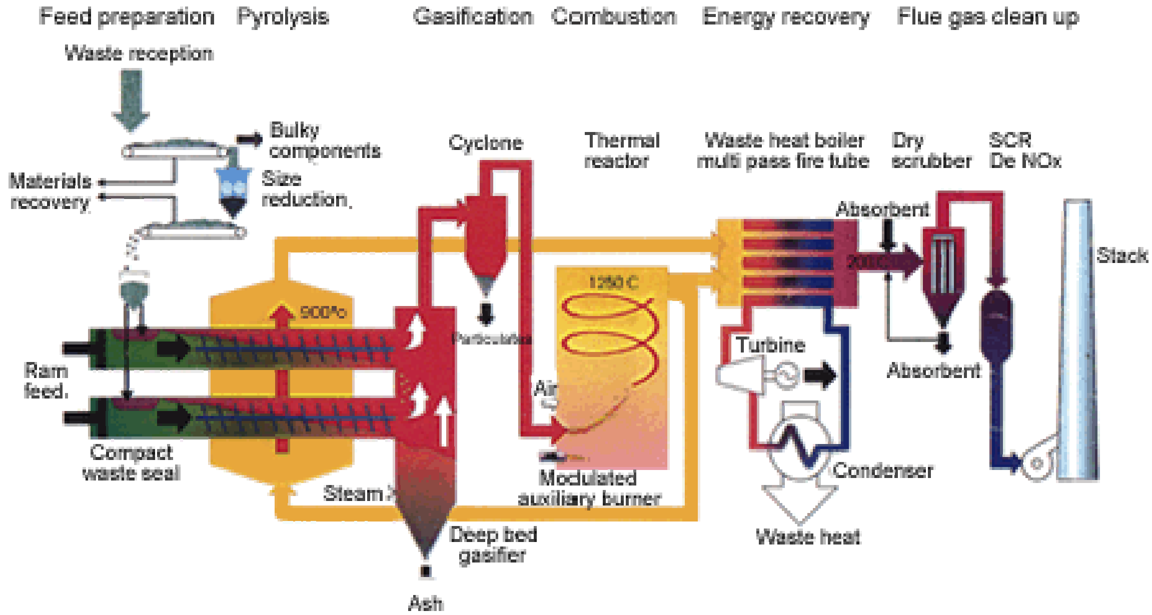
Compact Power have sold the Dumfries site, for which they had planning consent to build a plant, as they were unable to develop this project. Compact Power went into administration on 16th January 2008. Compact Power were subsequently taken over by Ethos Recycling, who were formed from the skip-hire firm Sweeney Environmental, and who intend to continue to market the technology. According to Ethois Recycling, work has started on the construction of a larger Avonmouth facility to process residual municipal waste.

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 and 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 by 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 about 14%. 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

Current Position

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

Novera are developing the ELSEF project. The ELSEF project is ongoing but will not reach financial close in the short term and therefore will not be operational for at least 2 years. The plant will take 90,000 tonnes of refuse derived fuel (RDF) from the Shanks MBT plant at Frog Island providing Ford with between 8 and 10 MW of energy.

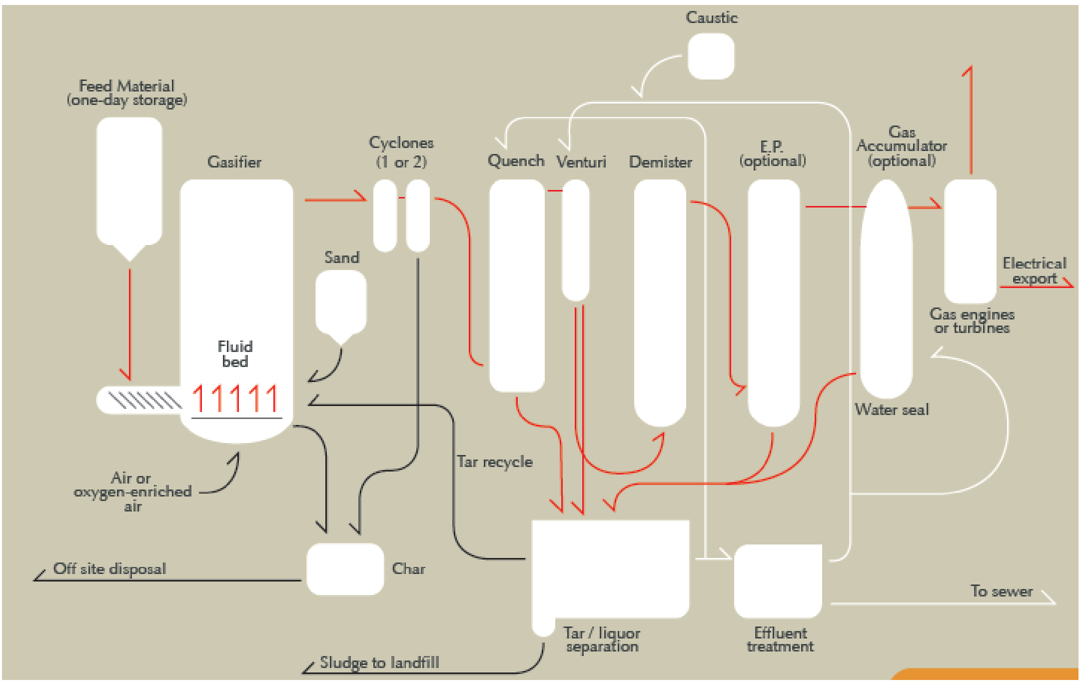
Process Overview

The proposed process includes the following steps:

1) Feedstock reception 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 a gas engine / turbine. 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

There is a single reference plant in Castellon, Spain using gas engines for power generation. The feedstock for the reference plant was plastics with a high net 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. The process can only process refuse derived fuel.

6.6 Ener-G / Energos AS

Current Position

EnerG are constructing an EfW facility on the Isle of Wight for the treatment of the Island's waste. This will be a single unit processing about 35,000 tpa of material.

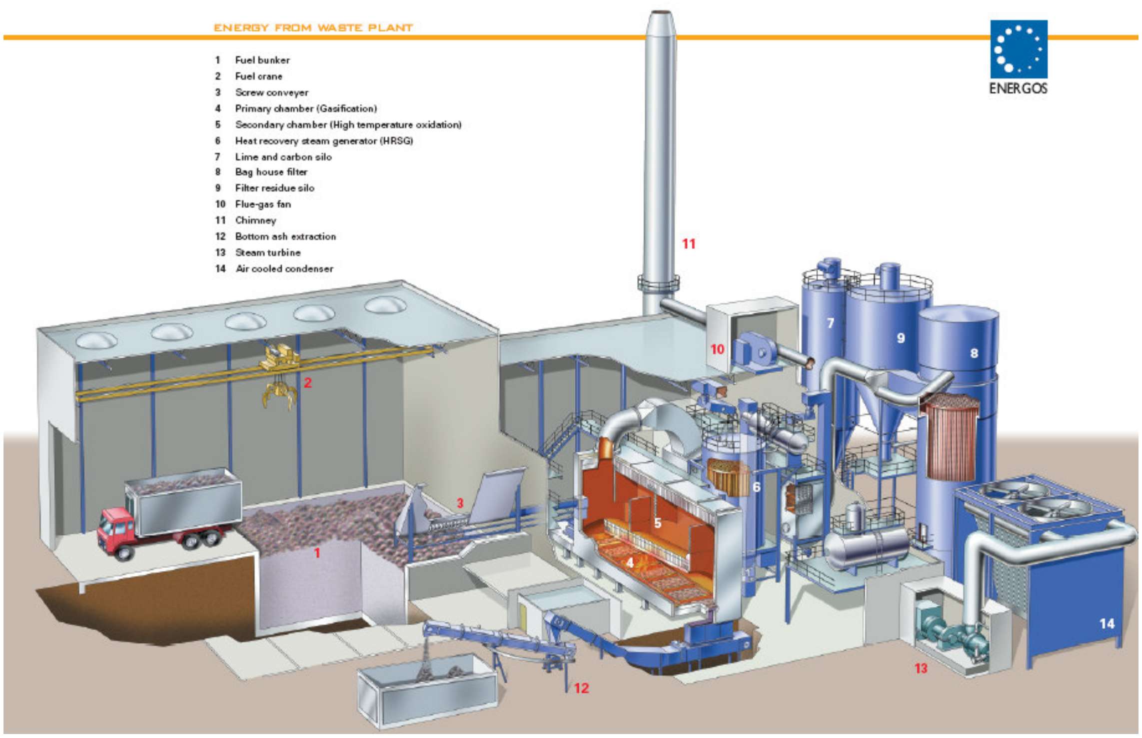
EnerG were placed on the shortlist for Jersey and asked to provide a proposal. Midway through the tendering stage the company withdrew from the process as they were having difficulties fitting their process into the available footprint, and also had resource problems due to several other projects which they considered they had a better chance of winning.

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 was considered a possible solution for Jersey because of the following:

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

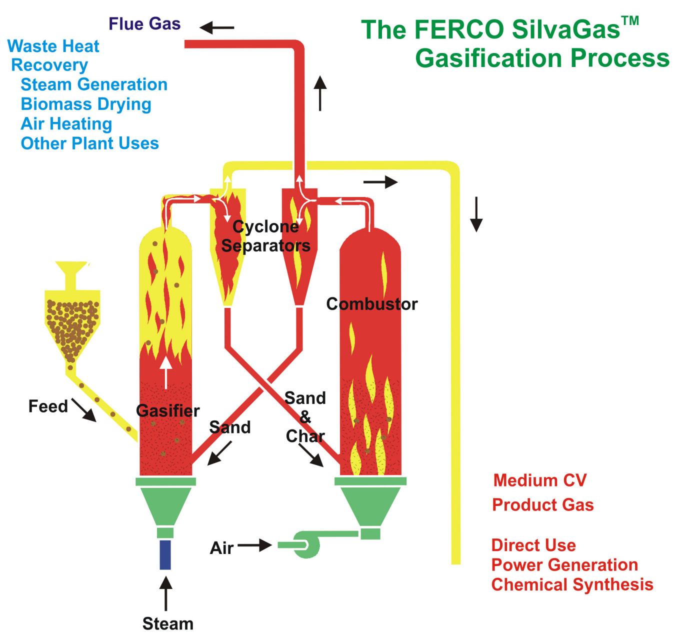
6.7 Ferco

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.

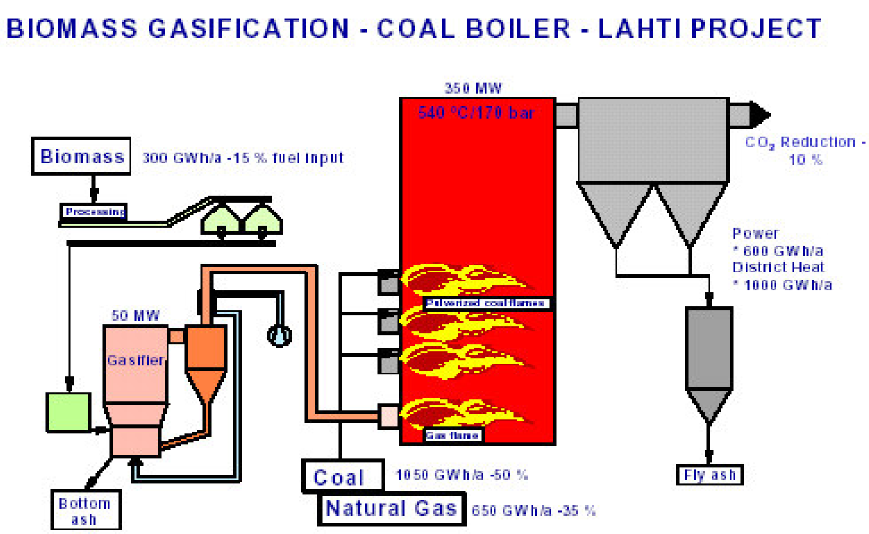
6.8 Foster Wheeler

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. The fuel input is 60 MW_{th}. The syngas is co-fired in a conventional power station. Foster Wheeler is targeting the gasifier for processing 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 which 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 in order 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)

Current Position

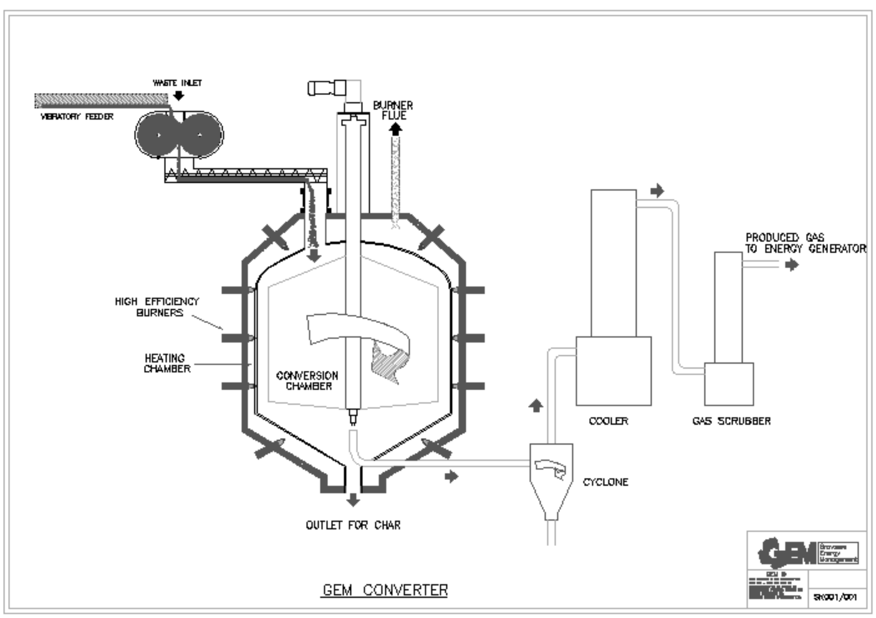
As part of the UK New Technologies Demonstration Programme, an EfW facility is to be built in North Yorkshire by a partnership of Yorwaste, NEL and GEM. The project is to be known as Scarborough Power and will process 18,000 tonnes per year of MSW into a prepared fuel. This fuel will then be converted into syngas using the GEM Technology. According to GEM, this plant is in construction and will be operational in 2008.

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. The 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 have operated a small test plant at Bridgend. 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:

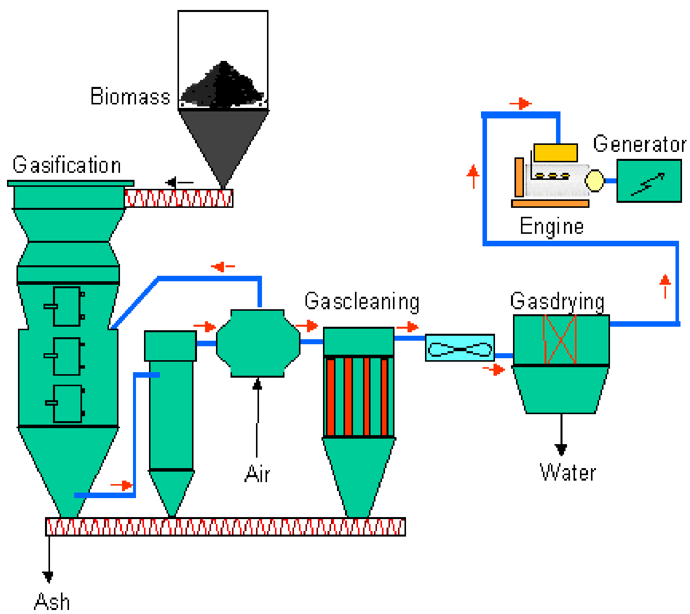
- There are no reference plants operating commercially.
- Pre-sorting and significant pre-treatment of the waste stream is required. The gasifier cannot accept broken glass and waste must be dried to a low moisture content of only a few percent prior to gasification.

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.

Illustration 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

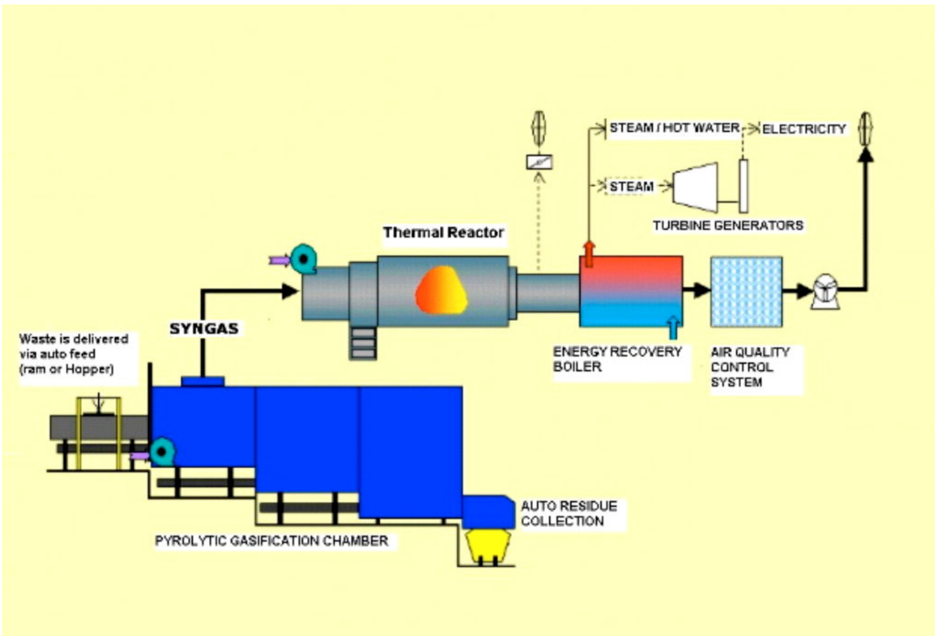
Process Overview

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 NOx 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 control of volatile organic compounds (VOC) 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). There is only one plant in Europe (Poland), which has a capacity 5 tonnes of clinical waste per day and where steam is vented to atmosphere, i.e. no energy recovery.

Suitability for Jersey

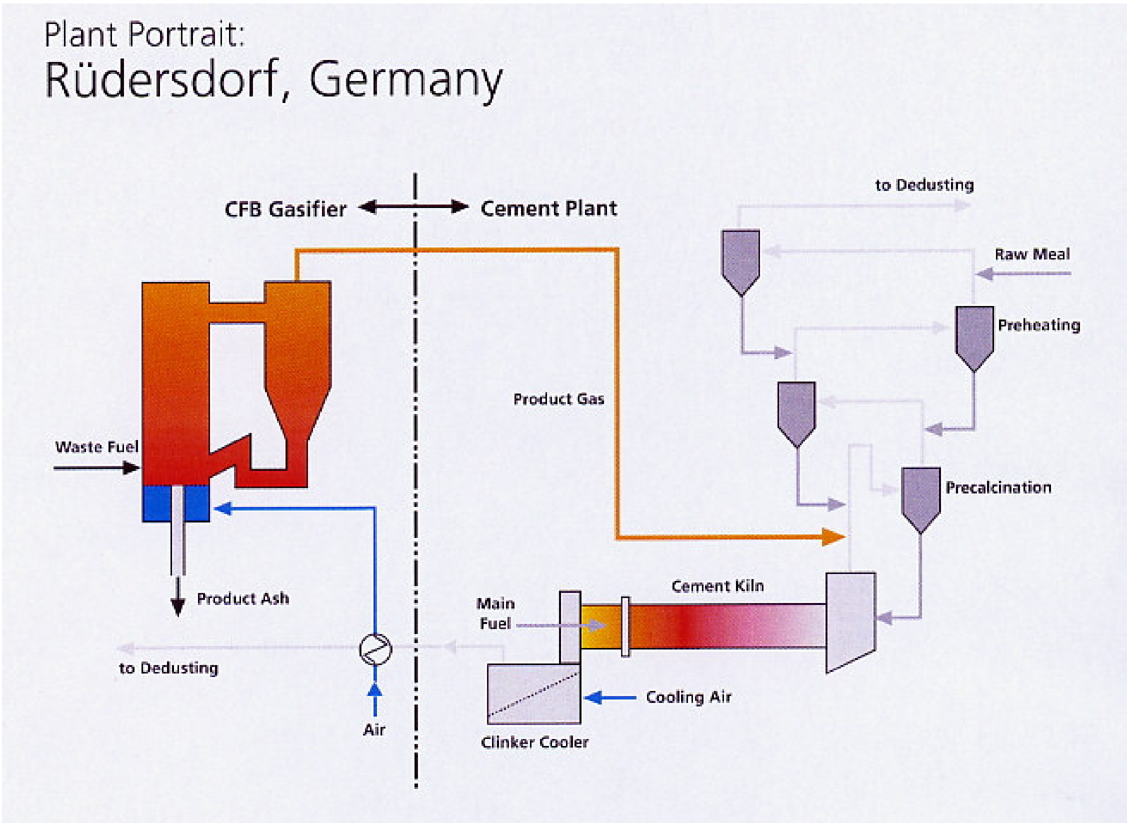
There are a number of plants in the Far East. However, the plants reviewed were of a smaller scale and the proposed feeding systems would not be suitable for the much larger tonnages in Jersey. It has not been possible to establish sufficient confidence in the applicability of this solution.

6.12 Lurgi (Lentjes, now AEE)

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, Germany which utilises 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.

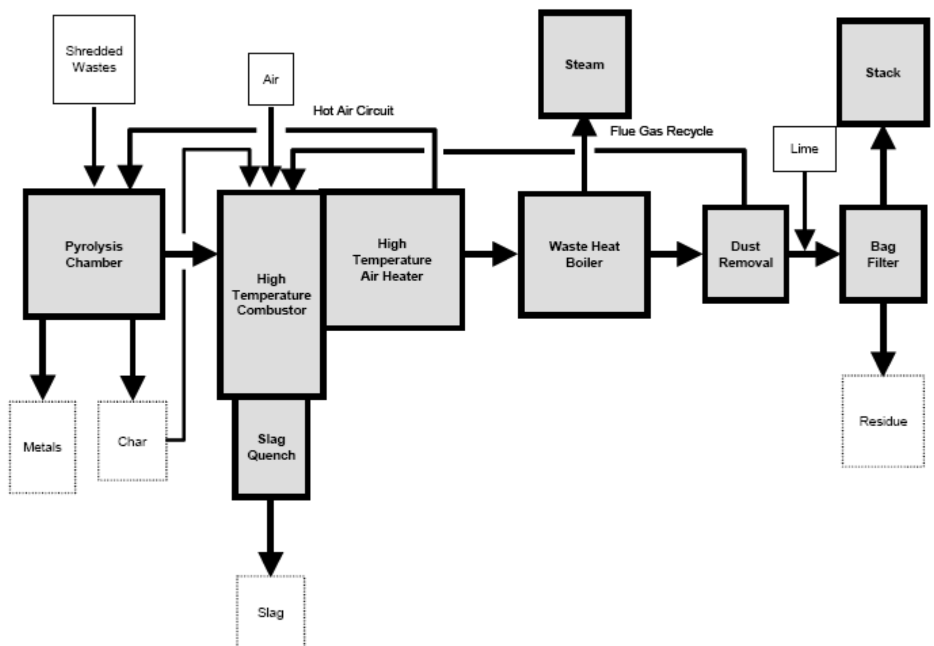
6.13 Mitsui-Babcock

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.

Image taken from Mitsui-Babcock 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

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

Gasifier unit (source Nathaniel Energy web-site)

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

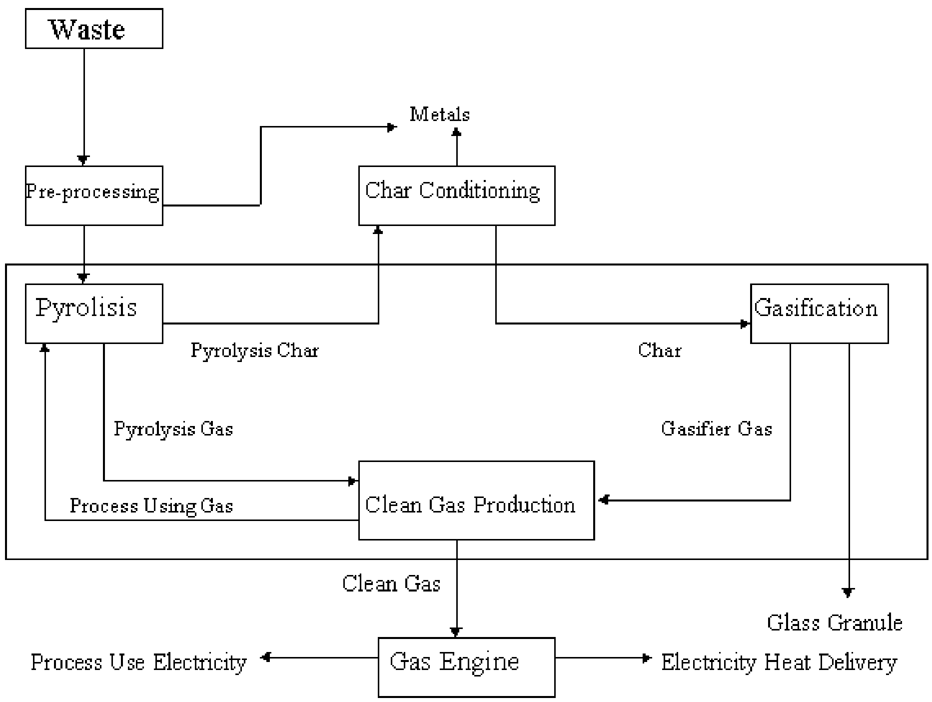
Process Overview

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 PKA website



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

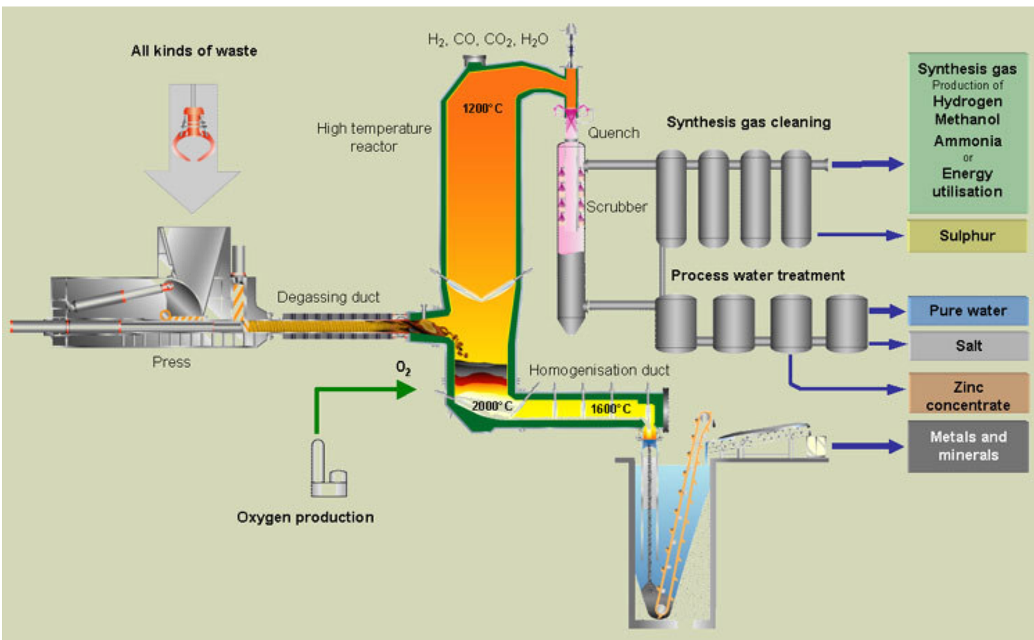
Process Overview

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°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;
- One plant in Chiba, Greater Tokyo, Japan (2 x 50,000 tpa) operational since 1999; and
- One plant, c. 40,000 tpa, in Mutsui, Japan.

Thermoselect tried to market this process in the UK several 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 it is no longer operating.

Suitability for Jersey

The technology is not considered suitable for Jersey because:

- The main European reference plant is closed having not operated successfully;
- 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.

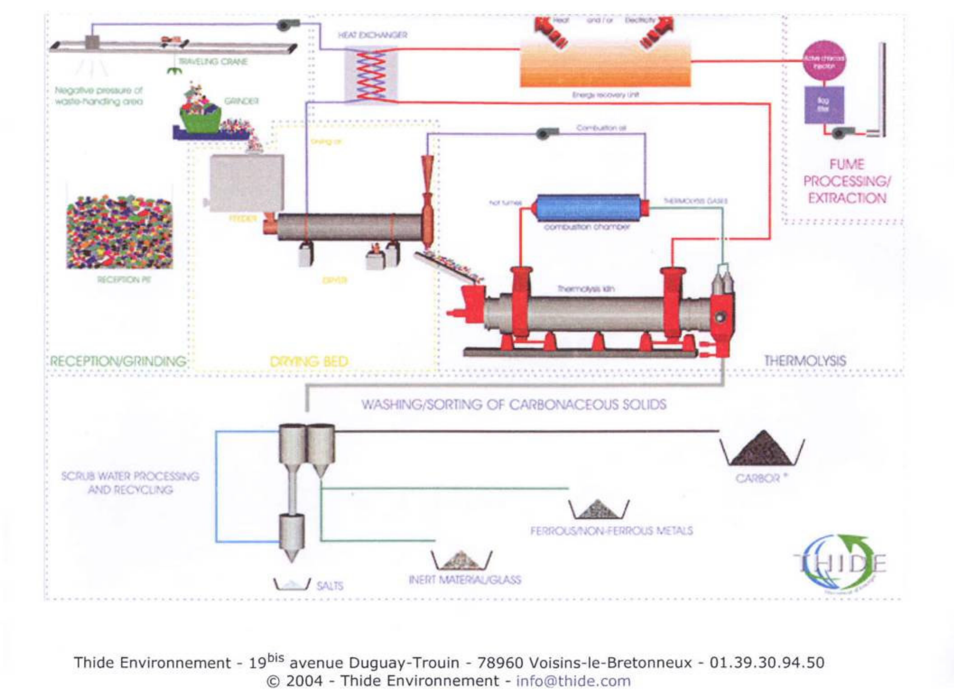
6.17 Thide

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 Thide website



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 there 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:

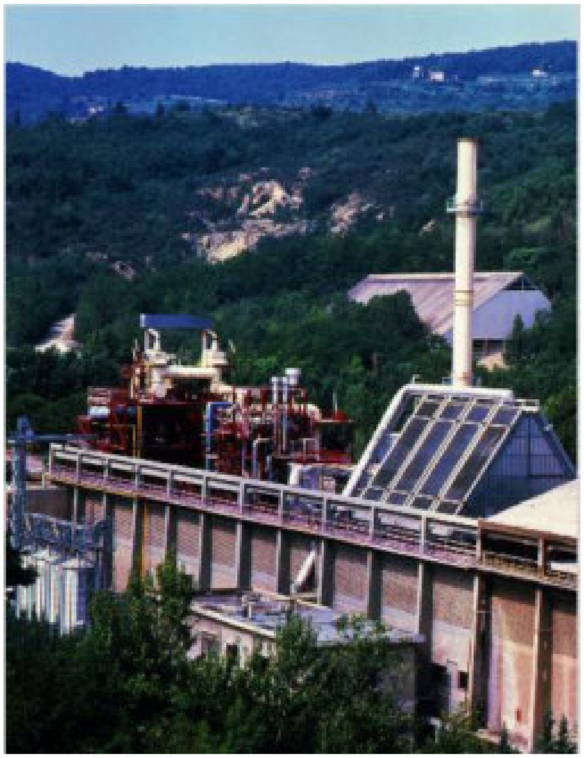
1) RDF reception, storage, and feeding;
2) Gasification using a circulating fluidised bed;
3) Syngas combustion;
4) Power generation via steam cycle;
5) Flue gas treatment.

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



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

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. They have designed and built an 'Integrated Fast Pyrolysis Plant' to produce pyrolysed liquid from biomass feedstock.

Integrated Fast Pyrolysis Plant

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.

6.21 American Combustion Tech Inc

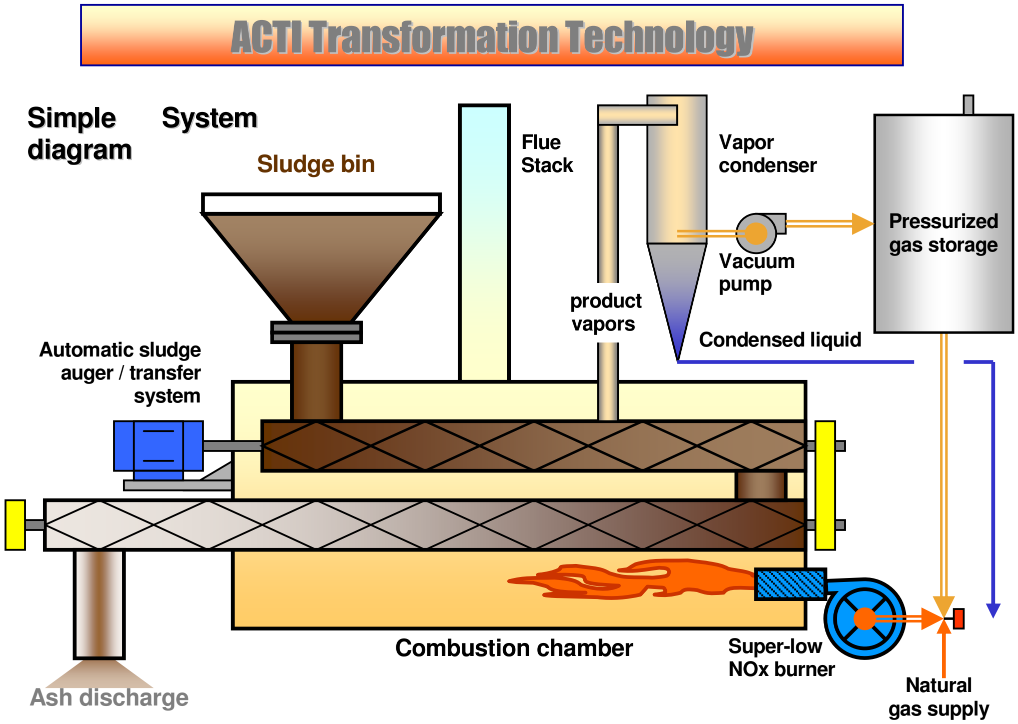
Process Overview

The process involves the formation of a syngas, cleaning of the syngas and energy recovery in a gas engine. The key process steps are:

1) Indirect heating of waste material to 540°C;
2) Transformation of solid waste into a syngas;
3) Cleaning of the syngas;
4) Liquefaction of the syngas or use in a gas engine;
5) Use of the excess gas for continuation of the process.

The process has one demonstration plant in the USA, processing cow manure. This plant does not use a gas engine. The process is being marketed in the UK by Bedminster, as part of an overall municipal waste treatment facility.

Gasification process from American Combustion Tech website



Suitability for Jersey

The technology is not considered suitable for Jersey because:

- There are no commercially operating plants processing MSW;
- The process requires extensive waste pre-treatment producing other waste streams.

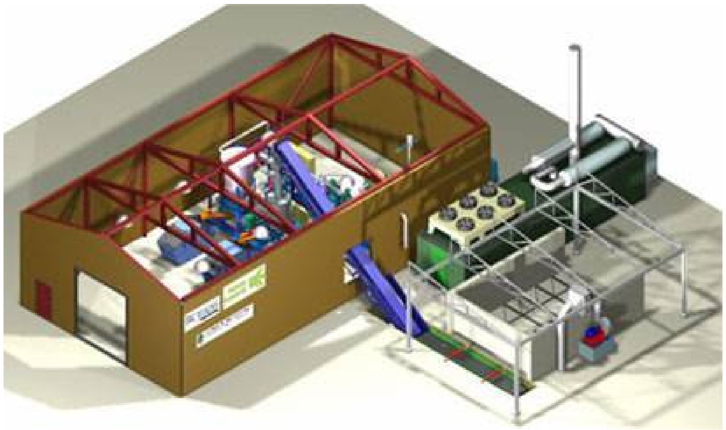
6.22 Biomass Engineering

Process Overview

This process releases energy stored in the biomass feedstock such as wood chippings, forestry wood or energy crops, converting the energy into a syngas. This is then used to produce heat, power or combined CHP.

Biomass Engineering have started commissioning of their first multi-module plant consisting of four gasifier modules and two gas engines, to process woodchips. The company has obtained funding to enable the development and operation of a series of these biomass energy plants.

Gasification process from Biomass Engineering website



Suitability for Jersey

The technology is not considered suitable for Jersey because

- There are no commercially operating plants processing MSW;
- The process is currently being developed to process biomass streams rather than MSW;
- The process will need pre-treatment of MSW to produce an acceptable feedstock.

6.23 First London Power

First London Power are developing a new pyrolysis technology. They have a test plant currently generating energy from 0.5 t/h of biomass. In addition they are developing a plant that will be capable of processing 3 tonnes per hour.

Process Overview

The key process steps are:

1) Feeding of the biomass fuel into the pyrolysis chamber;
2) Creation of a syngas;
3) Separation of a char from the syngas;
4) Gas scrubbing using water and activated carbon;
5) Use of syngas produced.

Suitability for Jersey

The technology is not considered suitable for Jersey because there are no commercially operational plants processing MSW. The process is being developed to process refuse derived fuel and therefore residual waste would require pre-treatment prior to processing.

6.24 ITI

ITI have been developing a gasification process out of Newcastle University.

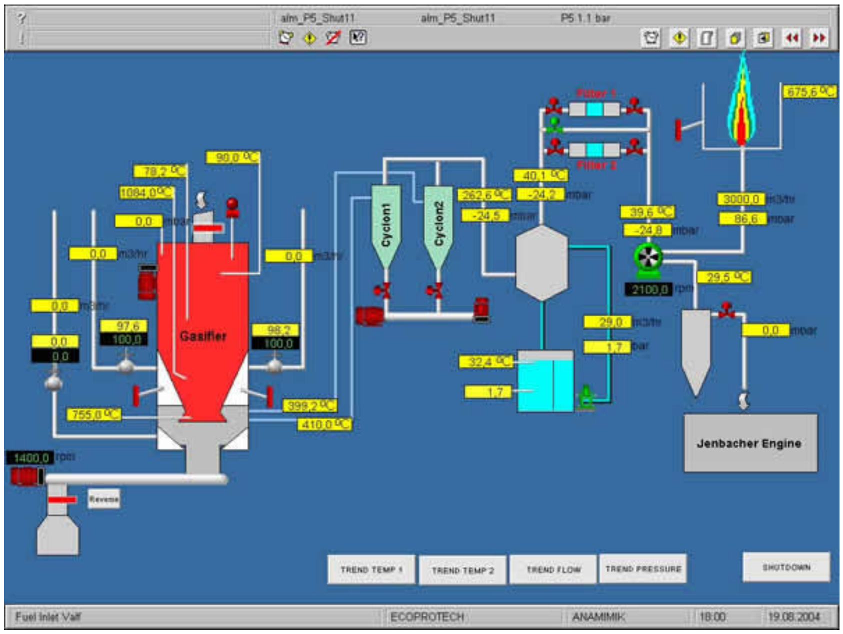
Process Overview

The fuel for the gasification process requires a consistent high density dry solid fuel (typically a RDF). The fuel is fed to the gasifier where a combustible syngas is produced to be utilised in gas engines.

Cleaning of the syngas is carried out prior to the gas engines. This is done by using cyclones for particulate control, a vortex water scrubber to cool the product gas and plasma for controlling of the fine particulates in the gas stream.

We are not aware that ITI have any commercial size plant in operation.

Gasification process from ITI website



Suitability for Jersey

The technology is not considered suitable for Jersey because there are no commercial reference plants processing MSW and the process would require significant pre-treatment of the residual waste.

6.25 Prestige

Prestige are a South African company currently marketing a new gasification process in the UK. Prestige have operated a demonstration unit in South Africa. There are no commercial plants of this type currently operating. The gasification plant is being considered for several projects as part of an overall waste management solution.

Process Overview

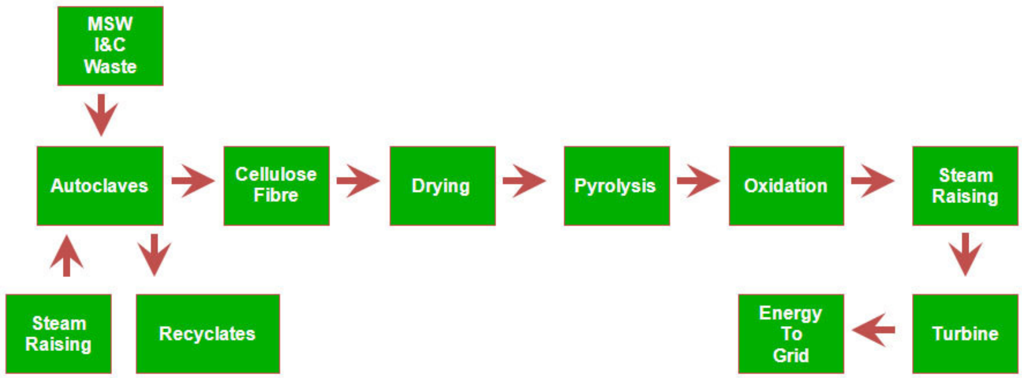
The key process steps are:

1) Waste delivery and storage;

2) Processing of the waste, for example through steam autoclaves using steam to break down the biodegradable fraction of the municipal waste. This produces a clean and sanitised fibrous material;

3) Mechanical separation of the autoclaved material into separate fractions including the recovery of recyclable material;
4) Drying of the fibrous material in a rotary kiln;
5) Gasification of the dried fibre and creation of a syngas;
6) Electricity Generation and steam recovery for use in autoclaves;
7) Flue Gas Treatment.

Autoclave and Pyrolysis process from Prestige website



Suitability for Jersey

The technology is not considered suitable for Jersey because:

- There is no commercially operational reference plant;
- The process will require significant pre-treatment, potentially using a steam autoclave or other process, and a drier to prepare the fuel.

7 MECHANICAL HEAT TREATMENT

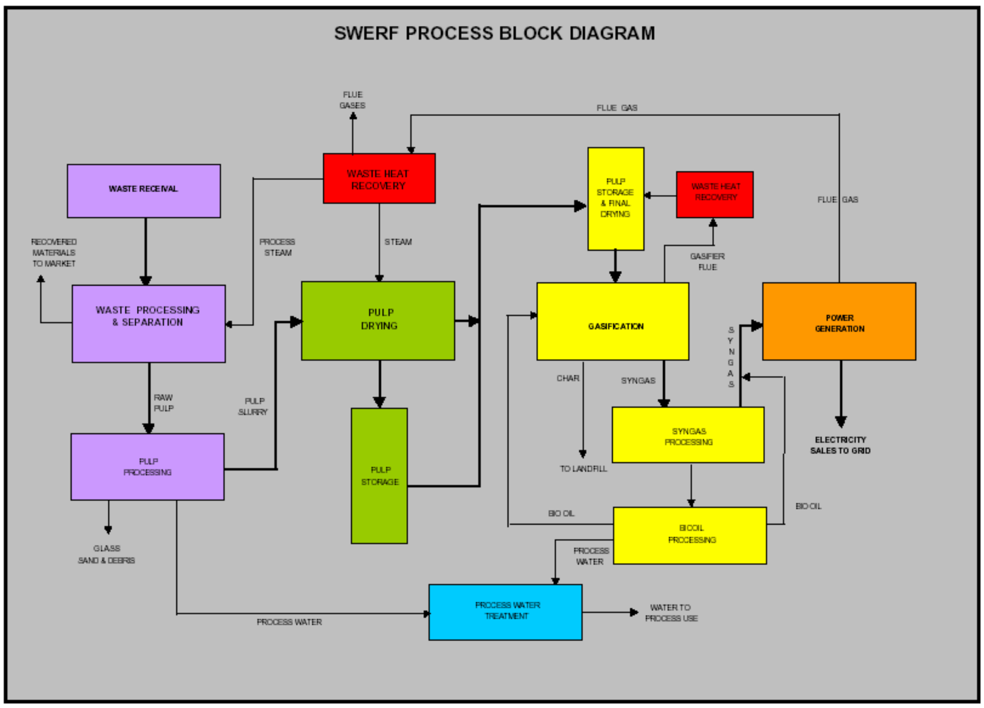
7.1 Brightstar Environmental - SWERF process

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 which operated intermittently with a capacity of 25,000 tpa compared to the design capacity of 100,000 tpa.

Gas engines were employed for power generation. The exhaust gases did not meet Waste Incineration Directive (WID) limits, however, 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, where 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 "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 from Estech Eurpoe website

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 are required for the recycled materials, i.e. organic fraction (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 reference 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 trommel 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 Fernwood website

Reference Plants

There is a demonstration plant at Alabama University, USA. 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

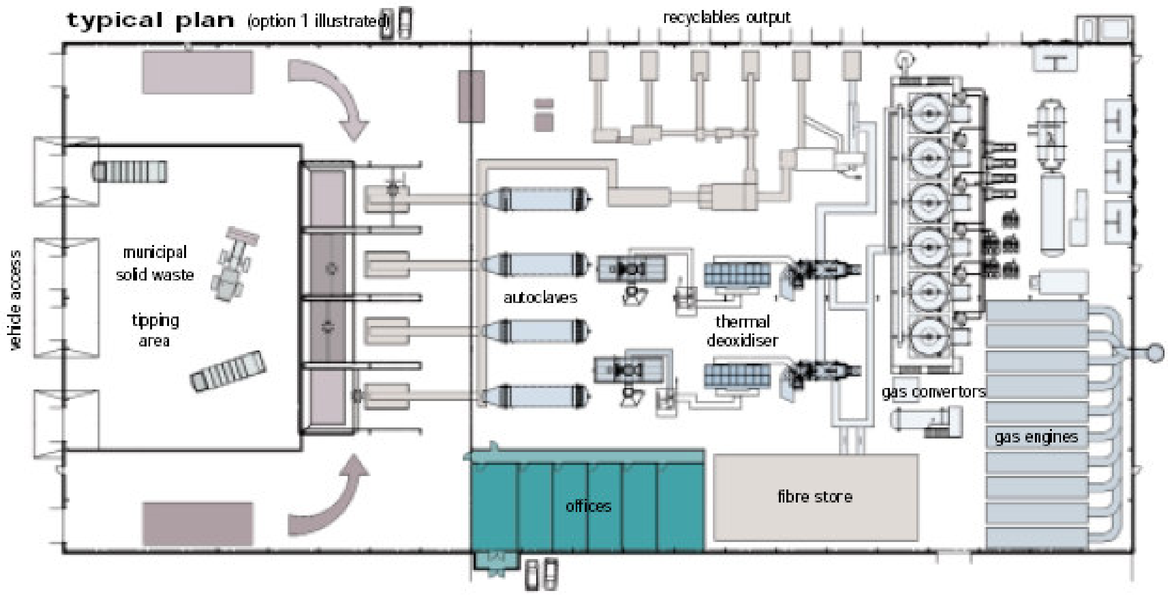
Process Overview

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 is proposed to 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. In 2005, Thermsave claimed to have been appointed as technology supplier to the main contractor Sembcorp Simon-Carves, who were 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 still 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 (i.e. gasification, combustion or anaerobic digestion) in order to fully treat Jersey's waste.

7.5 Comex

Process Overview

The key process steps are:

1) Waste reception and storage;
2) Manual pre-picking of items that could physically damage the plant equipment;
3) Charging of the waste into the autoclave with steam at 150-170ºC injected for 35-50 minutes, sterilising the waste and forming a fibre. With the full cycle of loading, treatment and sorting the residence time for waste is around 90 minutes in the autoclaves;
4) Separation and recovery of the waste using a series of screens and recovery systems. The systems used are: a debris roll screen, over-band magnet, eddy current separator and air classifier to separate the various fractions allowing recyclates recovery;
5) The residual waste is sent to landfill.

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.

7.6 Environmental Heritage Services (EHS)

Process Overview

Our understanding of this process, which has been proposed for Alderney, is that it uses a mechanical heat treatment to process the waste, which it is claimed is then used for building products. EHS is based in Jersey, but we have found no publicly available details of the proposed process.

The mechanical heat treatment process normally involves the following stages:

1) Waste reception followed by pre-treatment of the waste to remove unacceptable material;
2) Sterilisation of the waste using heat or direct steam injection into the waste at pressure. This also causes the breakdown of the organic fraction of the waste resulting in the creation of a fibrous material;
3) The fibrous material is screened out and the coarse material normally separated into different waste streams.

Suitability for Jersey

Whilst we have not been able to review the detail of this process, mechanical heat processes are not generally considered suitable for Jersey as:

- The process is a pre-treatment process. Disposal routes would need to be found for the separated materials, normally including fibrous organic material, glass and stones, metal, plastics and a residual stream;
- The mechanical heat processes consumes energy and normally slightly more waste material leaves the heat step of the process than enters it (because steam injection adds water to the process);
- The claim is that the process produces "building materials", but the quality of these and their sustainable use would need to be reviewed in detail;
- There are no commercial reference plants of which we are aware, treating mixed municipal waste of a similar composition as Jersey.

7.7 Orchid Fairport

Fairport Engineering's subsidiary company Orchid has developed an alternative mechanical heat treatment system which does not use a steam autoclave. Through the UK New Technology Demonstrator Programme, a facility has been built in Merseyside that will process up to 50,000 tonnes of MSW a year.

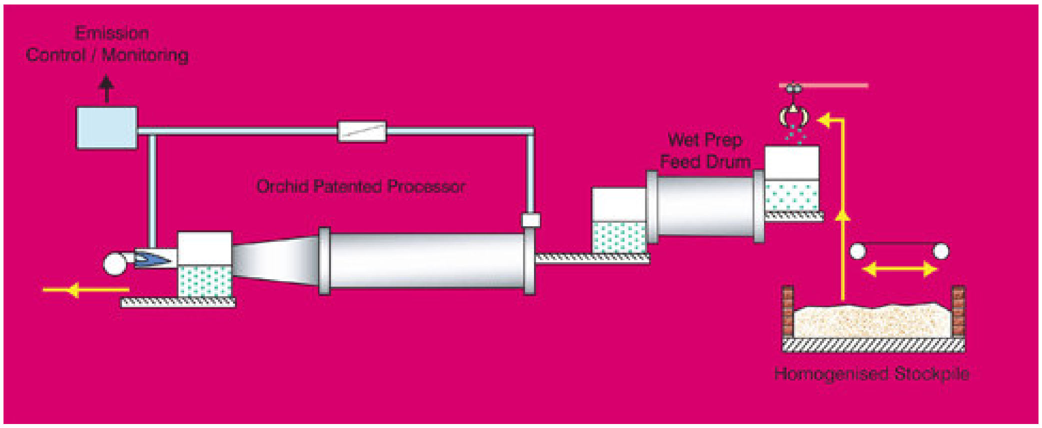
Process Overview

The key process steps are:

1) Separation of the incoming waste into an undersize and oversize fraction using a trommel screen;

2) The removed of miscellaneous items from the trommel oversize before shredding. The undersize from the trommel is then added to the shredded oversize and mixed into a homogenised stockpile, to provide consistency in the waste input;
3) The homogenised stockpile is then fed into the wet feed preparation drum, before being passed into the main waste processor which is heated using an external heating source;
4) At the end of the processing step, a mix of sanitised recyclables and unrefined biomass fuel product are produced for further treatment and separation;
5) The material then passes through a trommel screen, with the oversize going through a materials handling process to separate out the clean and sanitised recyclables.

MHT process from Orchid Environmental website



Suitability for Jersey

The technology is not considered suitable for Jersey because:

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

7.8 Sterecycle

Sterecycle are constructing a merchant waste facility in Rotherham, South Yorkshire capable of treating 100,000 tpa of commercial waste from hotels and offices.

Process Overview

The process includes the following stages:

1) Reception of the waste and transfer to autoclave;
2) Treatment of the waste in the autoclave at 140°C using steam. This temperature is maintained for a period of approximately 30-45 minutes to create a homogenous biomass fibre;
3) Post autoclaving, material separation occurs with the recovery of the product fibre and recyclables. Metals, plastics, glass and aggregates are separated and sent for recovery or re-use. The fibre product is generally clean and sanitised.

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.

8 ANAEROBIC DIGESTION

8.1 BTA

Current Position

BTA technology is currently being marketed in the UK by Enpure, and this technology is being proposed by Viridor/Laing for the Greater Manchester PFI contract.

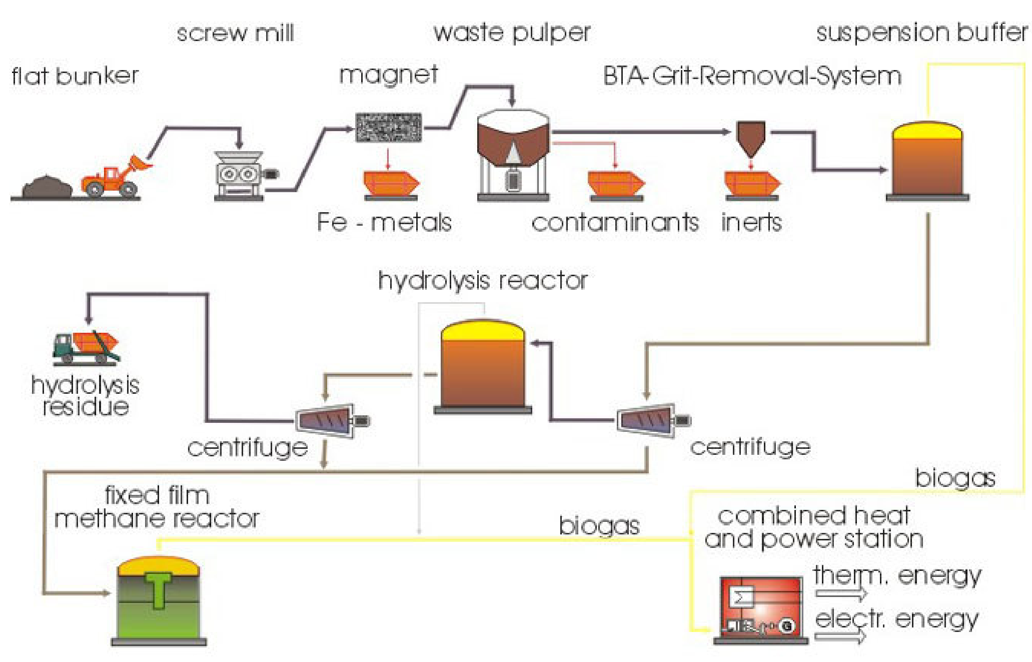
Process Overview

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

Current Position

A plant is currently operating in Shropshire processing source separated kitchen waste. This project is part of the UK New Technology Demonstrator Programme.

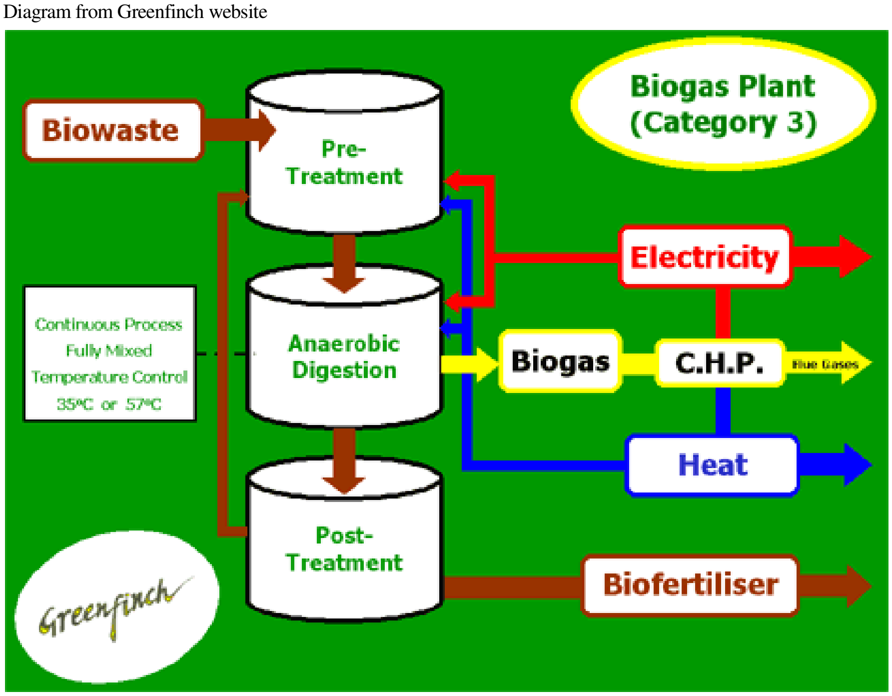
Process Overview

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



Reference Plants

A plant is in operation for South Shropshire County Council, which processes about 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.

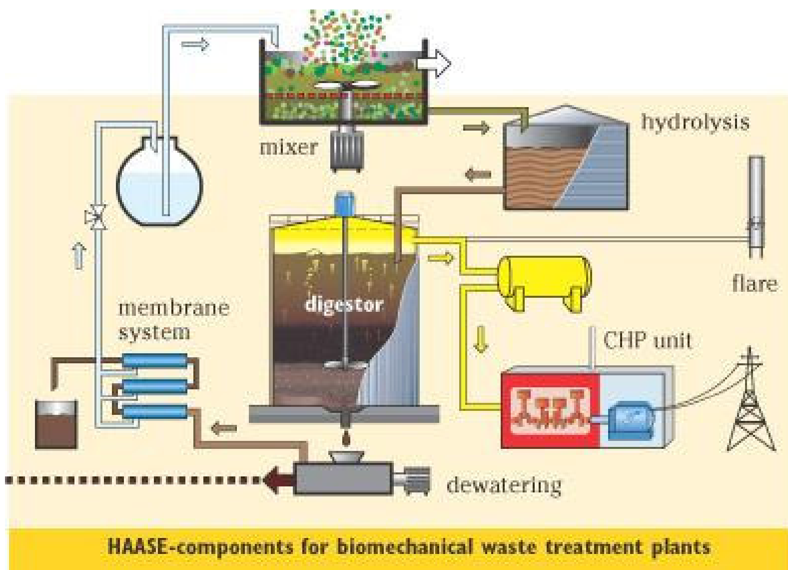
8.3 Haase

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.

Illustration from Haase website



References

There are several operating references for AD plants including Groeden, Germany (110,000 tpa manure and biowaste) and 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.

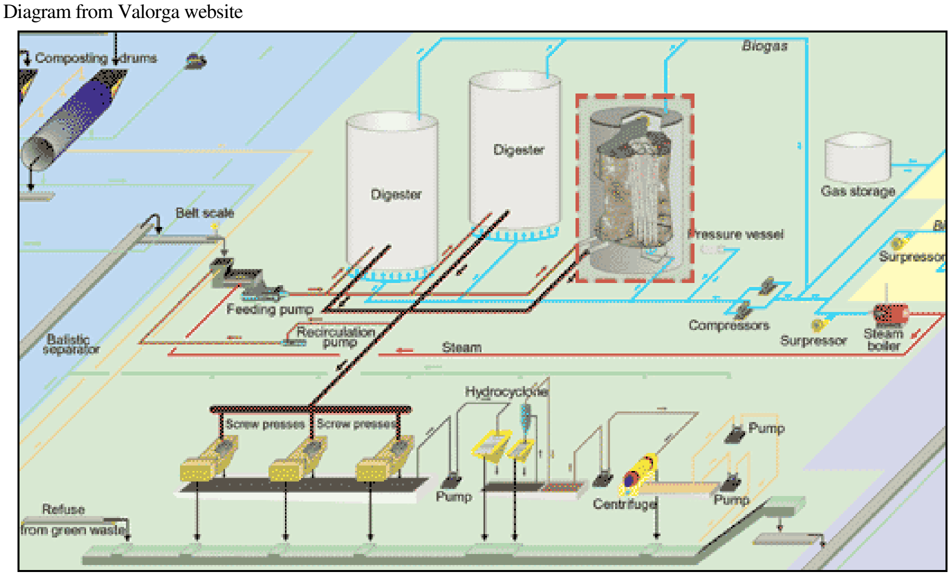
8.4 Hese-Valorga

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



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) and 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

Current Position

The licence for the technology in the UK is held by Global Renewables who are developing the Lancashire Waste PFI project. Two large facilities are under construction which will separate the plastics and other reject material at the front end for landfill. The separated organic material is then treated in the anaerobic digestion process, and the digestate will be used as restoration material for landfills.

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 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 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

Current Position

Linde have sold this part of their business to Strabag who are currently marketing it.

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-biological 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.

8.7 Oak Tech Environmental

Oak Tech Environmental uses the ArrowBio MBT process which utilises water as a medium for the gravitational separation of inorganic and organic fractions of MSW.

The Process

The process consists of the following stages:

1) A wet Materials Recovery Facility combining standard solid waste handling technology with liquid and slurry pumping. Recyclable material is cleaned, recovered and further separated by type; ferrous metals, non-ferrous metals and plastics and residues that are sent to Landfill;
2) The second stage of the process is the Up-flow Anaerobic Sludge Blanket (UASB) Digestion system producing a biogas.

Reference Plants

There is a full scale commercial plant in operation in Tel Aviv, Israel processing 70,000 tpa of MSW and a second plant in Sydney, Australia that processes 100,000 tpa of 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. A separate disposal facility will be required for the non-organic waste fraction.

9 MECHANICAL BIOLOGICAL TREATMENT

9.1 ADAS

Current Position

As part of the UK New Technologies Programme ADAS/Envar have built an ABPR compliant, double ended, in-vessel composting plant in St Ives, Cambridgeshire, licensed to process up to 105,000 tpa of waste. The plant will produce compost and RDF from biodegradable municipal waste.

Process Overview

ADAS is a former government advisory service for agriculture and horticulture. 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 or disposal routes would be needed for each of these streams.
- The single reference plant has only been operating for a short period.

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

Current Position

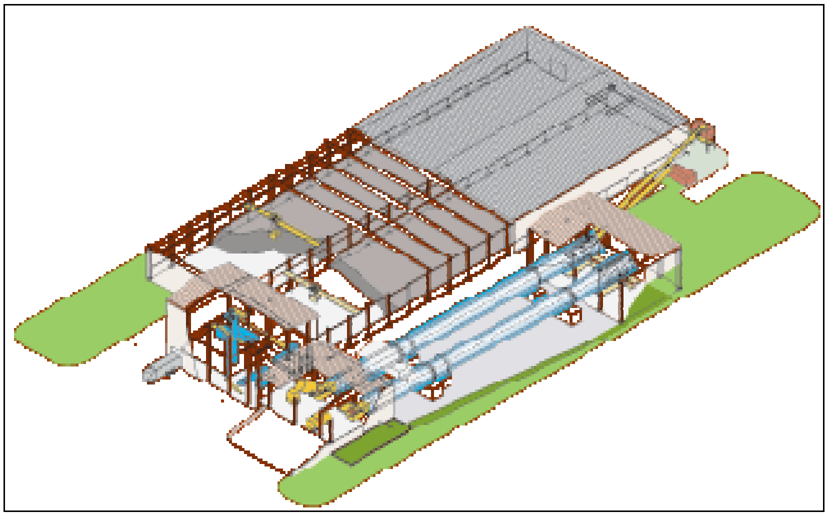
Bedminster are actively marketing their process to waste companies and authorities in the UK and have recently been granted planning consent for a facility in Cheshire. They have expanded their process to include a Bio-Energy process, using the ACTI process (see Section 6.21).

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, composting treated MSW, often 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 in the early stages of the Jersey project:

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

Current Position

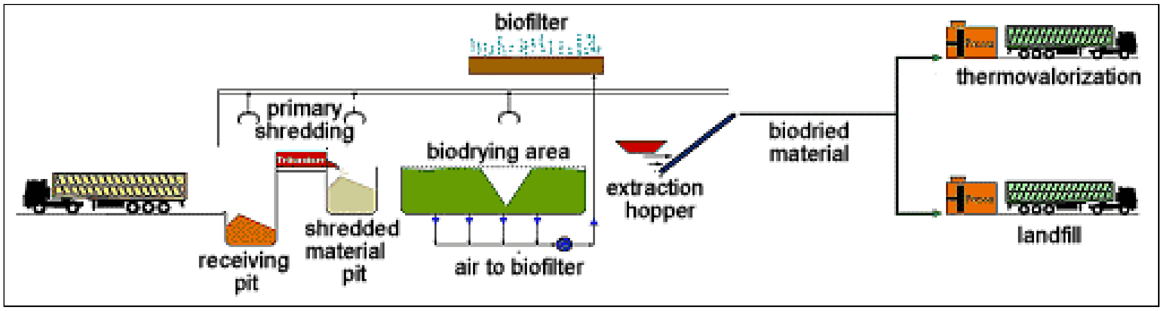
Two plants in London are now operational processing up to 400,000 tpa of residual waste, along with a smaller one processing 65,000 tpa in Dumfries and Galloway. In addition the technology has been selected as the proposed technology for Cumbria. In the UK, the Ecodeco process is marketed by Shanks Waste Management, who hold the exclusive licence.

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 screening, 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 and compostable organic 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 in operation in East London and a further plant is operating for Dumfries & Galloway Council (60,000 tpa MSW) starting processing waste in 2007.

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 Global Renewables

Current Position

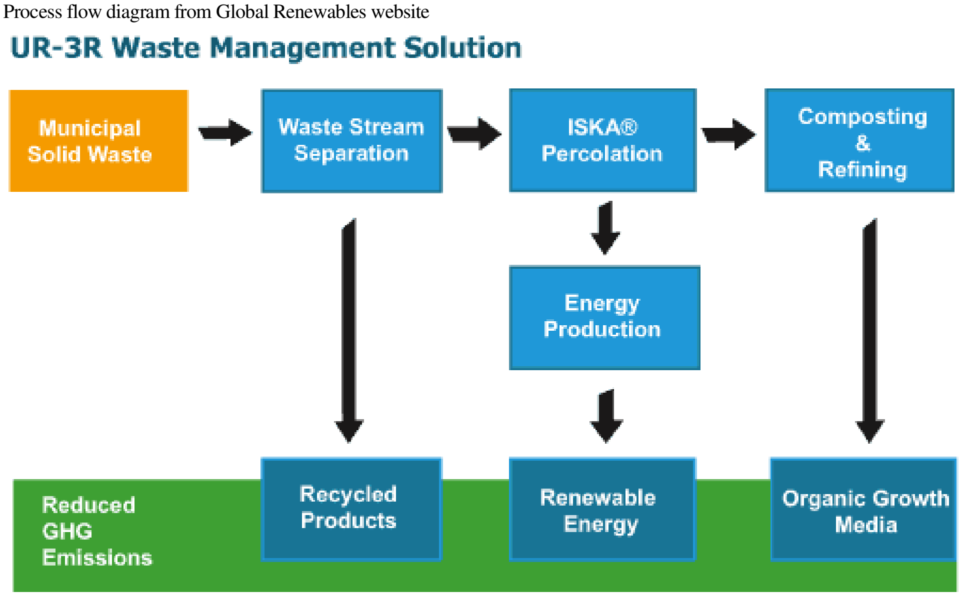
Global Renewables have secured a contract with Lancashire to handle 600,000 tpa of MSW. This will use two MBT facilities which are currently under construction. These plants will separate out rejects which will be landfilled, whilst the organic material is anaerobically digested, generating some net electricity. The digestate produced from the mixed waste is low quality with limited use, most probably as restoration material on landfills.

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



References

The Eastern Creek facility in Sydney, Australia with capacity around 200,000 tpa of MSW which came into operation in 2005. Global Renewables is constructing two similar facilities for the Lancashire PFI contract.

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.

9.7 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 is 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.

9.8 Haase

Current Position

Haase have completed construction of a number of new facilities, now operating in Europe, including Lübeck (150,000 tpa residual waste) and Schwarze Elster (50,000 tpa MSW). Haase are also selected to provide MBT facilities for the Greater Manchester Waste PFI contract which Viridor/Laing are developing.

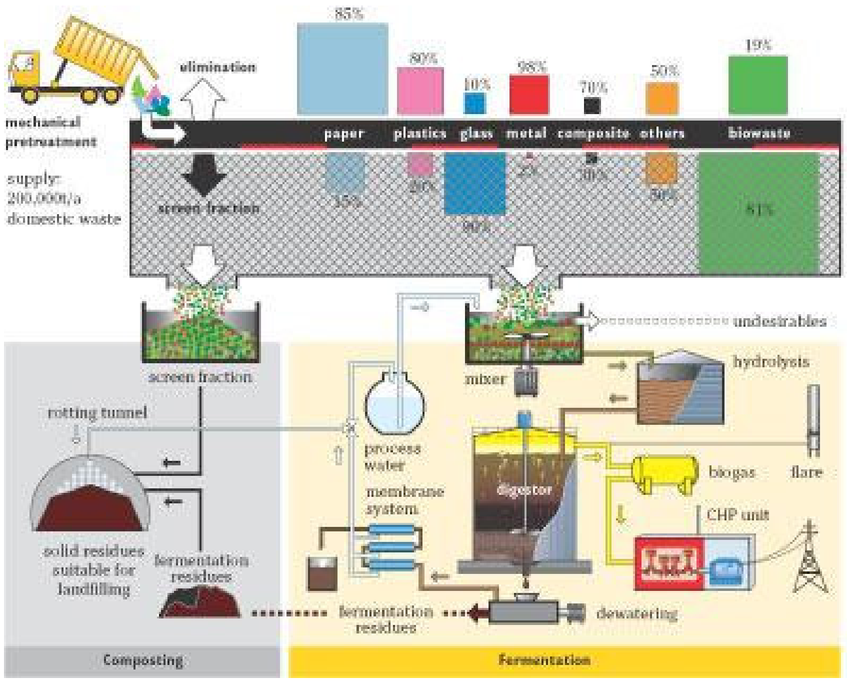
Process Overview

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 (150,000 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.

9.9 Hese

Current Position

Hese have constructed a 160,000 tpa MBT plant and a 60,000 tpa digestion plant in Leicester, currently operated by Biffa.

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 in its first year of operation, but has since been repaired.

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.

9.10 Horstmann

Current Position

Horstmann are currently in receivership.

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 was 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.

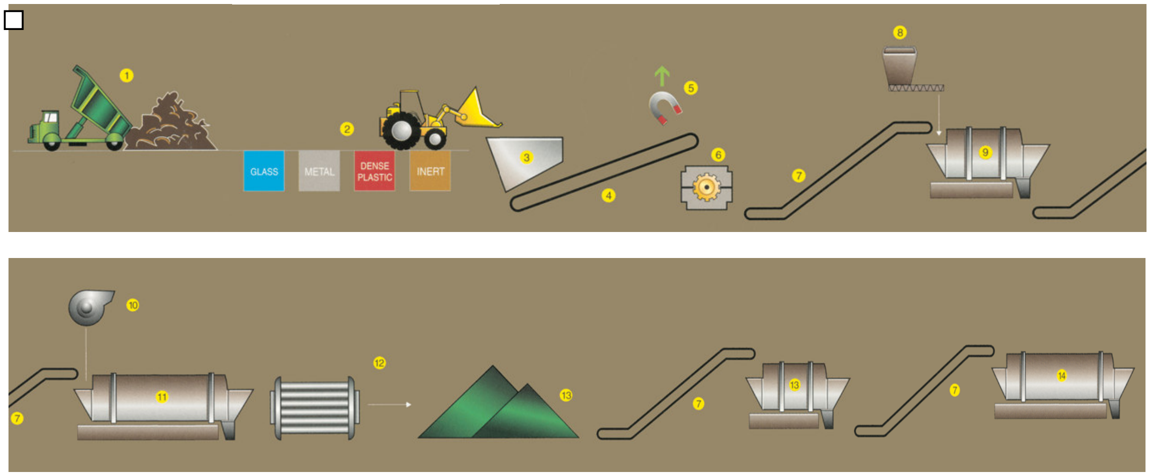
9.11 IWI

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



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

9.12 Linde

Current Position

The business area has been sold by Linde, the company is now trading under the name of Strabag.

Process Overview

Plant options for the treatment of MSW comprise either

1) Mechanical treatment, wet anaerobic digestion and 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 and 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.

9.13 Enpure

Process Overview

Enpure are marketing MBT technology in the UK. This process is being proposed by Viridor/Laing for facilities for the Greater Manchester PFI contract. The process combines:

1) Mechanical front end separation of the incoming residual waste;
2) Anaerobic digestion, using BTA's technology (see Section 6.1).

References

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 the MBT process is 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.

9.14 Premier Waste

Current Position

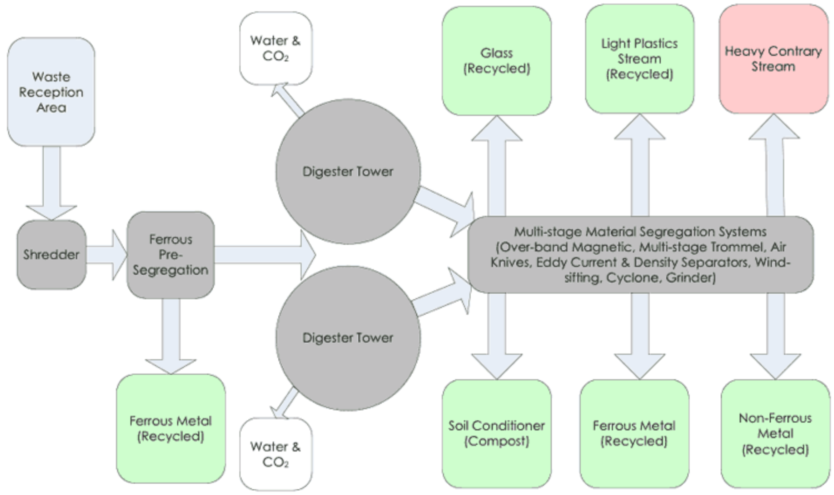
As part of the New Technology Demonstration Programme, an aerobic digestion plant in Durham has been developed to deal with source segregated organic waste.

Process Overview

The process incorporates the following stages:

1) Initial shredding of the MSW;
2) Extraction of ferrous materials;
3) Waste treatment, the waste is loaded into the top compartment of a 3 compartment vessel, within each composting compartment a large 3 limbed aeration and mixing assembly is located;
4) Waste spends two days sealed in each level, 6 days in total after which time the bio-waste fractions have been substantially stabilised and composted;
5) The mixed stabilised waste is separated into different fractions, recovering recyclable material.

Process overview from Recyclingre Invented website



Reference Plants

Premier Waste have started construction of a recycling and aerobic digestion plant in Sunderland, to process up to 400,000 tonnes of waste a year.

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.

9.15 New Earth Solutions

Current Position

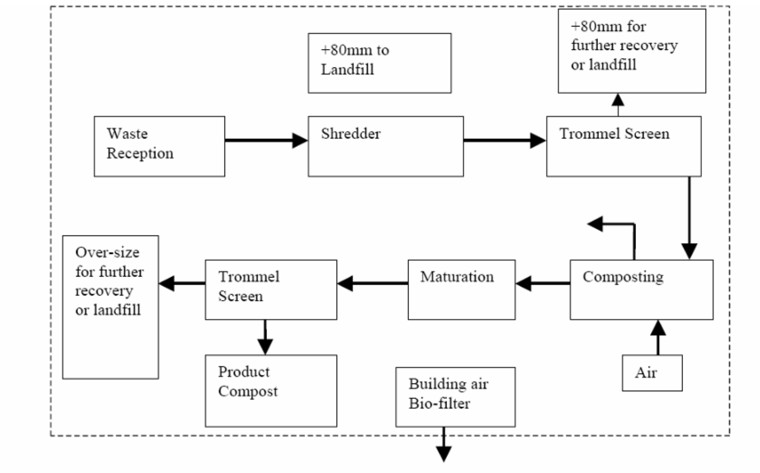
New Earth Solutions operates a 50,000 tpa operational facility in Dorset that handles source segregated green waste and MSW.

Process Overview

The process incorporates the following key stages:

1) Waste delivery and reception;
2) Shredding and screening of the waste down to a size of 80 mm using a trommel. This oversize contains a high proportion of paper and plastics that can be sent to a MRF for recovery otherwise it is disposed of;
3) Magnetic separation of ferrous metal;
4) The undersized material is wetted and transferred to the composting channels for bio stabilisation for a 6 weeks period. Aeration, mixing and leachate collection is carried out;
5) The bio-stabilised material is then screened and graded, with the removal of dry recyclables, air separation of light weight plastics and metal separation.

Process Overview from Environment Agency website



Suitability for Jersey

The process is not suitable for Jersey because:

- The process splits the waste into separate fractions requiring a number of additional processors to handle these separated waste fractions;
- A low quality compost is produced that is only suitable for landfill restoration.

10 PLASMA GASIFICATION

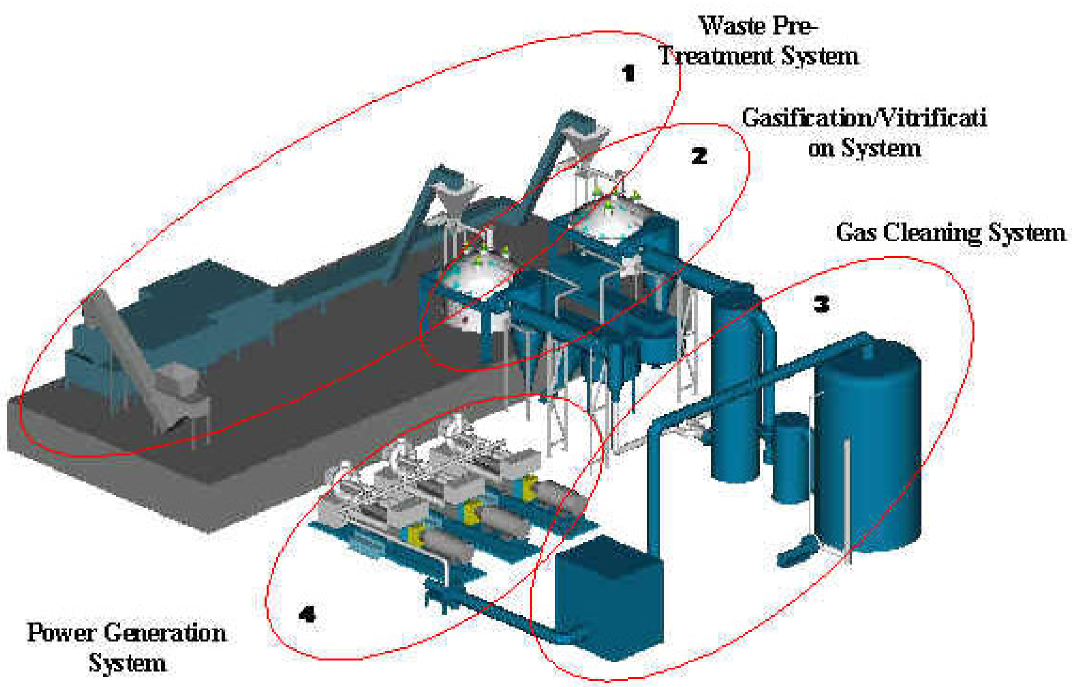
10.1 Verno / Pyrogenesis

PyroGenesis, a Canadian technology company, specialising in the use of plasma arc and thermal processing technology have developed the Plasma Resource Recovery System (PRRS).

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 system from PyroGenesis website



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 (1,250°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 Pyromex 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.

10.3 Advanced Plasma Power

Process Overview

The process involves:

1) Sorting of recyclable material out of the waste using a Materials Recycling Facility;
2) Drying of the waste producing a prepared RDF for the gasification process;
3) Gasification of the dry RDF to produce a syngas;

4) Tar and particulate removal from the syngas using a plasma converter, utilising high temperatures and intense UV radiation. This is carried out in a refractory lined vessel at around 1,200ºC;
5) Heat is recovered from the cleaned syngas using a waste heat boiler;
6) The gas is then treated using a dry scrubber then a wet scrubber to remove acid gases, particulates and sulphurous compounds;
7) This clean gas is passed into a gas engine where energy is recovered;
8) Heat is then recovered from the gas engine exhaust.

Process pilot plant from Advanced Plasma Power website

References

There are no commercial scale plants in operation.

Suitability for Jersey

The technology is not considered suitable for Jersey because there are no commercial reference plants.

10.4 Europlasma

Current Position

Europlasma are currently involved in the planning stage for their first 12 MW facility in Morcenx, France, to produce energy from waste. The intention is for the plant to be operational from the middle of 2009.

Process Overview

The process involves the following steps:

1) Feedstock handling;
2) Initial sorting of the waste followed by crushing;
3) Gasification using high temperatures and a low oxygen atmosphere, producing a syngas;
4) The use of plasma torches to refined the syngas to crack the remaining tars, creating a hot, high calorific value syngas;
5) Gas scrubbing to remove acids and heavy metals brought by the waste;
6) Burning of the syngas in gas engines or gas turbine for electricity production;

7) Heat is recovered by drying the input waste, maintaining the gasification reaction and the recovery of excess heat through a steam turbine;
8) The non-organic part of the waste is collected at the bottom of the gasifier and introduced in the ash melting furnace. It is there transformed into an inert glass-kind material.

References

There are no commercial scale plant is operation processing MSW.

Suitability for Jersey

The technology is not considered suitable for Jersey because there are no commercial operation reference plants currently using MSW as a feed stock.

10.5 Solena

Process Overview

The process involves the following steps:

1) Feedstock handling system;
2) Gasification using high temperature plasma torches to heat the waste to 4,000 – 5,000ºC;
3) Oxygen generated by a vacuum swing absorption system will be used to partially oxidise the hydrocarbon or organic material using a carbon based catalyst;
4) Production of a syngas with a heating value around 150 to 300 BTU/scf;
5) The gas is then cooled down and cleaned before it can be used as a gas turbine fuel. This typically involves the removal of any sulphur compounds, chlorides, mercury, other volatile metals, acid gas, and any particulate matter;
6) The cleaned syngas is then combusted in the gas turbine to produce electricity.

References

There are no commercial scale plant is operation processing MSW.

Suitability for Jersey

The technology is not considered suitable for Jersey because there are no commercial operation reference plants currently using MSW as a feed stock.

11 BIO-BUEL PRODUCTION

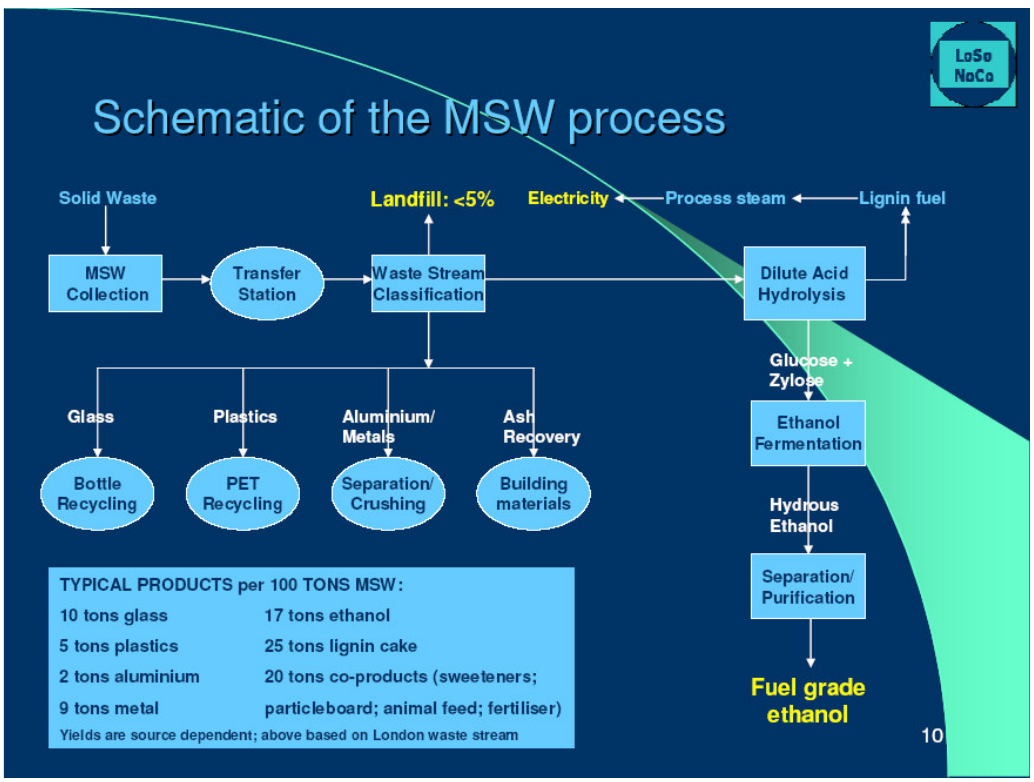
11.1 Losonoco

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;

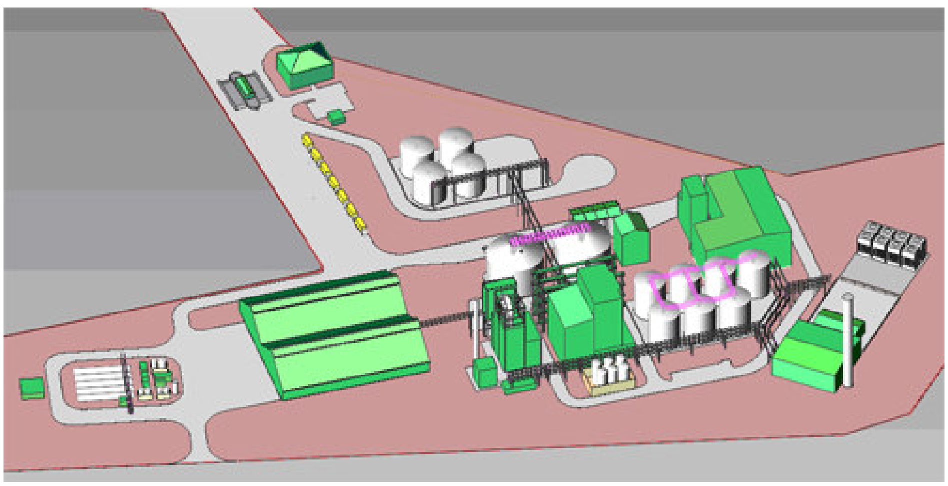
- It is only a partial solution as extensive upstream pre-treatment of waste is required to separate the organic fraction prior to processing, requiring disposal routes for recovered materials. Also a power plant is required if the produced ethanol is not sold;
- The process produces lignin, which would 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.

11.2 Green Spirit Fuels

Process Overview

Green Spirit Fuels Ltd was launched in June 2005 by grain trader Wessex Grain and is in development of a number of bioethanol plants in the UK using GEA as the technical provider. It is expected that Green Spirit Fuels will be the first producer of bioethanol in the UK, and will be the first company to produce bioethanol from wheat. Currently the estimated yields are inadequate to consider using MSW as the feed stock.

Computer model of the plant at from Green Spirit Fuels website



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 other disposal routes for the non-organic recovered materials. Also a power plant is required if the produced ethanol is not sold.

11.3 Reclaim Resources

Current Position

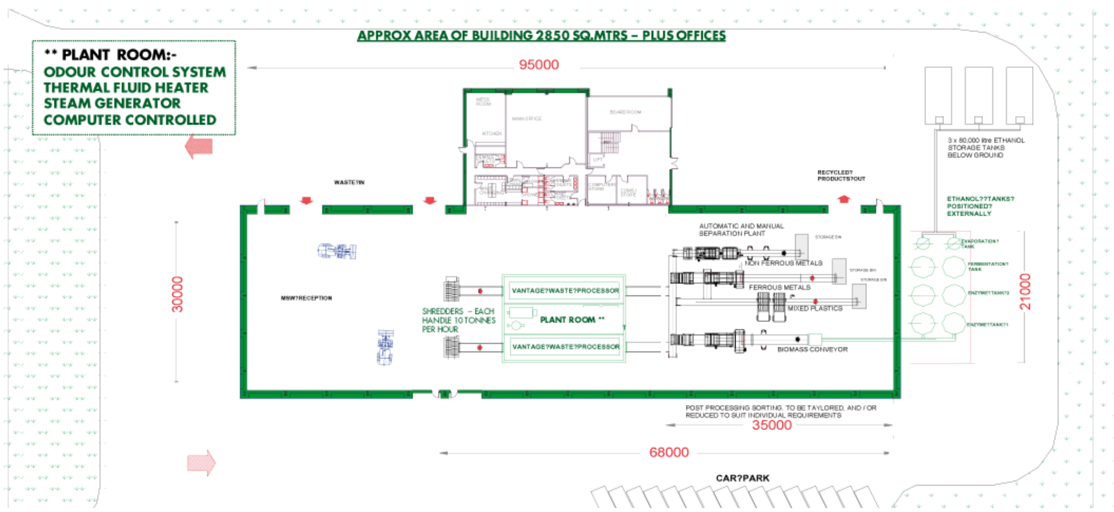
The company is currently in the process of building a trial plant capable of handling 75,000 tonnes of municipal waste a year on the outskirts of Bournemouth.

Process Overview

The process involves the following key stages:

1) Waste reception;
2) Shredding of the MSW;
3) Use of heat and high pressure steam jets in a rotating waste processor to sanitise and break up the organic fraction of the waste;
4) The sanitised waste is then sorted into different waste fractions, with the biomass fraction receiving further processing to produce a bio-fuel.

Site plan of a proposed facility from Reclaim Resources website



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 other disposal routes for the non-organic recovered materials.

It is also noted that a number of other bioethanol facilities are planned to be built in the UK in the near future, for example at Wilton in Teesside. However, none of these are considering using MSW as a feed stock and will instead utilise grain or agricultural waste.

12 OTHER PROCESSES

12.1 Oxalor

Process Overview

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

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.

12.2 Cierra

Process Overview

The process involves the following stages:

1) Waste reception followed by initial separation of the organics fraction using a trommel;
2) Manual sorting to separate out bulky items, large items, metals and rubble;
3) Shredding, grinding, magnetic separation and the separation of plastics;
4) Sanitation of the remaining waste fraction using heat, steam and pressure. This also has the effect of separating the clinging organic food residues on the waste;
5) The sanitised material is then pumped into a Fluidiser where it is dried;
6) The bulk residue is then blended with high quality recycled plastic and heated with the addition of plasticisers and catalysts;
7) The material is then churned into the plastics processor, where the raw plastic material is extruded to produce composite plastics.

The process is advertised to split all the incoming municipal waste into metals, compost, greenhouse and nursery medium, animal bedding, mulch and composite plastics, with no residues.

Suitability for Jersey

This technology is not close to implementation in the UK as far as we are aware, and we have not been provided with a detailed understanding of the proposed solution. Details are available on the Cierra website, with links to other websites, but no reference plants are indicated. Whilst the production of low grade composite plastic products from mixed plastics is a proven process, the content of plastics in MSW is quite low. The use of mixed municipal waste derived material for animal bedding and growing media is not considered a realistic outlet in the UK due to quality concerns. From the understanding we have, 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 non plastic oversized product, the non-organic material which bypasses the process and the large amount of organic material separated;
- The main part of the process as highlighted by Cierra is to produce products from the extruded waste plastics. This will only be possible for a very small part of the waste stream, and it is unclear what disposal route is to be employed for the majority of the waste. Blending significant amounts of residual waste with plastic will lead to a very poor quality plastic product, with limited uses;
- There are no commercial reference plants of which we are aware, treating mixed municipal waste of a similar composition as Jersey.

13 CONCLUSIONS

Transport and Technical Services and the Waste Strategy Steering Group have reviewed all of the available 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 overall 78 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 six suppliers were 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 – 25 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) Mechanical Heat Treatment – 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 recommended 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. Mixed waste AD plants have been dismissed for the Island as the digestate produced would have no sustainable disposal route. 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 on-Island EfW plant. Few advantages have been identified, whilst the additional costs and difficulties involved mean that this technology is not recommended for Jersey.

8) Alternative Processes such as plasma gasification, bio-ethanol production, a liming process and waste plastic extrusion have all been considered, but are 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
NO_x	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