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New Technologies Demonstrator Programme

Catalogue of Applications

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Waste Implementation Programme
New Technologies

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Contents

1	**Introduction**	**2**
2	**Description of Applications**	**3**
	Mechanical Sorting & Processing, Thermal Treatment & Composting	4
	Composting	8
	Anaerobic & Aerobic Digestion	22
	In Vessel Digestion	26
	Mechanical – Biological Treatment	34
	Thermal Treatment	42
	Other	62
3	**Summary Table**	**70**
4	**Glossary**	**72**

1. Introduction

The New Technologies Demonstrator Programme was initiated by DEFRA as part of the Waste Implementation Programme (WIP) in 2004.

The aim of the Demonstrator Programme is to provide around £30m to help to establish new waste treatment technologies that require pilot plants to demonstrate their viability. The programme is intended to help overcome the perceived risks of implementing new technologies in England and to provide accurate and impartial technical, environmental and economic data. The objective of the programme is to have five demonstration plants in operation by the end of 2005 and a further five by the end of 2006.

There were two rounds of bidding for the funding in 2004 and DEFRA received around 90 applications. In order to assess the applications each project was reviewed by a Technologies Advisory Committee, which gave a series of recommendations on the suitability of the projects. It was recognised that the applications were of a high quality and that a record of the projects would be a useful resource for academia and local government. Therefore, each applicant was given the opportunity to be included in a catalogue of the applications.

The catalogue that follows gives the basic details of each application, describes the inputs and outputs of the project and includes project contact details. The descriptions of the applications are divided into technology groups, such as composting and thermal treatment. Urban Mines Ltd with support from the Mini Waste Faraday Partnership produced the project summaries from the full applications.

2. Description of Applications

Mechanical Sorting & Processing, Thermal Treatment & Composting

Integrated Mixed Waste Processing Systems 4
Advanced Thermal Process, In-Vessel Composting and Associated Developments 6

Composting

Holistic BMW Diversion Project 8
Rotary in-vessel advanced aerobic composting 10
Processing of School Canteen Waste in Redcar and Cleveland 12
Intermediate Scale In-Situ Food-Waste Composting 14
SBS Biotel 16
MORE-Compost – Modular Outdoor Recycling Environments 18
WH White – New Earth System 20

Anaerobic & Aerobic Digestion

Enhanced Anaerobic Digestion for the Production of Biogas using Ohmic Heating Pre-Treatment 22
The "Cary Moor" Anaerobic Digestion Plant 24

In-Vessel Digestion

The IWI RAD (Rotary Aerobic Digester) System 26
Myerscough College Anaerobic Digestion System 28
South Shropshire Biowaste Digester 30
Community Organic Recycling: CORe Plant 32

Mechanical – Biological Treatment

H.E.BIO.T.® High Efficiency Biological Technology 34
The ArrowBio Process 36
Organic Resource Technologies Ltd 38
The reCulture Process 40

Thermal Treatment

Solid Recovered Fuel Production Plant, Materials Recovery Facility and Energy Generation 42
Continuous Feed Process for the Pyrolysis/Gasification of BMW and other Wastes 44
Compact Power ATT Avonmouth 46
Recycling and Recovery of Biodegradable Municipal Waste by Fluidized Bed Gasification Technology 48
Advanced Thermal Conversion of Residual Biodegradable Waste 50
Gasification of BMW Residues 52
RESULT – Renewable Energy Station Utilising Landfill & Technology 54
The Planet Project 56
The RTAL Trefoil Process 58

Other

EECO Integrated Recycling Centre 60
Estech Europe Fibrecycle™ System 62
Project Orchid 64
The GeneSyst Process 66
The Sterecycle Process 68

Integrated Mixed Waste Processing Systems

Bio-Resource Ltd.

Technology type: Mechanical Sorting and Processing & Anaerobic Digestion

Project Description

The objective is to separate the various fractions of mixed waste before shredding to avoid excessive cross-contamination and then pass the separated <50mm putrescibles fraction through an inert separator for anaerobic digestion (AD). After AD, the digestate will be dewatered and the separated solid matter blended with oversize green waste for aerobic maturation prior to final screening and pelletisation of the woody finer fractions to meet the growing market carbon trading demand for renewable fuels. The liquid fraction would then go to an intensive oxygen destruction and purification process for discharge or re-use.

The project will test output variations from a range of locally available solid and liquid non-hazardous wastes as well as the core MSW feedstock in order to determine process parameters and waste combination variables to the biogas quality and yields. The process will separate waste through simple, robust and proven mechanical handling and separation equipment. The unique elements of the project are the innovative approach to bio-waste handling, processing, treatment and end market focus. Comparisons will be made to the Life Cycle Analysis of output quality and transport impacts relevant to present and potentially excessive source separation schemes that rely on human quality control in separation and handling.

Technology Background

The facility will use well-proven mechanical handling technology to test, develop and demonstrate this new integrated concept to achieving those technical, commercial and legal requirements. The ability to produce a high quality refined RDF from the separated paper and card, with ROC attracting secondary biomass from the AD digestate solid matter and green waste material is so far unique to the UK. The liquid digestate treatment system is also unique in this application and provides a simple and certain outlet for such an output which is not desirable [or permitted] to go to land. The separated plastics will be further processed and reprocessed in novel technology to the UK that can cope with slight contamination and mixing of different plastics into high value goods.

Inputs / Outputs

Input wastes will focus on MSW, using the BMW fraction in combination with more nitrogen rich Animal By-Products and food wastes. Balancing carbon to nitrogen values will be a major consideration in taking a variety of locally available wastes as well as the BMW fractions.

The facility would produce marketable secondary products (refined dRDF for coal replacement in conventional boilers and a ROC-able biomass pellet for CO_2 offset in cement kilns). The non-biodegradable fractions (metals and glass) will all be separated, processed or prepared according to local market outlets and facilities.

Plastics will be cleaned and blended for further reprocessing into value added products.

Costs

Subject to more detailed site specific analysis, the capital costs for the full facility handling 100,000 tpa MSW are around £15-20m.

Mass Balance

Mixed waste input of 100,000tpa (and a balance of process water) will result in the following approximate outputs:
Plastics 10,000tpa, Glass 5,000tpa,
Ferrous metals 8,000tpa,
Non-ferrous metals 1,000tpa

Putrescibles for AD:
35,000tpa leading to approx.
18,000tpa of dewatered solid matter for blending, dRDF for thermal recovery 25,000tpa (dried & refined)
Grit & sand 10,000tpa, Miscellaneous residuals 5,000tpa
Digestate liquid, plus biogas

Emissions

Emissions from the enclosed waste storage and processing system will be contained in wet scrubbers. Emissions to air will be via the gas engines (AD plant). Odour emissions from the AD plant will be in accordance with IPPC Licence standards and closely controlled using in-line analysis. Any wash water will be sent to the AD plant via interceptors. An intensive oxygen destruction and purification system will be used to reduce remaining dry matter in the separated digestate afterwards.

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Project Partners:
Institute of Grassland and Environmental Research, Advanced Recycling Technologies Ltd, Moore Bros (Frome) Ltd, AgRecycle Ltd

Advanced Thermal Process, In-Vessel Composting and Associated Developments

Yorwaste Ltd.

Technology type: Mechanical Sorting and Processing & Anaerobic Digestion

Project Description

The proposed development (of an existing waste management facility) includes the provision of:

- A residual waste sorting and segregation plant (Complex MRF);
- An in-vessel composting process;
- An advanced thermal treatment process (Pyrolysis unit);
- A gas-conversion electricity-generating unit.

This facility will divert from landfill 22,208 tonnes of BMW out of every 35,000 tonnes of household waste handled annually and provide 2,400kW of (Renewable Obligation compliant) electricity and 2,630kW of locally utilisable waste heat.

Technology Background

The Wastec 'kinetic separation process' (Complex MRF) is an established front-end separation process that will be used to separate different fractions of the input MSW, enabling recycling of metals, glass and heavy plastics, separation of wet organics for HotRot in-vessel composting, and separation of a high CV paper based material suitable for energy recovery. HotRot is a New Zealand designed in-vessel composting process which, although new to the UK and being used in its first MSW / BMW treatment application, has extensive proven operational performance. The GEM gas conversion technology and energy recovery process has had eight years of prototype operation and limited operation of a full size unit. The process is designed on a modular basis, providing a sustainable solution to EU requirements for the diversion of waste from landfill, whilst providing added benefits for the production of clean energy. NEL Power's role is to develop and integrate the design and in addition build and operate the gas conversion and energy recovery plant. The integration of these three patented technologies combined as an MBT and advanced thermal treatment system is unique and novel.

Inputs / Outputs

The process is designed to deal with conventionally collected household waste and therefore does not rely on householder goodwill or participation in pre-sorting. The HotRot system would be an accredited process for in-vessel composting of Animal By-products with State Veterinary Service approval. Output compost could be used as a soil enhancer and as a subsoil material within landfill restoration soils layer. The gas conversion stage produces a quantity of carbon/ash char residue. For the purposes of the project, it is assumed that this char will initially be disposed of to landfill, although alternative uses (e.g. as a compost enhancer or as a filler in concrete/brick type products) will be sought.

Costs

The combined capital investment for the land, Complex MRF, in-vessel composting and thermal processing units is £9.62 million. The facility will have a fully commissioned operating capacity of 35,000tpa.

Energy Balance

The plant will produce up to 2.41 MW of Renewable Obligation compliant electricity and up to 2.63 MW of available heat for local utilisation at design capacity.

Mass Balance

A summary mass balance for the three-year demonstration period is shown below. In the region of 54,000 tonnes of BMW will be diverted in this period.

Wastec Complex MRF: Household Waste 85,000t, Paper 18,800t, Paper-pellet RDF 9,250t Plastic 8,500t Recyclate 4,250t, Wet Organics 27,200t, Landfill 8,500t, Miscellaneous 8,500t

HotRot in-vessel composting: Wet Organics 16,000t, Compost 12,000t Water loss 4,000t

Emissions

The process is projected to operate well within the environmental limits of the Waste Incineration Directive (WID). CO levels in exhaust gases will be minimised by passage through a thermal oxidiser, while NOx levels can be controlled by various conventional means. The volume and properties of carbon/ash char produced by gas conversion will be dependent on the volume of inert material and make-up of the fuel. It is estimated that 10% by volume of received waste will remain as char. The char will be classified under the European Waste Catalogue as Waste from Incineration or Pyrolysis of Waste 19.01.18 (Pyrolysis waste not containing dangerous substances) and will be acceptable for landfill disposal under the waste management licence / PPC permit.

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Project Partners:
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Holistic BMW Diversion Project

Alpheco Composting Ltd.

Technology type: Composting

Project Description

The project would use the innovative BioColl method to co-collect and co-compost catering and 'green' wastes from 4,500 households plus commercial catering wastes and former foodstuffs from food-processing companies. The EU sanitization standard (ABP particles < 12 mm and enclosed composting to include >70oC for 1 hour) would be used.

Technology Background

BioColl gives primacy to source sorted and separately collected domestic catering wastes, to achieve high recovery and diversion rates and permit co-collection of commercial bio wastes. It draws on kindred kerbside collection trials that have included optimally sized bio-bins, high-rise blocks and use of pedestrian controlled vehicles (PCVs) in particular circumstances. Alpheco's in-vessel systems have been developed via a prototypes sold to Anglian Water in 1998. Progressive improvements with Alpheco's own prototype, in which over 3,000 tonnes of various biowastes were composted by the June 2001 moratorium due to foot & mouth. Alpheco supplied 15 vessels (3 systems) to Aberdeenshire in 2003/4.

Inputs / Outputs

Target waste streams are:

- Municipal/domestic catering waste (food waste and soiled paper) collected via weekly kerbside transfer from households' 25-litre bins in to 120-litre bins.
- Commercial catering wastes from restaurants and supermarkets plus 'former foodstuffs of animal origin' from food processing plants.
- Botanical wastes such as soft, 'green' wastes from household gardens (if not home composted) and woody wastes provided by a kerbside chipping service.

The resultant compost, to be applied to land, is expected to have a total organic matter content of 47%, with 2% N, 1% P and 1% K on a dry-weight basis. Recirculation of process gases and a stabilization temperature at about 45°C will help to fix N and minimize loss of C, thus enhancing the product. Inclusion of commercial bio wastes should enhance the nutrient levels compared to 'green' waste compost. The aim is to ensure the compost meets the PAS 100 standard. The un-wrapping line is expected to generate significant amounts of plastic and minor amounts of glass and metal. The latter two should be suitable for recycling. The plastic would probably be too soiled for recycling so would be amalgamated with residual wastes for 'MBT' drying.

Costs

Estimated capital costs for a complete HBMW collection system and facility (composting and MBT) handling 13,600 tpa are around £770K.

Energy Balance

The estimated total annualised energy input for the project is approximately 19,700 GJ, however this is dominated by transfer and logistics operations, in particular RCV collections for residuals, which would disappear if the residuals were utilised in an adjacent MBT plant. The estimated direct operational energy requirements for a composting facility and MBT plant are only 1,100 GJ/annum. The production of compost represents an energy output of 25,500 GJ/annum heat (potentially usable in MBT), while the residual material (potential dry fuel product of MBT) contains a further 21,300 GJ/annum.

Mass Balance

The mass balance for the process is influenced by the inputs, notably how much home 'green' wastes will be taken in. Output compost mass is estimated to be from 13% to 27% of the input mass with 100% and zero home composting respectively. Water loss during composting is about 14 –11% of mass in the same scenarios, with residuals of 42 – 24%.

Emissions

Previous co-composting experience has shown aerosols and smells from the system biofilters to be acceptable on site and some 50m downwind. The reception building will be maintained at negative pressure and bio-filtered to eliminate emissions during preparation and loading. The MBT plant would be similarly emission-free, while residuals after bio-stabilization would be less odiferous than current landfilling of untreated putrescibles. The associated 'MBT' plant for drying residuals using excess heat from composting, will lead to a potential RDF. No energy-from-waste plant has been found within economic range of the site, so it is planned to landfill that dry residual waste locally.

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Rotary in-vessel advanced aerobic composting

Bioganix Ltd.

Technology type: Composting

Project Description

The project involves a rotary "in-vessel" advanced aerobic composting system for source separated kitchen waste and other BMW. 10,000 tonnes per year of BMW combined with a further 5,000 tonnes of other organic wastes would be converted into high-grade fertiliser/compost to be supplied to farmer users.

The project involves building a new rotary composting vessel and batch treatment system incorporating design changes indicated by a research and trial programme. Existing buildings, a waste reception area and odour control system would be utilised. The original compost vessel, feed elevators, mixing system and compost screening equipment are optimised for the handling of waste materials arising from the poultry industry. Alterations, additions and improvements to this equipment would be necessary to accommodate the more varied waste streams arising from source separated BMW.

Technology Background

Bioganix has operated a reasonably large-scale experimental plant, processing up to 150 tonnes per week of organic wastes, for almost two years. Trial work on a range of biodegradable waste streams has managed to produce a valuable high quality compost / organic fertiliser. Bioganix's links to its farmer owners have ensured that there is currently an established market for this type of product into agriculture.

Inputs / Outputs

The plant will handle source separated mixed garden and kitchen waste. Waste will either be transported directly to the plant in Refuse Collection Vehicles or be bulked up into larger loads at a transfer station. Successful composting relies on a diversity of waste streams to provide a suitable mix with appropriate moisture content, Carbon/Nitrogen ratios and structure.

85% by weight of incoming waste material is converted to saleable compost for use on farmland. Compost produced by previous trials of the system has been to the standards of PAS 100 for pathogen contamination and foreign material. This project would reasonably expect to repeat this for BMW-derived compost.

Costs

The project is scaled to process 15,000 tonnes of waste per annum (including 10,000 tpa BMW). It is estimated that if the project were to start from scratch, overall cost would be around £2.4M.

Energy Balance

Composting does not produce any exportable or re-usable energy; it is a net user of energy. The main composting process is however remarkably energy efficient; bacterial energy creates all the required temperature rise and the rotating vessel will use only 10KW of power to operate. Most of the energy consumption within the plant will be for odour control, maintaining negative air pressure and scrubbing units. In the wider context the compost produced would displace artificial (energy intensively produced) fertilisers on farmland. Energy used in the process is less than 10% of the energy value of the fertiliser created.

Mass Balance

Trial work to date indicates that the composting process results in approximately 15 to 20% weight loss of input material. Most of this arises from moisture loss with a small amount of carbon dioxide given off during respiration. Thus 80 to 85% of input mass is transformed into a valuable compost/fertiliser.

Emissions

Odour emissions will be controlled by a sophisticated air scrubbing system. A large bio-filter has also been on trial and is successfully reducing odour levels to below Environment Agency H4 guidelines. The thorough, complete and continual aeration of the compost mass in a rotary compost vessel ensures that aerobic conditions are constantly maintained, minimising anaerobic production of methane. Ammonia emissions are scrubbed from exhaust air using acidic water scrubbers. Waste water from the ammonia odour scrubbing systems is not discharged but is used as a liquid fertiliser. There are no process leachates.

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Processing of School Canteen Waste in Redcar and Cleveland

E.A. Environmental (UK) Ltd.

Technology type: Composting

Project Description

Redcar and Cleveland Borough Council and E.A. Environmental (UK) Ltd. would operate a trial demonstrator scheme involving the collection of school canteen waste from Laurence Jackson School, and a maximum of 100 households in the immediate vicinity of the school, in Guisborough in the Borough of Redcar and Cleveland. This would then be delivered to a designated location where it would be processed and 100% recycled into a soil improver using the 'Ceres' machine. This waste is presently being disposed of in landfill. The trial has been geared around food waste generated by the school because it is predictable, constant and consistent. Also as a result of the introduction of new legislation, such as the Fresh Fruit in Schools Scheme launched in October 2002, and the necessity to supply pupils with fruit or vegetables at school, there will be an increase in canteen waste generated from such sources.

The Ceres is a new unique waste food-processing unit. It makes possible the truly organic processing of food waste, not using bacteria, but a special reducing liquid as a catalyst. It is therefore completely different from conventional composting. Installing the Ceres Waste Food Processor would provide a safe, rapid, clean and harmless process that is capable of recycling 100% of food waste input, in a controlled environment on site, thus reducing the environmental effects and costs of transport, handling and disposal.

Technology Background

E.A. Environmental is developing the 'Ceres' waste food processing machine for Daihatsu Diesel and they are working hand in hand with the necessary statutory bodies in order to observe legislative demands. It is their intention to provide customers with an alternative method of recycling food waste that will prevent any potential handling problems and remove the need for transportation of food waste produced on a daily basis. The Ceres unit is designed to be 'tagged' onto a canteen or food outlet to enable that facility to process their own food waste with the minimum of effort and in a safe, environmentally friendly way. The machine has been working successfully in a number of specific placements in various locations in Japan and is operating under license in Ireland. It caters for a cross section of canteen food wastes which are treated on site. The food is recycled into a nutrient rich sand that can be applied to land as a soil improver. Growth trials using the soil improver have been carried out successfully, with results showing much improved standards in plant and grass growth / product.

Inputs / Outputs

The unit is designed to handle degradable catering wastes on-site at establishments such as schools, hospitals, factories, nursing homes and hotels.

Typical input ratios to the unit are 100 parts food waste, 50 parts sand, 3 parts of a proprietary reducing liquid, and 30 parts water.

The sanitized and stabilized (pathogen free, ABP compliant) soil improver produced by the processing (2 – 4 day cycle), could be added to conventional composted green waste or blended with sub-soils to produce topsoil to BS 3882 standard. This may have a commercial value, but this cannot be assumed at this stage.

Scale / Costs

The trial machine is able to process 50kgs per day, however the technology is versatile and a machine that will process 1000kgs per day is also available. Purchase cost for a trial unit is around £40,000 with direct operating costs of £1,800 per annum.

Mass Balance

100% of inputs are converted to useable soil improver.

Emissions

The technology is an in-vessel fully chemical system, which makes the processing operation very consistent and stable. Organic matter is reduced and putrid smells are deodorised at high speed. It generates approximately 1/80,000 the level of CO_2 of conventional composting systems. The system does not produce any form of pollution or leachate.

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Project Partners:

Redcar and Cleveland Borough Council,
Bio Recycling Solutions Ltd,
University of Teesside – CLEMANCE

Intermediate Scale In-Situ Food-Waste Composting

The Eden Project

Technology type: Composting

Project Description

This project would trial in-situ food-waste composting for the significant sector falling between small scale domestic composting and larger scale plants requiring significant waste transport. If proved to be economically and environmentally viable it could be of great benefit to a broad range of organisations. Housed within the Waste Neutral Recycling Compound (WNRC) at the Eden Project, it offers an exceptional demonstration opportunity to both public and professional interested parties, and additionally to contribute to the wider diversion of BMW through informing the general public. The project would assess the environmental and financial outcomes, and make a recommendation on the suitability of complete in-vessel composting as a solution for environmentally-friendly disposal of small stream organic wastes, diverting BMW from landfill.

Technology Background

The system identified to deliver this project is Susteco's NETER 30 in-vessel composter. Susteco (Sweden) are experienced in providing quality systems, generally to schools and community groups throughout Northern Europe, and have a number of smaller (Big Hanna) units operating successfully in the UK. The NETER series of composters are designed and manufactured by Torsten Hultin, the inventor of the ALE trumman composter. From 1991 until 2003 over 500 ALE trumman have been sold worldwide, and there are installations throughout Scandinavia, United Kingdom, France and Japan. The NETER composter addresses the need for on site composting of food waste for those with a greater throughput.

Inputs / Outputs

The final output compost is very potent and will need to be mixed at a ratio of 1 part to every 5 parts soil.

Scale / Costs

Direct capital costs of the in-vessel composter are approximately £170,000. The NETER 30 has a capacity of 30 cubic metres, or between 1 and 1.5 tonnes per day of biodegradable waste, but the NETER system can be configured at various capacities.

Energy Balance

Composting is an exothermic reaction and therefore provides its own heat. Energy is "locked up" in the resultant growth medium for slow release when used for planting. The alternatives to composting on site would be to compost in a centralised facility, or to send to landfill. Both these transport intensive options have a negative effect on carbon balance and energy consumption. Electrical demand to run the system is about 25kWhr per day.

Mass Balance

Mass loss is calculated to be a reduction of 70-95% of the input, depending on the variation of the waste material in quality as well as quantity. The compost output is therefore expected to be around 10 – 20% of the input by mass, with a moisture content of 25 – 35%.

Emissions

Atmospheric emissions are mainly in the form of CO_2 and water vapour. Approximately 16.5kg CO_2 will be emitted for every 100kg waste treated, however, this does not affect total atmospheric CO_2, as the carbon was originally taken out of atmospheric CO_2 (via photosynthesis) when the food was growing. A biofilter deals with unwanted smells, and there is no methane generation. Any runoff will go into the closed drainage system, and be treated through a membrane bioreactor to grey water standards. There is no discharge to land other than composted material, which will no longer be waste but a recyclable product.

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Project Partners:
Susteco AB, Sweden

SBS Biotel

Sustainable Biowaste Solutions

Technology type: Composting

Project Description

The aim of the project is to combine biodegradable waste from a household collection round with ABP type wastes. The site for the scheme is a farm near Sittingbourne in Kent. All of the municipal waste will come from houses within 15 miles of the farm. The site already has a 15 tpd prototype of the plant up and running. The annual amount of waste treated by the project would be in the region of 15,000 tonnes. However, there would be considerable seasonal variations in the amount of waste collected from the households. In summer as much as 150 tonnes of waste a day could be delivered to the site, falling to around 50 tonnes per day in winter.

Technology Background

Upon delivery to the site the waste is taken to a sorting station for manual screening. At this stage an operator can remove unwanted objects such as stones, bottles and bags. The waste then enters a separator system, where loose soil is removed. After the initial sorting a preliminary biowaste characterisation is conducted to determine the other process inputs required to manufacture the specified fertiliser product. The Biotel system essentially comprises four vessels: an infeed reactor vessel (mesophilic); two (thermophilic) biodigester vessels; and a "finished product" storage vessel where the residue is kept until it is pumped out for agricultural use. The two central biodigester vessels use aerobic bacteria to break down and sterilise large batches of organic matter in less than 24 hours. The brown bin waste goes through a shredder and grinder to transform it into slurry. This slurry is then mixed with the ABP type wastes in the 90,000 litre infeed BIOTEL reactor vessel. The temperature of the waste is raised by activating bacteria through continuous aeration, this raises the temperature to between 40°C and 45°C.

The waste is then transferred into the primary mesophilic bio-digester, which is linked to a secondary thermophilic digester. In the first tank the bacterial action and an agitator mechanism raises the temperature to around 65°C. In the secondary digester the proliferation of bacteria raises the temperature to 75°C, where it is held at a controlled level. The whole Biotel process is completed within 16 to 24 hours. The output product is pathogen free product, which can be sold as an organic fertiliser with specified NPK control.

Inputs / Outputs

It is expected that around 10% of the waste from the household collection will not be suitable for the Biotel process, i.e. rubble and plastics. The annual input of 15,000 tonnes of biodegradable waste should produce 15,000 tonnes of liquid fertiliser or 3,750 tonnes of dewatered solid fertiliser granules.

Costs

The cost of building the plant would be somewhere in the region of £1 million.

Energy Balance

The main use of electricity for the plant is in the stirring mechanism of the tanks. It is estimated that the electricity cost is in the region of £1 per tonne processed.

Mass Balance

There is likely to be very little difference between the weight and volume of material entering the plant and that leaving as fertiliser. There may be a 5% moisture loss through the evaporation and egress of steam through an activated carbon filter but most of the moisture condenses and is fed back into the processing system.

Emissions

There is no liquid effluent from the bio process and bio-filters on the air vents eliminates odours.

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Project Partners:
Swale Borough Council & Biffa

MORE-Compost – Modular Outdoor Recycling Environments

Waste Audit Company Ltd.

Technology type: Composting

Project Description

The proposal is to employ an affordable and simple in-vessel composting technology (Rocket In-Vessel Composting) within a local level, community based biodegradable waste collection and treatment scheme. The proposed technology is mobile (easily relocated without disruption to the process), scaleable (up or down), clean, uses very little power, and produces nutrients to put back into the environment.

Composting will be decentralised, with each site offering capacity matched to the needs of the sub-district served, typically around 1,000 households. A high participation rate will be encouraged through multiple approaches including, supply of a free kitchen caddy, free bio-bags, weekly collections, a local bio-bag drop-off area at each compost station, and a local friendly service. Previous bio-bag schemes have experienced over 90% participation rate and negligible contamination.

Technology Background

The Rocket machine requires wet organic waste with equal amounts of dry green waste to produce a compost, and can process meat, bones, animal faeces, cardboard and paper. There are no operational equivalents with this technology, on this scale, and there are no commercial operations of this size, using this new technology. The Rocket Compost machine has been researched and tested since 1995 and was granted a patent in 2001. Some small facilities are in full operation processing feedstock to compost in two weeks.

Use of Bio-bags (bags that returned and degrade with the waste they contain) can overcome the "Yuck Factor" of community participation schemes; odours, slimes etc. or the need to wash permanent collection buckets. A number of biodegradable materials are available, the most suitable made from renewable resources such as GM-free cornstarch. In addition, Bio-bags allow collected material to "breath" assisting drying and settling, avoiding undesirable odours and reducing the contents weight by up to 25%.

Inputs / Outputs

Waste will be taken from two sources:

- Organic Kitchen Waste, including food waste, meat and bones, collected from curb sides and processed locally
- Green garden waste collected, shredded, then delivered to the Compost Station to be processed, or diverted from local businesses or civic amenity sites.

Station operators will mix the collected kitchen waste, with the equivalent shredded green waste.

The PAS100 compost standard can be applied to the end product of the Rocket process. Each machine will be monitored by PC-linked temperature probe to ensure the process complies with the Animal By-Product Regulations.

Scale / Costs

Scale will be affected by population density, local industries, communication and participation levels, population age and eating habits. Each station will process 3kg of organic kitchen waste from a thousand households giving a weekly total of 3,000kg. This would be matched by 3,000kg of high carbon green garden waste. Direct equipment costs to handle 8,500 litres (6,000kg) of waste per week are around £21 – £25,000.

This is a very clean community based solution that demonstrates a full loop and with the Rocket under development to increase is processing capacity; further economies of scale and more markets will benefit and develop.

Energy Balance

A 2,333kg per week Rocket Machine uses approx. 50kW per week to operate giving it renewable energy options and green credentials.

Mass Balance

The largest machine will process about 75 tonnes of feedstock annually and produce about 20 tonnes of compost. The Rocket currently under-development will increase this capacity by a factor of five.

Emissions

There are essentially no emissions to air, water or land. There is a small amount of steam from the Rocket machine that is released into the work area. The project is not expected to produce any solid residues from the in-vessel process. Any small amount of contamination such as plastic, metal or glass can be recycled through collection banks located at the compost stations.

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Project Partners:
Accelerated Compost Ltd

WH White – New Earth System

WH White

Technology type: Composting

Project Description

The project is for the development of a 50,000 tonne capacity in-vessel composting facility employing the New Earth Technology, which is a dynamic housed windrow aerobic digestion system. The system will treat unsorted MSW and segregated green and kitchen wastes to the standard required by the Animal By-Products Regulations.

The project is based at Poole in Dorset. The input material for the scheme is unsorted MSW. The waste for the plant will come from the Dorset Waste Disposal Authorities. The company has operated a plant treating up to 600 tonnes per month since June 2003.

Since applying for the NTDP the company is now operating on a commercial basis and the technology is proven and has been awarded Local Authority composting contracts through New Earth Solutions Ltd. The Poole facility is being expanded to 50,000 tonnes per annum capacity through private investment.

Technology Background

Waste is unloaded into a waste reception area, where the waste is inspected and any large items or potential contaminants are removed. The waste is then fed into a shredder. An over-band magnet removes ferrous metals from the shredder residue.

A screen segregates organics from none organics, the over 80mm reject fraction may then go for further processing to recover more recyclates. The organic material that passes through the screen is sent into one of two first stage digestion halls. The waste is built up into windrows, which are situated above aeration ducts in the floor. One of the halls is filled each week to form an ABPR batch.

The temperature of the windrow is monitored constantly and the rate of aeration is controlled automatically to maintain the required temperatures.

The waste is then passed to a screening area, where the material is screened through a multi deck star screen. Water is added to the windrows from an automatic overhead irrigation system. In order to ensure that all the material is treated the windrow is turned three times in the first 8 days.

After two weeks the initial phase of composting is complete and the material is passed into the second stage digestion halls for a further two weeks.

After this the primary hall is entirely cleaned and disinfected before the next batch of waste. In the second stage the temperature of the material is monitored and it is still subject to suction aeration, irrigation and turning three times. The waste is then passed into a screening hall where the material is screened through a multi deck star screen with magnets to remove metals and a wind sifter to remove plastic, which is then baled and sent for recycling.

Inputs / Outputs

For the NTDP the waste input would have principally comprised un-segregated municipal solid waste (MSW) after prior removal of dry recyclables through household kerbside recycling schemes. Where a sufficient volume of source separated material can be obtained to form a composting batch the technology enables this to be composted at the same time in a separate hall from the mixed waste composting. Refuse collection trucks and bulk loaders will deliver the waste.

The main output products are a soil improver product, ferrous and non-ferrous metals and plastics for recycling.

Costs

The overall project cost is in the region of £4.4 million.

Energy Balance

The energy input to the process will be 52 kWh per tonne of MSW treated.

Mass Balance

An input of 50,000 tonnes of MSW would generate the following outputs:

Soil improver – 9,180 tonnes,
Ferrous metals – 1,000 tonnes,
Non Ferrous metal – 500 tonnes, Plastics – 2,000 tonnes, Mass loss / energy conversion – 19,720 tonnes, Residuals – 17,600

Emissions

An assessment of trial facility in Canford by The Organic Resource Agency showed no major emissions issues.

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Enhanced Anaerobic Digestion for the Production of Biogas using Ohmic Heating Pre-Treatment

C-Tech Innovation Ltd.

Technology type: Anaerobic or Aerobic Digestion

Project Description

The project envisages a two-stage anaerobic digestion (AD) unit with an ohmic heating pre-treatment section. Two-stage AD can take a wide variety of waste streams and produce electricity and heat via CHP, and a solid residue which can be used as topsoil. Previous research into ohmic heating has shown its potential use in pre-treatment of high lignin-cellulosic content solid wastes to reduce the processing time and increase biogas production in AD.

Biodegradability is dependent on many factors, but one influential inhibitor is the presence of lignin-cellulosic material. Appropriate thermal treatment can engender autohydrolysis of this material, breaking it down in degradable form. Ohmic heating offers significant advantages (e.g. energy efficiency, no introduction of additional water) over conventional thermal treatments such as steam injection. Previous work has suggested that the throughput of digesters can be increased by a factor of 2-3, which both decreases the size of the units, and improves the cost benefits.

Technology Background

Bioplex's Portagester anaerobic digestion system treats high solid content organic and liquid organic wastes. It has been used successfully with farmyard and horse stable manure, dewatered sewage sludge cake, the organic fraction of municipal solid waste, food processing wastes, non-toxic sewage sludge, farm slurry and beverage processing wastes.

Ohmic heating technology has been used for over 20 years for large scale heating operations. The technology works by passing mains frequency electricity directly through the material to be heated. Heating occurs internally through the material's own electrical resistance so conversion of electricity into heat in the product is near 100% efficient. Ohmic heating is particularly useful for materials that are heat sensitive or subject to fouling. It has been licensed to APV for aseptic packaging of food and used by Thames Water to reduce pathogen levels in sewage sludge.

Inputs / Outputs

Target streams are source separated refuse or Municipal Solid Waste / Organic Fraction (MSW/OF), local authority green waste, catering waste, horse stable manure and other manures.

Solid digestate is aerated in a windrow system and can be used as topsoil. The anaerobic digester operates in the thermophilic region, and therefore conforms to EU and DEFRA regulations.

Scale / Costs

The footprint of an 8,000 tpa plant is estimated at 24m by 20m for the liquid digestion area. The reception area (which includes the ohmic heater) is estimated to be 20m by 20m.

Direct capital costs for the core ohmic heating and anaerobic digestion equipment is around £550,000.

Energy Balance

The process is a sustainable net energy producer. A conservative summary energy balance for an 8,000 tpa facility is that a rate of 100kW electrical input (to ohmic pre-treatment) will yield 135kW electrical output and 180kW heat via CHP of biogas. The effect of ohmic pre-treatment will be to increase energy output from 28,000kWh / 100 tonnes of waste to 56,000 kWh/100 tonnes.

Mass Balance

The total diversion from landfill is dependent on the content of non-biodegradable material (e.g. bottles, plastics etc.), the energy produced (i.e. the production of methane in the biogas), and the final solid material that can be used on land. From earlier experience there is a volume reduction of 50 to 70%, with 10 – 15% of plastics, metals and other reject materials.

The volume production of biogas is 60 – 120 m^3 per tonne of feed, with a content of between 55 – 65% methane.

Emissions

There are no hazardous pollution risks. Odours from raw materials handling and pre-processing will be mitigated by continuous use of the reception area headspace as CHP intake air. Simple carbon filter extraction fans will be used to clean maturation (windrow) air prior to discharge. The combustion product of CHP is carbon dioxide, however the process is carbon neutral, since the biodegradable waste is derived predominantly from carbon capturing plant-life.

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Project Partners:
Bioplex Ltd.

The "Cary Moor" Anaerobic Digestion Plant

Organic Power Ltd.

Technology type: Anaerobic or Aerobic Digestion

Project Description

The Organic Power project uses anaerobic digestion to process organic waste. The company is working with Somerset County Council and the intention was to secure the first fully commercial plant at the Wyvern Waste Services Ltd. site known as "Dimmer" near Castle Cary in Somerset. This will not now be the first commercial plant and another site has now been chosen. It was proposed that the plant at Dimmer would divert approximately 15,000 tonnes of BMW from landfill. Future, larger plants are expected which would have a significant impact on the volume of BMW that can be diverted from landfill. In addition, it may be possible using this project to develop methods to reduce the retention time and so significantly increase the tonnages that can be processed in this size of Maltin® System plant and so diverted from landfill.

Technology Background

Organic Power's technology is based on the Maltin® System for which worldwide patents have been granted. A wide range of organic wastes, including domestic waste, landfill leachate, slaughterhouse or dairy product effluents and energy crops can be continuously processed using a combination of aerobic and anaerobic digestion in a sealed system with no emissions.

A fundamental part of the Maltin® System is the shape of the tanks in which the aerobic and anaerobic digestion takes place. This shape is that assumed by a strip of relatively stiff material when its ends are rotated in opposite directions and then held together. Fitting two flat ends on to this minimum energy shape creates the form of the tanks which are the basis for the Maltin® System. Bubbling gas or air up from along the central cusp inside a tank of this shape will cause the liquid contents to rise vertically from the centreline of the tank and then to form two opposing circulation patterns, being constrained only by the minimum energy curve of the tank walls with no paddles or baffles or corners where material may get stuck.

At the centre of each flow pattern is an "eye" in the circulation path and by adding liquid at this point, the circulation patterns are hardly affected. Similarly, treated material can be removed from the corresponding eye at the other end and in the other half of the tank.

A continuous process can be maintained with feedstock passing slowly through the tank. This results in the combination of a plug flow with very efficient mixing of the contents and hence complete digestion.

The feedstock flows through a series of similarly shaped tanks, until it becomes fully treated digestate without the possibility of any partially treated material by-passing the system.

Putting these tanks into an insulated lagoon of clean warm water, to balance the hydrostatic pressures and to provide a stable temperature, gives the practical solution to organic waste treatment. It also results in a very low overall environmental and visual impact.

Inputs / Outputs

The waste stream will be source separated organic fraction of household waste collected by ECT Recycling. ECT operates a number of household waste collection schemes and have introduced systems whereby household kitchen waste is source separated from the general MSW collections. It is intended that the collection vehicles will be powered by the renewable natural gas produced by the process, as are other Organic Power vehicles.

Outputs from the plant are methane and CO_2 gas, a fibrous compost, and clean solid and liquid fertilisers. The methane gas output is approximately 97% pure methane after CO_2 separation and this can be sold as gas for heating or cooling, or for use as a vehicle fuel or to generate renewable electricity The CO_2 can be used for enhancing greenhouse crop growth, in carbonated drinks, for the preparation of decaffeinated coffee and in its supercritical form as a solvent, particularly in the electronics industry. Organic Power are working to commercialise the process of converting the fibrous output into a wood substitute using the CO_2 in supercritical form as part of the process.

Scale / Costs

The overall cost of building the first commercial plant is in the region of £3.5 million.

Energy Balance

The total energy saved and generated from using the plant will be in the region of 4.5 million kWh.

Emissions

As the system is totally enclosed there are no emissions to air. Any emissions from the head space above storage tanks and during loading and unloading are vented via a combination of water scrubbing and natural biofilters.

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Project Partners:
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The IWI RAD (Rotary Aerobic Digester) System

IWI (UK) Plc

Technology type: In Vessel Digestion

Project Description

The aim of this project is to process the residual waste fraction of MSW using aerobic digestion into a fuel known as green coal. The system would be capable of treating 23,000 tonnes of BMW per annum although the system is modular and can therefore be designed to process significantly greater tonnages.

The planned location for the project is the Isle of Wight and the feedstock for the plant would be separated and principally biodegradable waste supplied by IWS.

The project would involve conducting structured trials of the RAD process to ascertain the optimum operating parameters and the requisite process data. Detailed analyses of the green coal fuel will also be undertaken to identify its ability to meet the specification of industrial users.

Technology Background

The object of the RAD System is to produce a homogeneous, consistent fuel source with increased net calorific value (through the reduction of moisture content). This is achieved by initially shredding the waste to a defined size. The waste is mixed then supplied to a Rotary Aerobic Digester ("RAD"). The RAD is a slowly rotating, inclined, aerated drum where the biodegradable fraction is stabilized by microbial composting activity. The biodegradable fraction typically contains 40-60% moisture and provides a suitable environment for the microbial degradation process. Other residual organic sludge's and wastes (e.g. sewage sludge and green waste) may also be added and treated in the RAD with the compostable fraction of MSW to enhance the rapid breakdown of organic matter by adjusting the moisture and nitrogen status of the feedstock. Moisture is vaporised without applying an external heat source due to the production of metabolically generated heat by the natural composting process, which can increase the temperature of the composting material to 65 – 70 degrees.

Moisture is extracted by mechanical agitation and a forced counter current circulation fan and the quantity removed will vary between 20 – 30% by weight depending on the organic composition and other process parameters, such as particle size of material, speed of digester rotation and air flow. The thermophilic temperature conditions also effectively pasteurise the product inactivating potentially harmful, infectious pathogens that may be present in the waste. Therefore the process will enable compliance with Animal by-Products Regulations. The average retention time in the drum is 48 hrs and the product can be processed through a pelletiser to produce green coal, which is a consistent, homogeneous and stable fuel.

Inputs / Outputs

Annually this plant would process approximately 22,500 tonnes of input waste and create at least 13,000 tonnes of green coal.

Green coal will be a suitable fuel source for cement kilns and potentially power plants as well as producing a consistent feedstock for advanced thermal processes.

Scale / Costs

The capital cost of the required plant is in the region of £2.5 million.

Energy Balance

IWI believe that green coal derived from UK municipal solid waste will have relatively stable calorific values between 12-14 MJ/kg at 25-30% moisture.

Based on an input tonnage of 22,500 tonnes, The RAD plant would use around 690,000 KWe and produce approximitly13,000 tonnes of green coal with a CV of 13MJ. If combusted in a conventional waste combustion system to generate steam and electricity, approximately 9,000 MW of electrical power per annum would be generated, assuming an electrical generation efficiency of 19%.

Mass Balance

It is expected that around 90% of MSW would be suitable for processing into fuel. The remainder consisting of recycled metals and a proportion of rejects from the front end processing plant.

Emissions

The process emissions are dealt with via a bio filter. Past experience indicates that the emissions will comprise principally water vapor and carbon dioxide.

The burning of green coal will produce very low levels of Sulphur and Chlorine and a fraction of that occurring through the burning of coal.

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Myerscough College Anaerobic Digestion System

Myerscough College

Technology type: In-Vessel Digestion

Project Description

The project will be based at Myerscough College, near Preston and utilises anaerobic digestion to process waste materials. The estate at Myerscough consists of land owned by the College and some that is rented from the Duchy of Lancaster.

Three potential sites to build the digestion plant have been identified, each of which is land owned by the College. Each of these sites has relative merits; however, one site, situated closely to a recently constructed Sewage Treatment Plant, the Horticultural Unit and potential trials field, is particularly favoured presently. The project will be based on the fringe between rural and urban areas.

The overall viability of the system as a commercial venture will depend heavily upon the way in which the installation is operated and waste streams processed and used from a financial perspective. A key element of the project is having a clearly defined commercial aspect at all stages: if not commercially viable, the system will not become one that is utilised by others in the market.

Technology Background

The project will use an anaerobic digester to process biological municipal waste together with other typical organic wastes which will have a value for use on land. These other wastes can include blood, catering waste including meat products and other food industry waste such as potato waste. The project will involve a life cycle assessment (LCA) of the process and examine all carbon and nitrogen inputs and outputs in addition to tracking all energy requirements of the process.

In the processing of the material to render the pathogens benign, carbon is released but captured as methane, which is utilised as an energy source for further driving the process or for resale as an off-site resource. This reduces greenhouse gas emissions. Most of the nitrogen within the waste will be retained during the processing and subsequently be used on the land with its balance measured during crop uptake.

Inputs / Outputs

The planned system would be capable of handling around 5,000 tonnes of waste annually. The waste streams that the equipment could process include the organic fraction of MSW, blood, meat, catering waste and other food industry residues.

The marketable outputs of the project are essentially a fertiliser material and methane gas, which can be used as an energy source.

Scale / Costs

Total project costs are in the region of £3,250,000

Energy Balance

The project would involve a detailed appraisal of the energy requirements of the equipment. Through-out the operation of the plant key factors will be monitored to give an overall energy balance for the scheme.

Emissions

No residue streams exist and the only potential emissions are the release of various gaseous nitrogen compounds such as nitrous oxide.

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Project Partners:
Landmark Environmental

South Shropshire Biowaste Digester

Greenfinch Ltd. & South Shropshire District Council

Technology type: In-Vessel Digestion

Project Description

The aim of this project is to use anaerobic digestion to treat source separated kitchen and garden waste. The project will be based on industrial estate in Ludlow, Shropshire. The demonstrator plant will be capable of handling 5,000 tonnes of waste annually.

The council has a well developed plan for the collection of kitchen and garden waste covering 60% of the households in the district. The project partners, Greenfinch Ltd, have developed a number of anaerobic digestion facilities including seven on-farm biogas plants in Scotland.

Technology Background

The key components of the process for recycling household kitchen and garden waste are:

- Waste reception, which is inside a building with air emissions controlled by a biofilter;
- Mechanical waste conditioning, with primary shredding;
- Digester feedstock homogenisation, with secondary shredding;
- Digester feedstock buffer storage, to allow for 5-day delivery of feedstock;
- Mesophilic anaerobic digestion (37°C), a continuous process in a fully-mixed tank;
- Pasteurisation (70°C for one hour), a strictly batch process with zero by-pass;
- Fibre separation, to separate particles larger than 500µm for use as a soil conditioner;
- Liquid biofertiliser storage, in a sealed tank awaiting transport to a local farm;
- Biogas storage;
- CHP unit, to produce renewable electricity for the grid, process heat and district heating;
- Heat exchange units;
- Pumping systems;
- Biofilter system; and
- Instrumentation and controls

Inputs / Outputs

The input material will be 5,000 tonnes of source separated organic waste.

The outputs from the project will be electricity, heat and a fertiliser material that will initially be given to local farmers.

Scale / Costs

The capital cost, including civil works of the complete plant is £1.4 million plus the costs of a visitor centre estimated at £0.4million. Over and above this is a grant towards operating, monitoring and research in the first two years.

Energy Balance

The gross annual electricity production is estimated to be 1,615,000 kWh with process plant consumption of 125,000 kWh, giving a net output of 1,490,000 kWh. The electricity will qualify for renewable obligation certificates.

The gross annual heat production is estimated to be 2,690,000 kWh with process plant consumption of 500,000 kWh, giving a net output of 2,190,000 kWh.

Mass Balance

The mass balance of the project is the conversion of 5,000 tonnes per year of biowaste plus 200 tonnes per year of wash-water into 4,320 tonnes per year of biofertiliser and 880 tonnes per year of biogas.

Emissions

The only air emissions are the exhaust gas from the CHP unit and the filtered air from the biofilter.

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Community Organic Recycling: CORe Plant

Southwark Biogas Partnership

Technology type: In-Vessel Digestion

Project Description

The CORe project will use anaerobic digestion to process source separated organic / kitchen waste. The collection points for the waste include high and low rise flats, street level properties, school meal collections and a market. A total of around 2,500 tonnes will be collected for the plant.

The site will use anaerobic digestion technology, which has been developed by Greenfinch Ltd at their Ludlow site.

The plant is intended to be in operation for a minimum of ten years. The plant would then continue to act as a demonstrator because of its location next to the planned Southwark Environmental Futures Centre. The CORe plant will be specifically designed for visits and study and there will be facilities for training at the Environmental Futures Centre.

Technology Background

The plant will be based on operations at the Ludlow site where kitchen waste was delivered on five days a week to the biogas plant. It was then shredded, homogenised, pasteurised and digested, with the biogas used for greenhouse heating. Following six years of research, Greenfinch has developed an innovative design of biogas plant for the recycling of catering waste and other Animal By-products Regulations category 3 materials.

From research carried out and from visits to Europe, there do not seem to be any examples of pure source separated household waste digestion in densely populated urban area. Therefore the CORe plant is innovative and will provide useful information for future developments.

Inputs / Outputs

The input waste for the project will be source separated kitchen waste.

The outputs will be a fertiliser, which can be used for improving soil quality. Additionally, the CHP unit will generate electricity and heat.

Scale / Costs

The total capital cost of the project including the purchase of vehicles and CHP plant would be in the region of £975,000.

Energy Balance

The figures below show the overall electricity balance for the plant:

Gross Output	735 MWh/yr
Plant Consumption	70 MWh/yr
Net Output	665 MWh/yr

The figures for heat produced by the plant are:

Gross Output	1,225 MWh/yr
Plant Consumption	270 MWh/yr
Net Output	955 MWh/yr

Mass Balance

It is expected that from 2,500 tonnes of organic waste the plant will output around 2,000 tonnes of fertiliser.

Emissions

The only gaseous emission from CORe is CO_2 from the CHP engine, however this is in the form of a release of previously sequestrated CO_2. If the greenhouses or poly-tunnels, currently in use on the site, were supplied with some of the CO_2 to stimulate plant growth, emissions could be reduced further.

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Project Partners:
London Borough of Southwark, Sustainable Energy Action, Greenfinch Ltd, Rutherford Collins Ltd, Community Re-cycling organisation

H.E.BIO.T.® High Efficiency Biological Technology

Entsorga S.r.l.

Technology type: Mechanical – Biological Treatment

Plant at Vazzano, Southern Italy

Project Description

The project proposes to demonstrate the flexibility of the Entsorga High Efficiency Biological Treatment (HEBIOT®) technology to treat a wide range of waste inputs and accommodate changes in the waste composition over time. Objectives are to show how this technology is able to produce a contribution to recycling, a Solid Recovered Fuel (SRF) to specification, and significantly divert Biological Municipal Waste (BMW) from landfill.

Technology Background

The technology is a "reverse air flow" three stage Mechanical Biological Treatment (MBT). Residual MSW or source segregated organic waste will be biostabilised or biodried and then further refined to generate a range of streams suitable for recycling and energy recovery. The technology is operating in Italy for source separated MSW. A new air emission cleaning system is also being developed that is expected to show some advantages compared to other systems.

Inputs / Outputs

The facility is designed to provide considerable flexibility, the input material can either be residual MSW, currently sent to landfill or source separated organic waste (green and kitchen). Yields of various outputs (e.g. calorific value of SRF, moisture and solids content) are calculated using an input/output modelling tool enabling users to estimate the level of recycling, recovery and BMW.

Two main modes of operation will be considered with different objectives and outputs. In biodrying mode the waste is stabilised and dried as rapidly as possible in order to produce an SRF to a relevant (CEN or customer specific) standard, maximising the energy content of the SRF. There is potentially strong interest is using the SRF as an alternative to fossil fuels, for example in the cement industry. In biostabilisation mode, used in the event that an immediate SRF market outlet cannot be organised, there will be a longer and slower aerobic treatment phase in order to extend the reduction of active organic material and increase BMW diversion.

In addition to SRF it is anticipated that the primary and secondary mechanical treatment stages will give rise to quantities of recyclates and other recoverables: paper / cardboard, textiles / wood, plastic / rubber at the primary stage, ferrous metals, aluminium, fines and inerts at the secondary stage, depending on the needs of the user.

Scale / Costs

A single facility has a capacity in the range of 50,000 to 80,000tpa (multiple units can be used for higher capacities) residual MSW and will be able to divert up to 50% of the material as SRF for energy recovery. BMW reduction will depend upon cycle times and waste input but significant reduction can be expected.

The minimum footprint required is approximately 10,000m^2. Approximate capital project costs are between £7.8 and £11m depending upon mode of operation and specification of the output materials.

Energy Balance

If the SRF is used in a thermal process there is a positive energy balance: for each tonne of MSW treated, 500kg of SRF is produced at a (minimum) energy content of 15MJ/kg giving a total energy content of 2400kWh.

Mass Balance

For a typical residual MSW waste stream, 50% of the mass is lost through the bio-drying process and recovery activity leaving 50% as a solid recovered fuel (SRF); practically 100% diversion of BMW occurs when using this in a thermal plant. In biostabilisation mode the level of BMW diversion depends upon the input level and time for treatment, very low levels are achievable.

Emissions

Typically a biofilter is used for cleaning all the emissions. Alternatively, an innovative low energy consumption ceramic / catalytic emission control system "Phoenix" is being developed to provide improved emission control, particularly of VOCs, in comparison to biofilters and thermal oxidisers. Typical operating performance parameters for the Entsorga Phoenix system are less than 300 OU/m^3 of odours, non-detectable amounts of ammonia and hydrogen sulphide and less than 15 mg/m^3 VOCs. Small amounts (c.a. 5 tpa) of non-hazardous inert residues will accrue from disposal of spent catalyst from the Phoenix system.

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Project Partners:

Hills Waste Management, Wiltshire CC Entec

The ArrowBio Process

Oaktech Environmental

Technology type: Mechanical – Biological Treatment / Anaerobic Digestion

Project Description

The ArrowBio system is an MBT-anaerobic digestion process that uses a water separation system to divide waste. The project plan was to take waste generated in Epping to the facility in Thurrock. The Thurrock site is in an industrial area and has jetty access to the River Thames.

The initial capacity of the plant is 45,000 tonnes of MSW per annum, but the plant capacity could be increased to 70,000 tpa once the process has been optimised. A plant using the same technology is already in use in Tel Aviv.

Technology Background

The waste goes through two processing stages, physical and biological. Firstly the MSW is tipped into a tank of circulating water. The water in the tank allows the gravitational separation of non-biodegradable and biodegradable wastes. Items that sink in the water are passed sequentially through a bag breaker, a magnetic pick up, eddy current separators and an air separation system. These processes remove the metals and plastic film from the waste stream. These can then be sent for recycling.

The water prepares the biodegradable items for the anaerobic digestion stage, by absorbing soluble substances. At this stage the waste material is an organic rich fine suspension. The addition of water to the waste also suppresses dust and odours.

In the biological phase the plant uses a digestion method known as Upflow Anaerobic Sludge Blanket (UASB) digestion, which is a technology used extensively for the treatment of high strength liquid wastes and municipal sewage treatment. The system uses two bio-reaction tanks. In the first tank easily metabolised substances are fermented into acetic acid. The solution is then passed to the second reactor where methane is generated.

In the UASB bioreactor, solid organic matter is suspended in a layer near the surface of the water in the vessel where up to 80% of it is converted to biogas and water over a period of 80 days. The biogas is extracted to feed power generators and the water is returned to the gravitational tank at the beginning of the physical separation process. The remaining 20% of solid organic waste which does not break down into biogas and water can be skimmed off and fed into a pasteurisation unit where it is heated to a temperature to meet EC Regulation No 1774/2002 before being either used as a soil amendment product or being dewatered and sent with the waste plastic for conversion into fibre polymer composites.

Inputs / Outputs

The input material for the plant will be unsorted MSW. The initial capacity for the plant would be 45,000 tonnes per annum.

Plastics and metals are separated from the MSW. The main outputs of the project will be water, an organic soil conditioner and biogas for electricity generation.

Scale / Costs

The total value of the project is £12.2 million.

Energy Balance

To process 1,000 tonnes of MSW the plant will require around 55 MWh of electricity. This amount of waste should generate 140 tonnes of biogas, enough to generate 323 MWh of electricity. Additionally, around 675 MWh of exhaust heat will be recovered to dry residuals and plastics.

Mass Balance

Estimated volumes of primary outputs

- 3,600 tonnes per year of mixed recycled plastic
- 1,710 tonnes of ferrous metal.
- 2,160 tonnes of glass.
- 405 tonnes of non-ferrous metal.
- About 1.5-2 MW (approx 10,000 MWh) electricity (net, after self-use and assuming generators are purchased) generated from biogas
- About 4500 tonnes of cleaned water

About 4500 tonnes of soil amendment to BSI PAS 100 profile standards

Emissions

The process of adding the waste to water means that any potential odour and dust problems are removed.

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Waterman Group,
South Herts Waste Management Ltd,
Industrial Chemical Group Ltd

Organic Resource Technologies Ltd

Technology type: Mechanical – Biological Treatment

Project Description

This technology has two distinct elements, the first is a waste sorting facility that separates recyclable and organic material from a mixed waste stream delivered to the facility. The second uses three bioconversion vessels to process the organic material removed from the mixed waste using the DiCOM® process, which has been patented by Organic Resource Technologies Limited, a subsidiary of ORT Limited (ORT).

ORT is based in Western Australia and has developed a prototype plant in Perth.

Technology Background

The planned site is split into two parts; a sorting plant and an in-vessel bioconversion system.

The elements of the sorting system are based upon rapid mechanical separation incorporating trommel homogenisation, pulverisation, screening and subsequent processing of component fractions. Ferrous and non-ferrous metals are removed using magnetic and eddy-current separation, and glass and grit is removed from the organic fraction in a wet separation process, prior to bioconversion.

ORT has developed a design for a Waste Sorting Facility comprising two independent, parallel sorting trains incorporating a shared reception area with a capacity of 100,000tpa MSW. The facility can be developed in stages, with initial capacity of 50,000tpa MSW.

The organic fraction of the waste is then passed on to the DiCOM® bioconversion process. The aim of this process is to generate a net energy surplus and a stable, agricultural grade compost from a bioconversion process occurring in a single vessel. Trials have successfully treated materials such as MSW organics (from multi-bin and single bin collection systems), as well as blends of other organic materials.

DiCOM® is a batch process that operates continuously using a sequencing method comprising three vessels. The process integrates the natural aerobic and anaerobic bioconversion cycles at the biological, rather than infrastructure or logistical level. This integration creates a new process with a unique set of biological conditions for the microorganisms, resulting in accelerated bioconversion of organic material to stabilised compost, together with a period of biogas production.

Processing time includes 5 days for loading each vessel, followed by 14 days of biological treatment. Once loaded, the material remains in the vessel until the end of the process. At the end of the cycle, the material requires no further maturation or biological processing.

The process produces a net energy surplus, in the form of biogas and heat. The biogas is converted to electricity using standard power generating equipment.

The DiCOM® Processing Sequence:

After separation, homogenized and pulverized organic material is loaded into the vessel over 5 days. During loading, the material undergoes controlled aeration resulting in biological heat generation. Once loading is complete, the anaerobic process is established with the addition of carefully regulated anaerobic inoculum. The inoculum is already warm, being derived from one of the other vessels having just completed the anaerobic phase of its batch process. The anaerobic phase is thermophilic (>55°C), and has a duration of 7 days.

When the anaerobic phase is complete, the inoculum is drained and supplied to the next vessel, and the final aerobic conditioning phase is initiated.

The control system is fully automated. Sensors monitor the conditions within each vessel, set and vary the flow of air and water, thereby regulating moisture levels, temperature, pressure, oxygen, carbon dioxide and methane, as well as odour generation and control.

Overall batch cycle time is 21 days. Continuous processing therefore requires three identical bioreactor vessels, operated concurrently, each one week out of phase with the next.

Energy Balance

The process is a net energy producer. Sufficient biogas is produced within the process to meet plant energy requirements, and surplus energy can be either sold under an off-take agreement to an external energy user, or used for value adding of the composted biomass fraction.

Mass Balance

For every 100 tonnes of MSW received the process will produce*:

3.4 tonnes of dry recyclables, 23.2 tonnes of non-recyclables, 12.7 tonnes of glass / grit, 69.1 tonnes of compost (with added water), 4.3 MWe of electricity available for export to the grid

* Subject to variation with MSW composition; figures based on MSW data from Perth, Western Australia.

Emissions

The process occurs inside a sealed, light pressure-vessel, and therefore all possible emissions can be controlled and treated prior to release to the atmosphere. This is especially important when dealing with highly putrescible wastes. The sealed vessel eliminates the risk of accidental emissions. The process utilises a unique odour control system that can remove over 94% of odorous compounds.

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The reCulture Process

reCulture Engineering AB

Technology type: Mechanical – Biological Treatment

Project Description

The reCulture process involves separating MSW using a complex Materials Recycling Facility (MRF). The proposed plant would sort household waste from the Local Autority into various waste streams. A suitable site for the development has been identified.

The main output would be a refuse derived fuel, which could be burnt for power or heat. Additionally, metals and heavy plastics would be collected for recycling. The plant is based on a similar trial facility in Sweden. Salts and heavy metals are removed.

Technology Background

The waste is delivered to the site and is collected in a reception area. The waste is then transported to a dissolving tank, which is filled with water. The process developed by reCulture for the refining of household waste to a clean and effective fuel is based on the technique used in the recovery of cellulose fibre from recycled paper. Hot water is used as a medium to dissolve the material in the waste, to divide it into its constituent materials, and to transport it. At its least concentrated, the slurry is 1 per cent waste and 99 per cent water.

Dense materials such as metals and aggregates are collected from the bottom of the dissolving tank for recycling. The lighter fraction of the waste is collected from the top of the tank and is sent on for de-watering and drying. The water displaced from the waste is then sent to a water purification system.

The reCulture process is closed and works under low, sub-atmospheric pressure in order to avoid leakage of environmentally hazardous substances. Machinery and storage tanks are encased in an airtight system. All process air and other gas passes through an advanced purification system, as does the water used in the process. Because of the water content in the waste, the process results in a water surplus, which is purified and bled into the dissolving tank.

Inputs / Outputs

The plant would be capable of handling a minimum of 50,000 tonnes of MSW per annum. This will be processed to produce a refuse derived fuel, metals, plastics and a filling material, with less than 1% to be landfilled.

Scale / Costs

The total investment for the project is in the region of £17 million including CHP plant.

Energy Balance

The energy value, per tonne of dry substance fuel, has been found to be about 5.7 MWh. This makes the fuel ideal for use in heat and/or electricity generation.

Mass Balance

From each tonne of waste the following products will be generated:

- Fuel 620 kg
- Filling material 150 kg
- Metals 20 kg
- Water 197 kg
- Plastics 8 kg
- Residuals 5 kg, i.e. less than 1% to be landfilled

Emissions

The processing system is held within a low pressure area and all air emissions go through an air purification system.

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Project Partners:
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Solid Recovered Fuel Production Plant, Materials Recovery Facility and Energy Generation

Bronzeoak Ltd.

Technology type: Thermal Treatment

Project Description

The project will divert 100,000t of mixed municipal waste from landfill, recycling sterile product and using solid recovered fuel (SRF) to generate up to 6MW (gross) of electricity. Linked demonstrator plants will process municipal waste by autoclaving, extracting saleable recyclables, and using the resulting SRF in an adjacent CHP pyrolysis generator. The project aims to divert from landfill (90%) and recover value by processing the biodegradable fraction into SRF (65%), and recyclable inorganics (25%). The pyrolysis process also produces an ash (10%), which can be vitrified for recycling.

Technology Background

The Bronzeoak Group has been developing renewable energy and waste to energy plants for the last 10 years including extensive project experience in South-East Asia. Autoclaving mixed waste is a near-market technology which has been successfully trialled with MSW, but requires extended evaluation with SRF, post-treatment sorting, and energy recovery at the point of diversion.

Inputs / Outputs

The plant will be supplied with mixed waste presently sent to landfill and a Household Waste Recycling Centre. Municipal Solid Waste (MSW) with a substantial biodegradable fraction (65%) will be received, discharged to a reception area, and pre-sorted to remove outsize items.

During the demonstration stage the autoclave will produce 750t/week (39,000t/year) of SRF, plus about 500t/wk of recyclables, and the SRF will be used to generate 6MW gross electricity plus heat. In addition to SRF, principal output materials will be textiles, plastics, glass cullet, ferrous and non-ferrous metals, aggregate and, subject to the outcome of engineering studies, vitrified ash. The quantities of all recyclates will vary according to season.

Scale / Costs

The autoclave demonstrator stage will be based on a 2 x 20t system (2 hour cycle, 16 hours/day), which will process 100,000t of MSW per annum. The cost is estimated at £29M for the first project, but a roll out cost of about £24M is envisaged. The ideal project size is about 160,000t of MSW per annum which will provide 100% of the required autoclave steam, 9MW of electricity and be a 24hour process.

Energy Balance

Each unit will have a thermal input of 12.5 MW. The process delivers a syngas stream with a fuel heat rate of 8.66 MW. Utilising reciprocating engine generators with an efficiency of 35%, 3.03 MWe can be produced. With two adjacent units operating simultaneously the total gross electrical generation will be a little over 6 MW. The process is able to produce 60% of the autoclave steam requirement from energy recovered from flue gases from the gasifier and the gas engines.

Mass Balance

From 100,000t of MSW at 40% moisture content, if dried to 5% moisture, about 39,000t will be available for energy generation, 25,000t will be recycled and 7,000t returned to landfill. The ash from the pyrolysis stage will be recycled to the construction market. 100,000 tpa input equates to 750 t/wk of SRF production.

Emissions

Principal wastes from the process are:

a) Solid Recovered Fuel (used as fuel in the adjacent pyrolyser) 39,000tpa

b) Liquid effluent from autoclave 1,000 tpa from quench system 3,000 tpa

For off-site disposal after effluent treatment (reverse osmosis). It is hoped to demonstrate a treatment system that will allow re-use with the contaminated fraction treated on site

c) Ash from char reburner 5,000 tpa

d) Fly ash from boiler 400 tpa

These will be landfilled, however there is potential for a vitrification process for reuse in the construction industry.

d) Non-biodegradable fraction of MSW (to landfill) 10,000t/pa

There are no emissions to air from the autoclave process; the steam vented on opening the vessels is contained and condensed. Any odour will be treated with carbon filtration or thermal oxidisation if necessary. Flue gas from the gasifier and from the gas engines will be processed in a waste heat boiler with the resultant flue gas being treated to comply with Waste Incineration Directive limits.

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Project Partners:

EcoTran & Wyvern Waste

Continuous Feed Process for the Pyrolysis / Gasification of BMW and other Wastes

Carbon Processing Ltd.

Technology type: Thermal Treatment

Project Description

The proposed project will study the thermal and environmental characteristics of various samples of BMW and use the data to develop and construct a commercial unit for the conversion of domestic MSW and other domestic and commercial wastes into heat and power. The proposed system will incorporate integrated pyrolysis and gasification under low temperature, controlled operating conditions and absorbent injection to retain problematic elements in the ash residue and to minimise the formation and release of toxins.

Technology Background

The project will use a low temperature rotary pyrolysis and up-draft gasification technology. Pyrolysis applies external heat in an inert atmosphere at a controlled temperature to achieve specific processing objectives for the feedstock. For BMW, the objective would be to provide only sufficient heat to volatilise the high (up to 80%) organic component and retain alkali salts, chlorine, sulphur and heavy metals in the carbonaceous char. Absorbent materials such as limestone will be injected with the char into the downstream gasifier, which operates at a higher temperature but will retain at least 70% of the acid compounds and some heavy metals in the ash residue. It will substantially lower or eliminate the formation of dioxin type chemicals. This 'prevention rather than cure' approach will significantly lower the capital and operating costs for the flue gas clean up system. The gasification of the carbonaceous char will produce a clean, low CV fuel gas that can be used to heat the pyrolysis system and avoid importing fuel. This project would determine the best design and operating conditions for pyrolysis and absorption gasification, with maximum thermal and environmental efficiency.

Inputs / Outputs

The feedstock will be shredded BMW with minimum pre-treatment following collection from domestic homes, hotels etc. Sorting and coarse shredding may be required to remove materials. If the bulk density of the shredded material is low, pelletisation may be necessary which would require drying to about 10% moisture. Pyrolysis results in the production of three products; carbonaceous char, condensable volatile and non-condensable volatiles. The hot pyrolysis volatile gas will be combusted in a gas boiler for subsequent energy recovery within the process.

Scale / Costs

The dimensions of the rotary reactor for a 150 kg/h feedstock research facility are 0.35 metre diameter and 3 metre length. Design of a 50,000 tpa commercial plant indicates a footprint, including a power plant and material handling, of approximately 1000m^2. Capital expenditure for this research facility partly utilising existing equipment is around £266K. Approximately £15 million for the commercial CHP plant of 50,000 tpa capacity.

Energy Balance

The total energy recovered from the feedstock for the continuous pyrolysis and gasification process will be similar to incineration, but involves only the simple combustion of gas and not solids. For a commercial plant, the hot pyrolysis gas would pass into a conventional boiler to generate 40 bar steam, for turbine power generation. At 6 tonnes per hour feed-rate the total energy in the feedstock is 30 MW, and 6.90 MW of heating is required for the pyrolysis stage. Resultant electrical power generation is about 6 MWe with energy recovery, and a further 23 MW of low grade heat available from the low pressure steam from the turbines.

Mass Balance

A 6,000 kg/h BMW commercial plant yields 833 kg/hr inert ash (13.9 % of feedstock), providing a BMW landfill diversion of 86% or 43,000 tpa. 100% of the acid gas elements are retained in the charcoal during low temperature pyrolysis, while 70% by weight of the acid gas elements are retained in the ash residue during gasification.

Emissions

This approach produces a clean fuel gas and only minimum gas clean up equipment would be required following discharge from a standard gas boiler. A minimum acid gas clean-up would lower the acid gases, principally HCl and SO_2/SO_3, to the set regulatory limits. For a feed rate of 6,000 kg/h, the total flue gas flow rate will be 57,500 Nm^3/h, composed of CO_2 9.3% (by volume), N_2 80.6%, and O_2 10.0%.

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Compact Power ATT Avonmouth

Compact Power Limited

Technology type: Thermal Treatment

Project Description

Compact Power Ltd and Bristol City Council are collaborating on the development of a demonstration project for an advanced thermal conversion energy from waste plant at Avonmouth.

Bristol City Council will provide the site and supply the necessary waste feedstock produced. This will facilitate the demonstration of the production of combined heat and power (CHP) and almost complete diversion from landfill through the use of an integrated waste management process with energy recovery.

Technology Background

Compact Power has developed a thermal process technology that will deliver sustainable solutions for the safe and clean disposal of waste and the conversion of wastes and biomass material into renewable sources of energy.

The technology is advanced thermal conversion that combines the processes of pyrolysis, gasification and high temperature oxidation. The technology works by heating waste at a high temperature in an oxygen free chamber. This converts waste to simple gases and carbon char. The carbon is then also converted to gas and the resulting gases are combusted to produce heat, which is then converted to energy as steam. The process generates low levels of emissions that are well within the increasingly rigorous regulations. The technology also allows efficient energy recovery and has the potential to produce valuable by-products.

Compact Power technology is designed in a configuration based on a multi-tube (“MT”) module consisting of a two tube pyrolysis unit feeding carbon and ash residues to a single gasification unit. Each tube has a throughput capacity of 500kg per hour when processing material with a calorific value of 12 MJ/Kg. The modular design offers small scale solutions for waste and biomass processing with low visual impact. Up to 80% of the energy value of the waste can be recovered as usable power and heat. Units of plant are small, but the concept is modular so that plant design can be optimised to meet requirements from 6,000 tonnes to 60,000 tonnes per year and more.

The Compact Power plant fits ideally into an integrated waste management scenario producing energy from the residual non-recyclable waste after recycling and composting has taken place. The technology has the potential to convert wastes into high value recycled products such as activated carbon, carbon black, and lightweight aggregates.

Inputs / Outputs

The outputs will be electricity and heat and an ash residue from the combustion process.

Scale / Costs

A project diverting 21,700 tpa of BMW from landfill would have a capital cost of £8.4M.

Energy Balance

The system can accept 3,224 kg of waste per hour. This amount of waste would have an energy content of 13,330 kW. The useable energy outputs from the process will be 2,400 kW of electricity and 7,620 kW of heat.

Mass Balance

The hourly input of waste is 3,224 kg after combustion 652 kg of ash will be left. Another 42 kg of material will be filtered from the flue gases.

Emissions

Operational experience shows that Compact Power technology achieves emissions levels far below the European Waste Incineration Directive Limits.

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Project Partners:
Bristol City Council & AMEC

Recycling and Recovery of Biodegradable Municipal Waste by Fluidized Bed Gasification Technology

EBARA Corporation

Technology type: Thermal Treatment

Project Description

This demonstration plant is intended to gasify various types of pre-treated wastes derived from MSW. Examples are high calorific value fractions from MBT processes. It will be a major goal to compare overall BMW diversion performance with differently pre-treated input materials. This would result in knowledge of which pre-treatments are actually necessary to achieve overall best ecologic and economic results in BMW diversion.

This plant would be one of the first waste gasification installations in England of near-commercial size and the first in England to continuously generate a fuel gas from BMW. Globally there are currently no commercially successful waste gasification installations in operation except for Japan.

Technology Background

EBARA has constructed over 200 waste treatment plants using internally circulating bubbling fluidized bed technology, 25 of which apply gasification. The proposed ICFG plant, to date realised in two pilot plants, applies the same proprietary technology. ICFG generates a product gas for high efficiency power generation, co-combustion or feedstock recycling.

ICFG is a fluidized bed gasifier, operating at low temperature and atmospheric pressure. Its most distinguishing feature is separate gasification and char oxidation chambers, which enables production of a high heating value product syngas from the biodegradable and volatile part of the waste, without using expensive (energy consuming) oxygen as a gasification agent.

Inputs / Outputs

The plant can accept various qualities and mixtures of waste. The basic requirement is a maximum particle size of approximately 300 mm, and a lower heating value of 10 MJ/kg, so plain MSW screened for bulky material, shredded MSW, and waste after various grades of mechanical-biological pre-treatment (MBT) are all acceptable. Also, liquid wastes like oils and sewage sludge may be co-gasified.

All output streams have market potential. For some products – combustible gas, metals and electricity – well-established markets exist in England. Inert bottom ash may be used in construction. While this will not generate large amounts of revenue, it will save landfill costs, increase diversion from landfill and replace virgin construction materials.

The metallurgical industry will charge for recycling of (heavy metal rich) fly ash. Market conditions will decide whether land filling of this small mass fraction is more economical.

Scale / Costs

The demonstration plant is scaled at only 4,500tpa (15 tonnes per day), or 2 MW thermal input. This is the minimum size to achieve scaleable results.

A commercial plant with 2 process lines of 40 MW each would serve a community of about 500,000 people. A 15 tonnes per day plant would cost £6.25M to construct. Operational costs during an 18-month service period would be around £1.35M.

Energy Balance

ICFG will offer excellent energy efficiency in a commercial installation, where more than half of the energy content is transferred to the product gas, which can be used for power conversion in large-size efficient generators, while the remainder of the energy content is still available as heat for steam generation. In the demonstration facility, it will not be efficient to recover that heat, and so work would focus on the fuel gas generation.

Mass Balance

It is intended that the demonstration plant would be operated in campaigns, with varying testing and demonstration targets. Theoretically, in full continuous operation (300 d/y), the plant would gasify 4,500 t/y of waste, corresponding to 3,060 t/y of BMW. No biodegradable waste is land filled after treatment with ICFG. The total mass flow of ash is 34 kg/h, including gasifier bottom ash, fly ash, and metals.

Emissions

The main emissions would be combustion products from utilisation of the derived fuel gas, and the flue gas of the ICFG process ($2952 m^3/hr$), which is predominantly nitrogen (54%), and water vapour (32%), with smaller amounts of oxygen (8%) and carbon dioxide (5%). Levels of SO_2 and HCl would be maintained in compliance with all relevant regulations, especially the Waste Incineration Directive.

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Advanced Thermal Conversion of Residual Biodegradable Waste

Energos AS

Technology type: Thermal Treatment

Project Description

This project relates to the upgrading of an existing waste incinerator on the Isle of Wight. The installation of an Energos Advanced Thermal Conversion (ATC) unit and other associated modifications will allow the operation to be re-established with reduced flue gas emissions. The proposed plant is designed to treat up to 30,000 tonnes of RDF floc per annum.

The two new steps at the core of the ATC technology are Gasification followed by High Temperature Oxidation. The Gasification unit operates at sub-stoichiometric conditions to create a syn-gas which is transferred to the High-temperature Oxidation Unit. Energy is subsequently recovered from the resultant flue gases to produce electricity through a steam turbine.

Technology Background

The Energos gasification process has been developed through extensive research over the past ten years. There are currently 6 Energos gasification plants operating commercially in Norway and Germany, treating a range of MSW, commercial and industrial wastes. In total these units process 230,000 t/yr waste, and generate 570 GWhth/yr which is used to generate steam either for direct utilisation or for electricity production through a steam turbine. Energos now have almost 200,000 hours of operating experience

The technology was developed as small scale waste treatment process which would produce low emissions and offer a local solution for waste processing. The Energos gasification technology can process a range of MSW derived streams and requires less pre-treatment than many other ACT processes. As an ACT the electricity produced from the biodegradable content of the RDF will attract Renewable Obligation Certificates in the UK.

Inputs / Outputs

The input to the IOW gasification plant will be an RDF floc material which is produced in an adjacent MRF. This material has a biodegradable content of 70 – 80% and a calorific value of 11 – 14 MJ/kg.

The principle output from the plant will be electricity generated by the steam turbine. The net power export, after supplying the onsite requirements, will be 1.8 MW.

Scale / Costs

The upgrading of the former Isle of Wight incineration site to a 30,000 tpa ATC is estimated as a £3.4M capital project. Significant cost savings are achieved by utilising the existing boiler, turbine and flue gas treatment facilities.

Energy Balance

The Energos gasification plant will export 1.8MW of electricity for 7,500 hours per year produced from an annual RDF feed of 30,000 tonnes. The plant balance below shows the overall energy export and the major mass outputs. A minimum quantity of fossil fuel will be required during start-ups of the plant.

The electricity produced from the biodegradable content of the RDF will attract ROCs

Mass Balance

The annual feed into the Energos plant is 30,000 t/y and the anticipated ash quantity is 5500 t/year in the form of bottom ash and fly ash. These ash streams, which will be sent to appropriate landfill for disposal, also contain the residual chemicals which are utilised in the flue gas treatment system.

Emissions

The Energos gasification system has been developed to produce a flue gas stream with low emissions. Both the CO and NOx values are achieved without any post combustion treatment and are a result of the control systems in place on the gasification and oxidation stages of the process.

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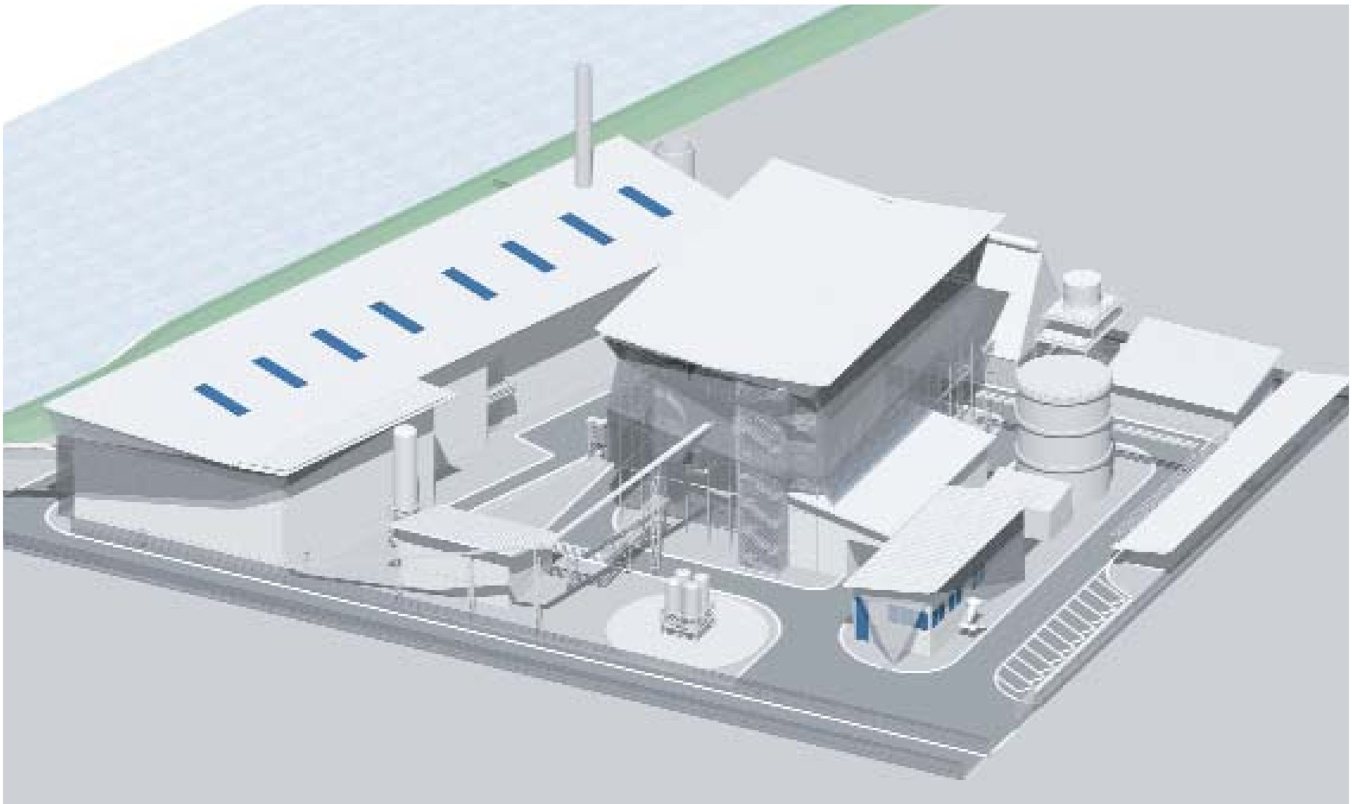
Project Partners:
EnerG Plc

Gasification of BMW Residues

Novera Energy Ltd.

Technology type: Thermal Treatment



Project Description

The aim of this project is to process around 70,000 tonnes of material annually using a gasification plant. The project will be based in East London and will use a fermented output material from an MBT plant owned by Shanks. The material from the MBT plant would otherwise be sent to landfill.

The proposed site for the facility is within the Ford Motor Company site at Dagenham. The surrounding industrial uses would be a potential user of the electricity generated by the plant.

Technology Background

The processing of the waste produces a synthetic gas for use in a power generation plant, which can export electricity into the grid. The core element is Enerkem's fluidised bed gasifier that uses organic waste as the feedstock to produce a syngas. The syngas is conditioned and fed to a steam boiler, the steam from which drives a steam turbine generator. The electricity generated satisfies the load of the plant with the balance being exported into the grid or sent to local user.

Within the gasification reactor the waste is injected into the fluid bed by a screw feeder.

Here alumina acts as the fluidisation medium. Air is injected into the bed via a distributor grid located at the bottom of the reactor. The fluidised patterns result in high mixing and heat transfer rates that are responsible for the reactions taking place during gasification. The amount of air is about 30% of the amount required for complete combustion of the organics in the waste. The temperature in the reactor is controlled between 700ºC and 800ºC to produce the desired synthetic composition of the gas.

The produced syngas is composed of nitrogen, carbon dioxide, carbon monoxide, hydrogen and small amounts of light hydrocarbons and some solid particles (char) carried over with the gas. Gas exits the reactor via cyclones, which remove the char (which contains the bulk of the inorganics), before being cooled and cleaned to remove any entrained tar (high molecular weight intermediates) and contaminants. Following cleaning the gas is fed to the fired boiler / steam turbine facility where it is burned in a conventional boiler (not a waste heat boiler) to generate steam.

Inputs / Outputs

The input material is Solid Recovered Fuel (SRF) from a Shanks MBT facility designed to process municipal solid waste arising from the East London Waste Authority. The wastes undergo a sorting process where recovery of materials takes place. The remaining biodegradable fraction of the wastes undergoes a stabilising process using the biodegradable part of the waste as a source of energy in a biological fermentation process that requires no external heat.

The resultant stabilised material is processed to produce SRF, which is an ideal source of energy for gasification having a calorific value in the order of 17MJ/kg and a moisture content of around 13%.

The outputs will be electricity, heat and char, which could potentially be used as an aggregate material.

Scale / Costs

The overall cost of the project will be in the region of £15 million.

Energy Balance

Operating at 10 tonnes per hour for 7,000 hours annually the facility will produce 9MW of electricity of which 8MW will be exported with more than 5MW of this being ROC eligible renewable energy.

Emissions

The emissions to air will be the flue gases discharged from the steam boiler. The emissions will meet or be better than the limits set down under the Waste Incineration Directive.

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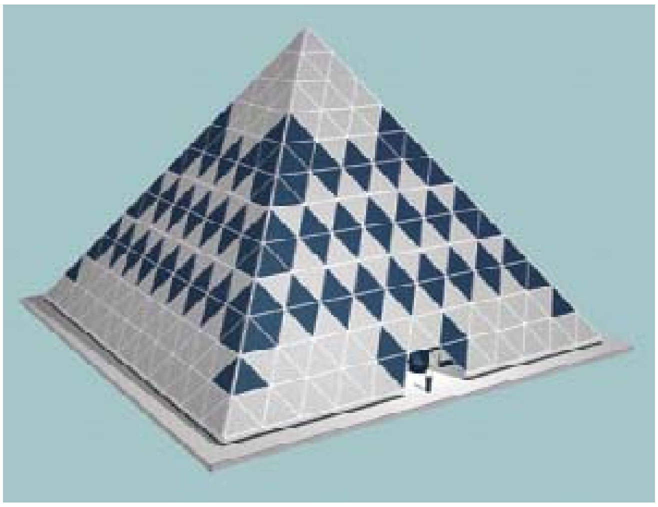
Project Partners:
Greater London Authority, Ford, Shanks & Enerkem

RESULT – Renewable Energy Station Utilising Landfill & Technology

Omega Power Ltd

Technology type: Thermal Treatment



Project Description

The Omega Power project is an innovative compact power station for a local community. It uses a series of existing, proven and hence technically feasible, technologies in a novel and patented assemblage to address obligations for diversion of biodegradable urban biomass materials from landfill as required under EU Landfill Directive, and use of non-fossil fuel for energy production required by government renewable energy targets ratified at a local level under Agenda 21.

RESULT will make use of sorted materials: mixed paper and card forming an "urban biomass", as fuel for power generation and heat recovery. The Urban Biomass may come from a variety of sources, although, much waste paper and card is separated by householders, little of it finds its way into recycled paper, due partly to the mixed qualities of paper collected and the energy inefficiencies in making high quality recycled paper from this source. The "urban biomass" can be used with no detrimental effect on availability of waste paper for recycled paper production since there is more than enough to go round.

The iconic pyramidal structure will capture energy by utilising urban biomass as a resource and photovoltaic panels within the structure.

Technology Background

The fuel may come from a variety of sources. The material is dried using heated tunnels and moving floors. It is then shredded and separated by combining pre-shredders, windsifter, ferrous and non-ferrous separators and polished using infra-red optical sorting to give a 98% biomass fuel. It is then stored in appropriate storage bunkers.

The urban biomass fuel then follows an automated path using hydraulic lifts, into the loading hopper of the combustion process. The lightweight material is then blown into the combustion chamber of the RESULT boiler. Combustion occurs in a conventional grate, raising high pressure steam with conventional gas clean up and CO_2 emissions monitoring. Other fuels such as energy crops could be added to the fuel mixture.

A combustion rate of 10 tonnes per hour will generate 12MWe: sufficient power to 12,000 homes.

Inputs / Outputs

The Urban Biomass fuel for the project may come from a variety of sources; blue bag household collection, bio-fibre sludge from an autoclave process or solid recovered fuel after aerobic fermentation.

The primary output is electricity which can be exported to the grid. In addition waste heat may also be available for local heating requirements.

The combustion process will produce c.5.8 tonnes of ash for each 100 tonne of fuel.

Scale / Costs

The overall cost for a 12MWe station is of the order of £30M. When operational the plant should provide an annual return of c.23% on capital employed.

Energy Balance

Every 100 tonnes of fuel will provide 49.76 kWth input to the system. From this 13.50 kWe of electricity will be generated, 8.61 kWth of heat will be available for local heat requirements and 21.93 kWth be rejected from the condenser. The rest of the fuel input energy will be lost as boiler, stack and turbine losses.

Mass Balance

Every 100 tonnes of fuel will require 551.5 tonnes of air for combustion producing 5.8 tonnes of ash and 645.7 tonnes of flue gas.

Emissions

RESULT has been designed to minimise emissions and will be fitted with monitoring and abatement equipment to determine that all emissions will be below the levels required by the legislation. It is anticipated that the plant will meet the requirements without the need for any scrubbing facility thus eliminating any concerns regarding disposal of contaminated liquids.

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Project Partners:
Vecoplan, AET, Biffa, Cleanaway & Shanks

The Planet Project

Planet Advantage

Technology type: Thermal Treatment

Project Description

The aim of this project is to take unsorted MSW and process the waste to create a fuel product, which can undergo gasification and be burnt for electricity generation. The gasification occurs in a Batch Oxidisation System (BOS). The scheme is a joint venture between Planet Advantage who will provide the engineering experience and Skipaway who have knowledge of the waste industry.

The project would be based in Rochester, Kent.

Technology Background

Initially MSW is brought to the site in black bin bags. The received waste is separated into its biodegradable and RDF fractions using a new press / extrusion system, developed by VM Press of Italy. The first stage of the VM Press is a pre-compression stage, where the waste is loaded loosely into a feed system hopper and undergoes a double pressing cycle with pressure applied by a forcing ram.

By submitting the municipal solid waste to a very high pressure in a perforated impact-plate matrix, the organic fraction behaves like a fluid and is expelled through the holes of the plates. After further compression the waste is extruded from the matrix.

The processing results in approximately 60% of the MSW being removed as the dry fraction (predominantly RDF along with a small percentage of biodegradable) and 40% wet fraction, which will contain minimal amounts of plastic and non-biodegradable material.

The wet biodegradable (BMW) fraction is dried using a combination of waste heat from the gasification process, along with shredded timber which is pre-sorted from the waste stream. A multi pass rotary dryer, along with a cyclonic combustion unit, facilitates the drying operation.

This process reduces the moisture content and increases the Calorific Value of the material.

The dried BMW is then processed via Planet's BOS gasification system, converting it into heat and electrical energy, using a steam cycle for the energy recovery.

Recovered electricity will be exported to the grid, whilst other outputs including recovered metals and bottom ash will be sold to the recycling industry. The residue from the gasifier will contain very little metal, which will be previously recovered from the VM Press process and segregated / sold by Skipaway, as part of their current recycling operation.

As 100% of the waste processed by the system will be BMW, the project will benefit from the generation of 'renewable energy' and additional income derived from Renewable Obligation Certificates.

Inputs / Outputs

The proposed plant will be capable of taking 390 tonnes of MSW per day.

After the VM Press there will be 157 tonnes of wet waste and 233 tonnes of refuse derived fuel. The drying process for the wet waste leaves 90 tonnes of product that can be sent on to the BOS plant. The 90 tonnes will produce 3.8 MWe of electricity, 1 MWth of recovered heat, 5.4 tonnes of ash and 1.8 tonnes of emissions.

Scale / Costs

The overall capital cost of the project is in the region of £13.5 million.

Energy Balance

The BOS plant feedstock for one day would be 90 tonnes this would have an energy value of 1,530 MWh. From this a total of 91.2 MWh of recovered energy and electricity would be obtained. The energy losses would be through boiler and steam losses, unrecovered heat and turbine losses.

Emissions

The process includes scrubbing and filtering equipment, along with continuous emissions monitoring, in order to meet the standards of Waste Incineration Directive.

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Project Partners:
Skipaway

The RTAL Trefoil Process

RTAL Ltd.

Technology type: Thermal Treatment

Project Description

The aim of this project is to use a rotating trefoil kiln to process waste materials. Clay, pulverised fuel ash (pfa), sewage cake and BMW can be fired in the kiln at a temperature close to 1200°C. The resulting product is an aggregate suitable for inclusion in a variety of construction materials.

The project involves modifying an existing plant in Tilbury to take BMW instead and as well as sewage cake.

The proposed BMW waste stream for the project is the separated fines from Greater Manchester Waste. The material is high in organics, contains grits and glass but very little plastic or metal. The material was originally produced as a soil improver but this was stopped because of BSE. With its' high moisture and low calorific value it is not suitable as RDF and currently GMW take 100,000 tonnes pa of this material to landfill.

Technology Background

The first stage of the process involves mixing the input materials in controlled ratios to ensure the consistency of the final product. The plant has a dry powder mixer which sends the combined material on to two pelletisers. The pelletisers are large rotating drums. The mixed materials are fed in at around 20% moisture and the rolling motion forms pellets. The longer the material stays in the pelletisers the larger the pellets. The pelletisers are controlled by a combination of speed and angle.

The pellets are then passed into a polishing drum, which has the effect of creating a hard outer shell to the pellets. The material is sent on to a fluidised bed dryer, which removes the moisture from the pellets. The hard outer skin means that the pellets do not reduce in size as the moisture is lost. The pellets are then fed either directly to the kiln or to a buffer store so that the amount of material in the kiln can be controlled. Pellets are fed into the Trefoil kiln at a controlled rate. The kiln is operated continuously. The required temperature and residence time are controlled by varying the speed of rotation and pellet feed rate, typically 25 minutes at 1,170°C. The high temperature melts the glassy constituents to form a vitrified interior and exterior structure thereby reducing the penetrability of the finished pellets.
The materials within the pellet produce most of the energy required for the sintering process. The precise temperature control required during kilning is achieved by controlling the gas burner via a series of non-contact thermometers continuously monitoring the temperature of the pellet bed. The fired pellets exit the rear of the kiln via a chute for cooling. This kiln was the first constructed of its kind. Whilst retaining the

long established structure of a conventional rotary kiln it was fitted with Incalloy inserts to give the kiln bed a trefoil pouring motion. This doubles the capacity of the kiln compared to a conventional rotary kiln. The motion gives a far more even firing allow better flow of oxygen to the pellets, it also increases the kiln surface area and exposes a much larger bed face to the radiant heat.

Inputs / Outputs

The planned inputs would be 100,000 tonnes of organic material from Greater Manchester Waste, clay, pulverised fuel ash from a power station and sewage cake from a water works.

Scale / Costs

This project would involve making alterations to an existing facility. Therefore, it is difficult to give an overall cost for the whole development.

Energy Balance

The Process is very energy efficient: -

i) Most of the energy required for the Process is supplied by materials being fired

ii) Kiln gases are recycled and used for drying of clay and reducing water content of other feed materials

iii) Heat from the aggregate cooling stage is used for green pellet drying and preheat of kiln combustion air

iv) Aggregate pre-heat prior to kiln feed

v) There is potential for electrical energy generation.

Mass Balance

A fully operating Tilbury plant would produce 240,000m^3 of aggregate which is equal to 350,000 tonnes of primary material input.

Emissions

No significant releases will occur from the process due to BAT being used to minimise fugitive dust from the process.

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Project Partners:
University of East London, University of Leeds

EECO Integrated Recycling Centre

EECO Ltd.

Technology type: Thermal Treatment

Project Description

The Integrated Recycling Centre utilises three core technologies;

- A Thermophilic Fermentation process, employing micro-organisms to produce industrial commodity chemicals, from the biodegradable fraction of MSW;
- A third party, Combined Heat and Power (CHP) technology, of either 'Advanced' or 'Conventional' design, used to convert clinical, other hazardous wastes, and the cellulose / lignin residues that result from the fermentation process, into energy; and
- A Synthetic Aggregate process, used to convert the solid ash residues of the thermal process, into a high value vitrified aggregate, suitable for use in constructional concrete.

These technologies, when used in the correct combination, maximise the opportunities for recycling or materials recovery, converting all of the 'waste' into useful, high value products. The process is designed, such that, no residues are produced from the reprocessing activities themselves. The IRC is modular and scaleable, additional technologies may be 'integrated', to produce other products, as appropriate.

Technology Background

The thermophilic fermentation process is the culmination of more than 20 years research, originated at Imperial College, London. Extensive experience has already been gained with a number of biodegradable, agricultural wastes, which has now led to specific testing of BMW. This work is expected to produce comparable results, in view of the similarities between BMW and the biomass, already successfully tested.

The CHP element is designed to convert the cellulose and lignin, fermentation solid residues, into electrical, steam or heat energy, whilst treating any other materials that require heat treatment disposal, i.e.; hazardous, clinical, pharmaceutical or solvent materials. This process can be selected from any suitable OEM of 'Advanced' (pyrolysis / gasification), or conventional equipment. Approximately 75% of the energy produced is available for 'export', 25% being required to operate the IRC recycling processes.

The Synthetic aggregate process is used to sequestrate CO_2, and to vitrify the Fly and Bottom ashes, produced by the CHP process, and to convert low value waste glass, into a non-leachable, lightweight aggregate; suitable for use as a high value pozzolan in constructional concrete.

Inputs / Outputs

The commercial IRC is designed to deal with all types of waste – from any local source, producing high value products from the wastes:

Conventional Recyclates: Glass, paper, plastics, soils and metals, sold into existing markets.

Paper and cardboard can be transformed into cellulose, for papermaking, high value fermentation products, or energy. Contaminated, mixed plastics can be decomposed into their constituents; oil and carbon. The oil can be used as a fuel, while the carbon can be used to produce energy.

The CHP process: Produces electricity, and heat for export.

Products of Fermentation: Bio-ethanol is a high value commodity chemical. Planned development of the Thermophilic fermentation technology could allow the production of a range of other bio-chemicals from waste, to create a 'Bio-refinery'.

Lightweight Synthetic Aggregate: For use in concrete construction or horticultural markets.

Scale / Costs

The IRC is designed to be small-scale and modular – scaled to service a single community or Borough. Typical IRCs could be designed to handle between 24,000 and 100,000 tonnes of mixed waste, per annum. Larger, or smaller, capacities are technically possible, if no loss of proximity benefit results.Direct capital costs to implement the IRC would be in the order of £9 – £20m.

Energy Balance

Both the Thermal and Aggregate processes generate surplus heat. This energy is captured, making the IRC a net producer of both electrical, and heat energy.

Mass Balance

Absolute IRC capacity (MSW) is directly proportional to the degree of non-fermentable / combustible material recovered for recycling – the fermentation and thermal processes modules being of defined capacity. The Mass Balance assumes fermentation of all BMW, and a 32,000 tonne per annum CHP process. In this configuration, the nominal IRC capacity is estimated to range from 43,900 tonnes per annum (with zero recovery of non-BMW recyclates), to 105,700 tonnes per annum, if all non-BMW is recycled, prior to the CHP process.

Emissions

Exhaust combustion gases are produced by the CHP and aggregate processes. Quantities will vary, dependant upon the CHP process employed, but will be fully compliant with EU WID limits. Emissions to air are minimised, and waste heat from the aggregate process recovered, by feeding the exhaust gases from this process back to the CHP process.

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Project Partners:
Bioconversion Technologies Ltd

Estech Europe Fibrecycle™ System

Estech Europe Ltd.

Technology type: Other

Project Description

This project uses an autoclave system to process Municipal Solid Waste (MSW). The planned project would be based at a Surrey County Council site in Sunbury. The project is a joint operation with Surrey Waste Management, who are the waste management contractor for the local council.

The aim of the process is to separate the MSW into four material streams. These are:

- A marketable cellulose fibre derived from the organic content of the waste
- Ferrous and non-ferrous metals for recycling
- Mixed plastics for recycling
- Residual waste that would be sent for further separation or disposal

Technology Background

The steam for the autoclave process is generated from an oil or gas powered boiler attached to the plant. The autoclave process washes and sterilises the waste and breaks it down into its organic and non-organic fractions.

Once the processed material has been ejected from the autoclave it is fed onto a conveyor belt for primary processing where oversized materials are separated out using a screen. The remaining materials are further sorted using disc screening that separates the fibre fraction from the treated materials. A further classification removes any foreign materials from the fibre.

The metals are removed using a series of magnets and an eddy current separator, leaving a residual material containing plastics, aggregate and textile. Plastics are separated out for mixed plastics recycling. The final residual waste materials can be further separated or sent for final disposal.

Inputs / Outputs

The autoclave has a minimum design capacity of ten tonnes per load and the plant proposed in the application would be able to treat 25,000 tonnes of MSW per annum. However, the system is modular and much higher capacities can be reached if required. The period of time that the waste spends in the autoclave varies according to the amount and type of waste in the system. For most situations the waste is treated in the autoclave for approximately 30 minutes.

The potential uses for the fibre include:

- Fibre board
- Insulation board
- Door and wall panelling
- Roof tiles and shingles
- Most products made using cellulose fibre as base material
- Absorbent Materials

The contract for the plant would be based on a design, operate, finance and built basis.

Mass Balance

Estech Europe has a smaller mobile demonstration plant that they have been using to conduct recycling trials. The breakdown of material percentages from the trial are shown in the table below:

Cellulose fibre	64%
Steel	3.5%
Aluminium	1%
Mixed plastics	9%
Glass	4%
Aggregate	2.5%
Residue	16%

Emissions

The FibrecycleTM process is a benign, almost emission free waste treatment method.

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Project Partners:
Surrey Waste Management

Project Orchid

Fairport Engineering

Technology type: Other

Project Description

The aim of Project Orchid is to apply proven technologies from other industries to firstly separate recyclables from Municipal Solid Waste (MSW). The organic fraction of the MSW would then be converted by the process into a range of new refined biomass products. The project would be based on a site adjacent to an existing waste transfer station in Merseyside.

Technology Background

The MSW is delivered to the site and undergoes a thorough pre-treatment process. Unsuitable items such as gas cylinders or concrete are removed after a visual inspection of the waste. The MSW is placed into a trommel, which allows fine waste items (-150mm) through. Oversized items (+ 150 mm) are passed through a shredder to be reduced in size. Once all of the waste has been reduced to below 150 mm it moves on to the next processing stage. The MSW is conveyor fed into a wet preparation drum, where a small amount of water is added to raise the moisture content of the waste to around 34%. The drum rotates and a series of blades and lifters within the drum further macerate the waste. The rotating action and the water causes the putrescible part of the waste to start to break down. The waste is then fed into the main processor, which is a rotating cylinder 2.8 metres in diameter and 13 metres long. From the opposite end of the processor air is heated using a gas burner and fans circulate the hot air around the cylinder into the moist material. The temperature in the processor drives off the water and the steamy environment breaks down the paper, food / putrescible matter and cleans and sanitises other materials such as cans and plastics.
As the waste progresses along the processor towards the heat source more water is driven off and the material enters a drying stage near the exit of the processor where the temperature is much higher. The processed waste is then separated into +50mm and -50mm fractions. The +50mm fraction contains the recyclates such as metals, aluminium and large plastics which are separated using traditional materials handling systems such as magnets etc. The -50mm fraction is then fed through the unique Fairport Biomass Density Separator. The Separator incorporates a number of vacuum technology processes which at the first stage removes the residual heavier elements such as glass and metal from the processed material. The lighter element of the waste is then air separated again to remove the plastics and fine material, leaving mostly organic matter. The metals are then removed from the heaviest fraction of the waste and the remaining glass and grit can then be used as road aggregates. The air separated organic matter can then be compressed into fuel pellets for use in power generation, industrial boilers or gasification plants. The density separator enables all products to be made to meet precise end user specifications.

Inputs / Outputs

The facility will be capable of handling 50,000 tonnes of MSW per annum. It is expected that around 68% of the waste processed will be biodegradable. Around 15% of the waste will go to landfill, this waste will mostly be building rubble and wood.

Energy Balance

Total energy cost / tonne £8.00

Mass Balance

Non-biodegradable recycled products – 20%

Moisture losses – 15%

Landfill – 15%

New Biomass Products – 50%

The new refined biomass fuel products will be made to exact end customer specifications thus removing market risk

Emissions

It is the intention to submit samples of the new biomass products to a rigorous series of physical and chemical tests to analyse the characteristics of the products and potential environmental risks. Further tests will then be undertaken to assess emission levels of chlorine, CO_2, SOx and NOx and others.

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Project Partners:
Mersey Waste Holdings
Merseyside Waste Disposal Authority

The GeneSyst Process

GeneSyst United kingdom & Ireland Ltd.

Technology type: Other

Project Description

This project uses temperature, pressure and weak acid hydrolysis to process BMW into a variety of marketable products. The waste is treated in a pressure vessel, which descends and rises along a 700 metre shaft.

The demonstration plant would be capable of treating 52,850 tonnes of waste annually. The planned location of the demonstration plant is Blackburn Meadows in Sheffield.

Technology Background

The GeneSyst process uses a weak acid hydrolysis process within a patented gravity pressure vessel (GPV) to convert biomass, largely starch and cellulose, to sugars, which can be fermented to produce ethanol.

The GPV is a set of concentric pipes suspended over a drilled shaft.

In order to convert cellulose to sugars it has to be treated by a 'cooking' process, i.e. promotion of the reactions at high temperature and pressure. A mixture of acids, typically carbonic acid derived from carbon dioxide generated in the fermentation process, is introduced into the GPV to promote the reaction. The degree of hydrolysis is controlled by pH neutralisation of the reaction by subsequent addition of calcium hydroxide.

The BMW solution that enters the vessel collects heat as it descends, whilst gaining pressure. The reaction is then started and fixed within the reaction zone. The finished mixture then rises and loses pressure whilst it is cooled. The heat surrendered by the cooling mixture transfers to the incoming BMW solution. The process vessel hangs within an evacuated annular chamber, grouted into the ground, over its full height, resembling a large vacuum flask. The evacuated outer chamber provides both environmental containment and thermal insulation.

The GeneSyst process will use the biodegradable fraction of MSW. To handle and process this waste, the MSW will be pre-processed in a conventional MRF. This will remove recyclables, as well as inert materials, leaving the biodegradable fraction for processing.

Initially, the MSW is visually checked for larger unacceptable wastes before being milled and screened under water to produce a pumpable suspension, in the form of slurry.

The mixture passes down the outer passageway of the pressure vessel, gaining heat from the adjacent rising material as it descends. The temperature of the mixture entering the reaction zone is adjusted by adding steam as required. The mixture is, at this point, at significant pressure because of the head of mixture above it. Acid is now added and hydrolysis commences.

After a short controlled reaction period calcium hydroxide is added at a higher elevation to neutralise the mixture and stop the hydrolysis. The mixture rises up the vessel, surrendering its heat to the adjacent incoming mixture as it rises.

The mixture passes to one or more fermentation chambers where yeast is added and fermentation progresses at a controlled temperature. The fermented mixture passes to a distillation process, where the ethanol is separated and condensed.

The remaining mixture is passed to a dewatering stage where a large proportion of the water is removed from the mixture. The majority of the supernatant water is passed back to the waste mixer for reuse. The dewatered cake contains substances, such as furfural, acetic acid, levulinic acid and fermentation nutrients, which can be extracted and marketed commercially.

Inputs / Outputs

The total annual MSW input to the site will be 52,850 tonnes. The process will produce marketable products including CO_2, ethanol, methane, lignin, yeast, furfural, acetic acid, levulinic acid, formic acid and xylose.

The planned plant will be capable of producing all these products but only ethanol will be produced in commercial quantities. Research will be carried out as part of the demonstrator programme to prove the commercial viability of extracting the other products in a full-scale plant.

Scale / Costs

The construction costs for the demonstration plant are in the region of £8.5 million.

Energy Balance

The demonstration project will annually use around 1,152,000 kWh of electricity and 27,000 litres of diesel for transport.

Mass Balance

An input of 7,000 kg of BMW should produce a total of 1,100 kg of fuel grade ethanol.

Emissions

Major process emission and residues include waste water, CO_2 and yeast. The necessary measures for cleaning emissions to achieve UK and EU standards have been included in the project outline and costing.

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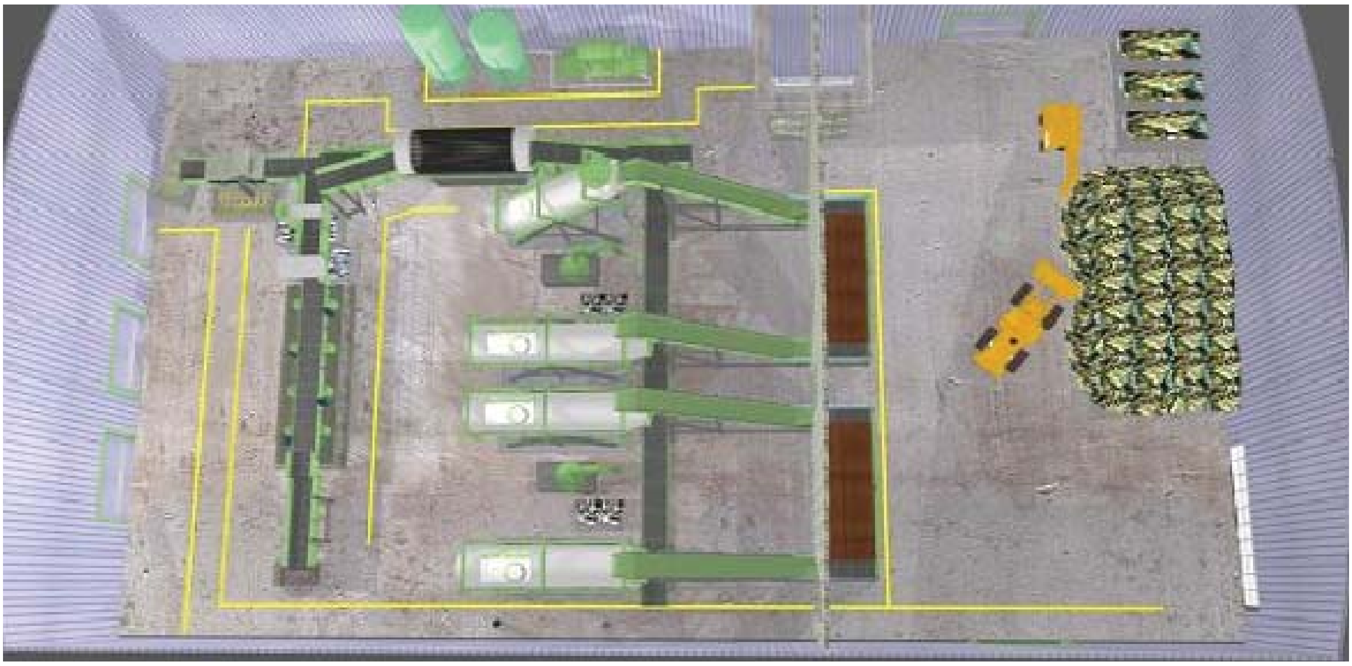
Project Partners:
Halcrow Group Ltd & Industrial Storage Systems BV

The Sterecycle Process

Sterecycle

Technology type: Other



Project Description

This project aims to use a series of autoclaves to process unsorted MSW. The autoclave process converts the MSW into a series of recyclables including a organic fibrous material which could be used as (1) a fertiliser or (2) a feed source for paper recovery, or (3) a feed source for Anaerobic Digestion, all of which also incorporate Stereycle's patented Integrated Waste Solution. The facility will be capable of handling 50,000 tonnes per annum of MSW but is scaleable to over 300,000 tonnes per annum as needed.

Technology Background

The Sterecycle process is a patented autoclave system developed in the US over a period of 10 years dating from 1992. The heart of the Sterecycle system is a series of interconnected steam conditioning pressure vessels.

Unsorted bagged MSW is introduced into the vessels and steam, heat and pressure are applied at 140 degrees C for around 1 hour. The vessels are rotated and, aided by helices within the vessels, the inorganic material is sterilised and the biodegradable fraction is broken down and converted into an organic fibre. The steam conditioning has two principal effects on the waste material:

- The material is now clean and can be easily separated by mechanical separation equipment;
- The material has been reduced in volume by 60 to 70 %

The sterilized material is then mechanically separated into its various constituents:

40% – Inorganics (already clean with labels, foodstuffs etc removed)

60% – Organic fibre

This sorting is done by means of processing equipment similar to that found in a standard Materials Recycling Facility ("MRF") including : a series of conveyors, trommel for removing the fibre, eddie current separator for the non-ferrous, magnet separator for the ferrous, lift-sep and sorting station.

After the two processing stages the organic fibre can be used as compost after a curing phase or in paper recovery or anaerobic digestion all based on Sterecycle's patented Integrated Waste Solution Technology.

While Sterecycle's patented autoclave technology provides on an isolated basis, cost effective autoclaving of the waste stream, Sterecycle's Integrated Waste Solution Technology provides an end to end system for handling and recycling MSW and many types of commercial waste.

Inputs / Outputs

The project can economically take 50,000 tonnes of unsorted MSW per annum. The outputs after processing would be:

40% – Inorganics (already clean and sterilised with labels, foodstuffs etc removed)

- Glass
- Non-Ferrous e.g. aluminium cans
- Ferrous e.g. steel cans
- Plastics
- Textiles

60% – Organic fibre

Scale / Costs

Lowest cost solution versus competing technologies and unit focused autoclaving. Please contact Sterecycle for more details.

Mass Balance

Dependant on geographic specific factors.

Emissions

The autoclave is a closed loop process that recycles steam and water used in processing. Further, even grey water can be used within the process.

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Summary

Lead Applicant	Technology Category						Waste Input	Process Outputs
	Mechanical Sorting	Compost	An/aerobic Digestion	MBT	Thermal Treatment	Other		
Alpheco		●					Sorted food, commercial & green waste	Compost
Bioganix		●					Separated garden and kitchen waste	Compost
Bio Resource	●						MSW	RDF pellets, sorted recyclables
Bronzeoak					●		MSW	SRF, electricity, heat, sorted recyclables
C-Tech Innovation			●				Separated garden, kitchen & farm waste	Compost
Carbon Processing					●		Shredded BMW	Carbonaceous char & a biogas
EA Environmental		●					Catering waste	Compost / soil improver
EBARA					●		Screened / shredded MSW	Gas, electricity, metals & ash
Eden Project		●					Catering & green waste	Compost
EECO						●	MSW	Electricity, heat & recyclables
Energos					●		RDF	Electricity
Entsorga				●			MSW or BMW	SRF & recyclables
Estech Europe						●	MSW	Organic fibre & recyclables
Fairport						●	MSW	Biomass & recyclables
Genesyst						●	MSW	CO_2 & various chemicals
IWI			●				BMW	RDF

Lead Applicant	Technology Category						Waste Input	Process Outputs
	Mechanical Sorting	Compost	An/aerobic Digestion	MBT	Thermal Treatment	Other		
Myerscough College			●				BMW & agri wastes	Fertiliser & methane
Novera Energy					●		SRF	Electricity, heat & char
Oaktech				●			MSW	Recyclables, biogas & fertiliser
Omega Power					●		SRF and BMW	Electricity & ash
Organic Power			●				Separated BMW	Methane, CO_2, compost and fertilisers
Organic Resources				●			MSW	Recyclables, electricity & compost
Planet Advantage					●		MSW	RDF, electricity & heat
reCulture				●			MSW	RDF & recyclables
RTAL					●		BMW, clay, sewage sludge cake & pfa	Aggregate
South Shropshire			●				Source separated organic waste	Electricity, heat and fertiliser
Southwark Biogas			●				Source separated organic waste	Electricity, heat and fertiliser
Sterecycle						●	MSW	Recyclables
Sustainable Biowaste		●					BMW	Solid and liquid fertiliser
WH White		●					MSW after dry recyclable collection	Compost & metals
Waste Audit Co		●					Kitchen waste & green waste	Compost
Yorwaste	●						MSW	Biogas, compost & ash

Glossary

Aerobic Digestion/Composting: Biological decomposition of organic materials by micro-organisms under controlled, aerobic, conditions to a relatively stable humus like material called compost.

Anaerobic Digestion: A process where biodegradable material is encouraged to break down in the absence of oxygen. Material is placed in to an enclosed vessel and in controlled conditions the waste breaks down typically into a digestate, liquor and biogas.

Animal By-Products (ABP) Regulation: Legislation governing the processing of wastes derived from animal sources.

Biogas: Gas resulting from the fermentation of waste in the absence of air (methane/carbon dioxide).

Biodegradable Municipal Waste (BMW): The component of Municipal Solid Waste capable of being degraded by plants and animals. Biodegradable Municipal Waste includes paper and card, food and garden waste, and a proportion of other wastes, such as textiles.

Green Waste: Vegetation and plant matter from household gardens, local authority parks and gardens and commercial landscaped gardens.

In-vessel Composting: The aerobic decomposition of shredded and mixed organic waste within and enclosed container, where the control systems for material degradation are fully automated. Moisture, temperature, and odour can be regulated, and stable compost can be produced much more quickly than outdoor windrow composting.

Mechanical Biological Treatment (MBT): A generic term for mechanical sorting/separation technologies used in conjunction with biological treatment processes, such as composting.

Municipal Solid Waste (MSW): Household waste and any other wastes collected by the Waste Collection Authority, or its agents, such as municipal parks and gardens waste, beach cleansing waste, commercial or industrial waste, and waste resulting from the clearance of fly-tipped materials.

Refuse Derived Fuel (RDF): A fuel produced from combustible waste that can be stored and transported, or used directly on site to produce heat and/or power.

Renewables Obligation: Introduced in 2002 by the Department of Trade and Industry, this system creates a market in tradable renewable energy certificates (ROCs), for which each supplier of electricity must demonstrate compliance with increasing Government targets for renewable energy generation.

Source-segregated/Source separated: Usually applies to household waste collection systems where recyclable and/or organic fractions of the waste stream are separated by the householder and are often collected separately.

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New Technologies