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Major Waste Treatment Technologies – Overview

This document has been produced to provide Members with a brief overview of the types of waste treatment technologies available to treat residual (black bin) waste. This should not be taken as an exhaustive list as other technologies are available, however the technologies listed below cover the main types that are currently in use in the UK. More information about waste technologies can be found on the DEFRA and Environment Agency websites.

Energy from Waste (EfW)

Energy from Waste is a general term assigned to any of the technologies that create energy in the process of treating waste. It is however commonly used to describe the 'Incineration' process, where waste is burnt in controlled conditions to produce electricity and sometimes heat.

EfW (Incineration)

This treatment process involves burning waste in controlled conditions at high temperatures (above 850^{o}C). Hot gases produced in the furnace travel through a boiler, transferring the heat that is produced to the water running through the boiler pipes. The water is heated to high temperatures creating steam which is used to drive a turbine. This turbine produces electricity which can be fed to the national grid, with a small amount being used on site to support the plant.

After the energy in the steam has been used, the resulting water is re-circulated through the boiler and reheated into steam again. Incineration without energy recovery is no longer allowed in the UK.

Complex emission control measures are a requirement by law in these plants. There is also a requirement to deal with the residues of the combustion process of which there are two principal types: the bottom ash, which is the solid remainder of the waste feedstock after processing, and the chimney (flue) gas treatment residues from the air pollution control process.

The bottom ash can be recycled into an aggregate material for use in construction applications or disposed of to landfill. The residues from the flue gas treatment process are classified as hazardous waste and require specialist treatment, however, due to their alkaline properties these residues are increasingly being used in industry to neutralize acids. Most facilities also recover metals for recycling from the bottom ash.

Advanced Thermal Treatment (ATT)

There are a wide variety of Advanced Thermal Treatment systems incorporating "advanced" or "emerging" technologies for the treatment of waste. The most common systems are **Pyrolysis** and **Gasification**.

- **Pyrolysis** is the chemical breakdown of organic materials by heating in the absence of oxygen or any other substances, except possibly steam. Pyrolysis is similar to the process which produces charcoal. Only carbon based materials can be pyrolised. Waste is normally pre-sorted to remove the majority of the non-organics and may be mechanically processed (shredded & mixed) to homogenise the feedstock.

  A prepared Refuse Derived Fuel (RDF) from another treatment process may also be used. Pyrolysis heats the waste, typically to around 500°C and breaks down plastics, paper and other carbon based materials to produce a gas. This gas may be condensed to produce a Pyrolysis Oil. This oil or gas can then be used as a fuel to generate electricity in a gas engine. Flue gas clean up measures are required for Pyrolysis facilities. Pyrolysis char is also produced which requires disposal or additional processing.

- **Gasification** operates at a higher temperature range than Pyrolysis. The process converts biodegradable material into carbon monoxide and hydrogen by heating the raw material at high temperatures over 700°C using a controlled amount of oxygen and/or steam. The resulting gas mixture is called 'syngas' and is itself a fuel. Air or oxygen is used to partially combust the waste to achieve these high temperatures. Water is added to the Gasifier, either as steam or as water included in the feedstock. At these high temperatures the water "cracks" into hydrogen and oxygen.

  The oxygen reacts further with the carbon in the waste material. The difference between Pyrolysis and Gasification is the high concentration of Hydrogen in the gas produced in the gasification process and the use of oxygen in one and not the other. A solid residue (char) is also produced which usually requires disposal if no markets for recycling are available. Flue gas clean up measures are required for emissions from Gasification facilities.

Anaerobic Digestion (AD)

This is a natural process in which micro-organisms break down biodegradable material in the absence of oxygen at temperatures of up to 60°C in an enclosed environment. The process causes the release of methane which is collected and used in a gas engine to produce electricity, therefore reducing the emissions of landfill gases into the atmosphere. Depending on the size of the facility this electricity can be exported to the national grid. Also, the nutrient-rich slurry-like material left over from the process can be used as a fertiliser.

Aerobic Digestion

The biological treatment of organic waste in the presence of oxygen under the action of micro-organisms. This is effectively what takes place in your garden composter. A by-product of this process is methane which can be collected and used in a gas engine to produce electricity if the system is enclosed (In-Vessel Composting). Depending on the size of the facility this electricity can be exported to the national grid. The fully decomposed material is usually landfilled but can be used in other locations depending on the waste feedstock.

Mechanical Biological Treatment (MBT)

MBT is a term used for a broad range of process systems. Depending on the configuration used, MBT can produce energy and therefore be classed as an EfW

process or not. All MBT options involve a mechanical stage and a biological stage and it is the type of biological stage used that determines whether energy is produced or not.

The mechanical stage of the process involves sorting and screening the incoming waste. It can also involve shredding material to homogenise the waste stream. It is in this stage that any additional recylates can be seperated and materials that are not suitable for the following processes are screened and sent to landfill.

The biological stage treats the remaining material requiring processing following the mechanical stage. The waste can be fed into an anaerobic digestion system and treated as described above or it can be dried (biodrying) or composted aerobically. Biodrying involves the drying of the material to produce a Refuse Derived Fuel (RDF), this RDF can then be used in a thermal treatment facility to produce energy. RDF can be used as a substitute fuel in non-waste facilities such as a cement kiln. All facilities where RDF is used as a fuel have to be compliant with the Waste Incinceration Directive. Aerobic composting leads to a reduction in the overall biodegradability of the waste. Following this process the material is typically landfilled.

Typical MBT configurations are:

Mechanical Screening → Anaerobic Digestion
Mechanical Screening → In-Vessel Composting → Landfill
Mechanical Screening → Refuse Derived Fuel → Thermal Treatment (Incineration)

Combined Heat and Power (CHP)

Combined Heat and Power (CHP) can significantly improve the carbon footprint of waste plants that produce electricity. Where CHP is adopted, in addition to the electricity generation, steam from the system is used to provide heat, either to an industrial user or through a district heating scheme. Significant improvements in overall thermal efficiency can be obtained this way.

The steam produced, as well as passing through the turbine to generate electricity can:

- be exported directly in a pipe to a neighbouring industry for use in a process (e.g. manufacturing) or for space heating.
- heat up water that is then exported in a pipe to local businesses or housing to provide heating and hot water. The pipe network of district heating is basically just like a domestic central heating system, only bigger and laid in heavily insulated pipes under the ground.

Mechanical Heat Treatment (MHT)

MHT as with MBT is a two stage process but with a heat stage rather than a biological stage. Although either stage may occur first, in most systems the waste is first “heat treated”. This is frequently achieved through an ‘autoclave’, which involves steam treating the waste at high pressures, although there are other systems. The heating process sterilises the waste and reduces waste components to more managable elements; metal cans are de-laquered and organic materials are reduced to a floc-like substance.

The mechanical stage includes sorting and screening the treated waste into streams for recycling, disposal and further treatment.

The MHT process does not reduce the biodegradablity of the waste and the process generally has to be partnered with another process, for example biological or thermal treatment, to treat the MHT products which are not recycled or landfilled.