

Thermal Treatments

Fact Sheet 6

This fact sheet focuses on thermal (heat) treatments. The following treatments are described:

- **Energy from waste (EfW), Incineration and Combined Heat and Power (CHP)**
- **Advanced Thermal Treatments**
 - **Pyrolysis**
 - **Gasification**

The treatments displayed here all deal with ways of recovering energy (heat, electricity or fuel) from your rubbish. The table below shows an overview of the different energy forms that can be produced using each of the technologies.

Treatment	Oxygen Level	Energy Form
Energy from Waste (Incineration)	Excess of Oxygen	Heat, Electricity
Gasification	Limited Oxygen	Gas, Char
Pyrolysis	Absence of Oxygen	Gas, Char, Liquid (Oil)

After you have separated everything that you can recycle and compost from your rubbish the material that remains (your 'black sack' rubbish) needs to be treated. Thermal treatments are one of the ways of treating this rubbish.

Energy from Waste

Energy from Waste is a general description for all the technologies that can be used to gain (generate) energy from treating our rubbish. It is commonly used to describe the Incineration process where rubbish is burnt to produce heat and/or electricity. Incineration without energy recovery is no longer allowed under UK law. This section of the fact sheet will describe the energy from waste process.

The Process

The flow diagram below illustrates the general operation of an energy from waste facility.

Collection

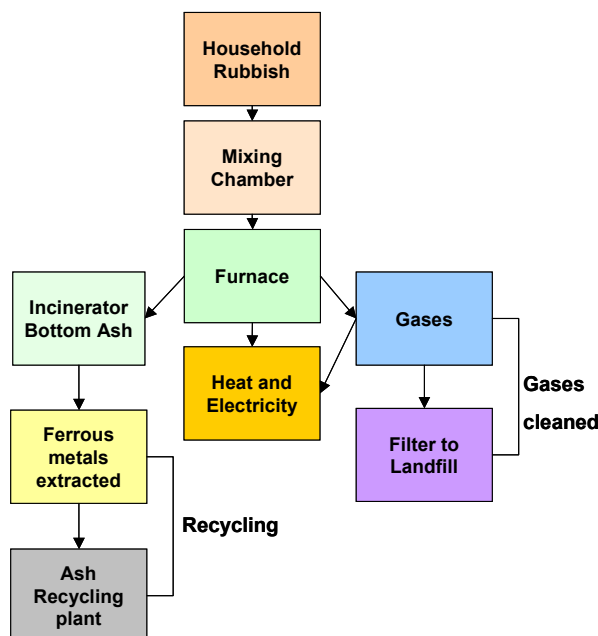
When your household rubbish (black sack rubbish) is collected from your kerbside there are several options as to where it can go next. It could either go straight to an EfW plant for treatment, or it could go to a Biological treatment plant (MBT/BMT/MHT) for pre-treatment facility (see fact sheet 4).

The route it takes depends on your local authority and what their current kerbside and household waste recycling centre (HWRC) recycling and composting collection schemes are. Some Local Authorities will use a biological treatment step before EfW so that any materials that are currently not separated from your rubbish for recycling are captured and recycled. Other local authorities have decided that they can collect enough good quality material for recycling through their kerbside collections and HWRCs that they do not need a pre-treatment step.

Your rubbish arrives at the EfW facility either directly from the kerbside as mixed rubbish ('black sack' rubbish), or as rubbish that has been pre-treated and might be in the form of either mixed rubbish (after some materials have been taken out) or as 'Refuse Derived Fuel' (RDF). This is a high energy fuel made from rubbish and can be burnt in the same way as mixed rubbish in an EfW facility to produce heat and/or electricity.

Preparation

When the rubbish arrives it is tipped into a large bunker and thoroughly mixed to help it to burn evenly when it reaches the furnace. In order for it to reach the furnace the rubbish must be put (by crane) into a feed hopper, this allows the facility to control how much rubbish is burnt at a time.



The Furnace

When the rubbish reaches the furnace a series of grate bars move the waste through the furnace where it is dried and burned at temperatures of around 1000°C. The rubbish stays in the furnace for 30 – 90mins during which time it (generally) goes through two stages.

During the first stage the rubbish is burnt at a very high temperature and in the presence of oxygen, so that as it burns it turns into gas (Carbon and Hydrogen present in the rubbish converts to Carbon Dioxide and Water). This stage lasts for almost as long as the rubbish is in the furnace for. The second stage lasts for only a couple of seconds. All the gas and particles released during the first stage are then burnt to make sure that complete burning (combustion) occurs.



Photo: The Marchwood Incinerator in Hampshire, one of three county incinerators

Incinerator Bottom Ash (IBA)

Even though the furnace in an incinerator reaches very high temperatures not everything in the rubbish will burn. The ash from the burned waste drops into a 'quench tank' then along a conveyor to a storage pit. Magnets above the conveyor attract the ferrous metals (iron) from the ash for recycling. The remaining IBA is sent to an Ash Recycling plant and can be used as a construction material for building roads (aggregates substitute).

Gases

Hot flue (chimney) gases produced by the furnace during the burning process travel through a boiler transferring the heat produced to water running through the boiler pipes. The hot water creates steam and the steam drives turbines (engines), which create electricity.

Gases from the burned waste are thoroughly cleaned by a flue gas cleaning system; some chemicals are added during this process to help the clean up. Lime is added into the gas stream to neutralise acid gases, this stops the gases from being acidic. Activated carbon is added to remove dioxins and heavy metals.

The gas passes through a gashouse filter (a filter made of fine fabric) that captures any particles before the now cleaned gas can be released through the chimney. Collected particles from the fabric filter are stored before being sent to a landfill site that can accept hazardous waste.

Location

Facilities of this type would again expect to have lots of vehicle movements both to and from the plant (similar to a landfill site) and so should be sited close to established road infrastructure.

Energy from Waste Impacts

Any new house or industrial facility constructed will have some impact on the environment. This section considers some of the potential environmental impacts that energy from waste facilities might have.



Photo: A Danish EFW Facility

Environmental Impacts and Benefits

Energy from waste facilities should be considered as one piece of the jigsaw when considering what to do with your rubbish. After everything that can be recycled or composted has been they provide a method of disposing of rubbish that is not in a landfill site and which can produce useful energy in the form of electricity and heat.

Odour / Dust / Litter

All waste treatment facilities are strictly regulated and will have systems in place to limit odour. Energy from waste facilities are enclosed and fitted with ventilation and filter systems to prevent odour and dust from escaping. As with all waste treatment facilities the Environment Agency strictly monitors operation and good practise during operation and good design of the plant during the planning stage can stop odour, dust and litter at the site.

Noise

The main noise coming from these facilities will be produced from vehicle movements and from the mechanical processing of the waste and air ventilation systems. As with all industrial facilities, hours of operation will be limited to times of the day that will not cause a nuisance to the local community.

Vehicle Movements

Energy from waste facilities require some vehicle movements so that your waste can be collected either from the kerbside outside your house or from your local civic amenity site and taken to the site. All vehicle movements produce carbon dioxide, which is another green house gas but is 21 times less potent than methane, which is produced when rubbish breaks down in a landfill site under anaerobic conditions.

During the planning stages for the facility the number of proposed vehicle movements will be taken into consideration and the access to the site and its impact on the local community will also be considered to minimise these impacts. Vehicle movements from the site could be reduced if the facility was located with other waste management treatment facilities or an operation that might be able to use one of the end products from its operation.

For an average sized plant that would accept 50,000 tonnes of waste per year Defra have estimated that up to 20 refuse collection vehicles per day would be anticipated.

Emissions & Health

Virtually all combustion processes produce hazardous or toxic emissions; they are an inevitable output of thermal processing. Such everyday combustion processes include smoking cigarettes, garden bonfires, BBQs, domestic coal fires etc, as well as industrial processes such as power generation. Only some of these combustion processes are subject to emission controls.

All energy from waste plants must comply with the Waste Incineration Directive (WID). This directive ensures that the gases (flue gases) produced by the facility and released into the air are thoroughly cleaned and constantly monitored. Emission levels allowed by the directive are a lot stricter than for coal fired power stations. The Environment Agency regularly checks that each facility has cleaning systems that are in good working order and that records are kept of all emissions.

Dust and Bio-aerosols (biological particles) could be produced as the waste is transferred from the collection vehicles into the facility and from movements within the facility. The impact of this is limited by staff working at the facility wearing the correct protective equipment and by the facility having enclosed collection areas and ventilation systems.

Compliance with modern regulatory requirements (such as WID), should mean that there will be little contribution to the concentrations of monitored pollutants in ambient air. Epidemiological studies, and risk estimates based on estimated exposures,

indicate that the emissions from such incinerators have little effect on health. The Environment Agency, not least through its role in advising Primary Care Trusts and Local Health Boards as statutory consultees for Pollution Prevention and Control (PPC), will continue to work with regulators to ensure that incinerators do not contribute significantly to ill-health.

The Health Protection Agency has considered studies examining adverse health effects around incinerators and is not aware of any consistent or convincing evidence of a link with adverse health outcomes. However, it is accepted that the lack of evidence of adverse effects might be due to the limitations regarding the available data.

The Department for Environment, Food and Rural Affairs have recently commissioned a review of the effects of waste management. Cancer, respiratory disease and birth defects were all considered, and no evidence was found for a link between the incidence of the diseases and the current generation of incinerators. It concluded that although the information is incomplete and not ideal, the weight of evidence from studies so far indicates that present day practice for managing solid municipal waste has, at most, a minor effect on human health and the environment, particularly when compared to other everyday activities.

Visual Impact

Large energy from waste facilities (over 200,000 tpa) can cover around 4Ha of land. The siting of these facilities will be carefully considered and will depend upon a number of factors. The site should have a good road network as refuse collection vehicles will need access everyday. The electricity and heat generated by the plant might be used locally, if so the plant should be fairly close to either a power plant or to an industrial facility that could take advantage of the energy produced.

Planning conditions will suggest that any new facility built should be in keeping with the surrounding area whether that is an industrial estate or a rural setting. Good design of plants can help to limit their visual impact. The largest stack (chimney) height a facility would have is around 70m high but as the picture of the Marchwood facility shows it can be made to blend in to the overall look of the facility.

Costs

If the biodegradable fraction (green waste and kitchen waste) of our rubbish cannot be diverted from landfill then the EU will fine the UK for every tonne of waste it continues to send to landfill. To avoid the fines and to find more sustainable ways of dealing with our waste local authorities are considering a number of different options to treat their waste. There is no right or wrong

combination of options and each local authority might have a different set of facilities depending on local circumstances. These facilities will cost a lot of money and it is important that all the options are evaluated when the decisions are made. The cheapest option is not necessarily the best and what seems like a good option for the present might not be a good choice for 10 or 20 years time.

The cost of a treatment facility can be dependant on many things: the cost of land, the current collection system, what other facilities your local authority is considering and whether this option will work well with them are just a few of the considerations.

Energy from waste facilities are expensive and have long operating life spans but are currently used in Europe in many high recycling countries.

Size

The size of an energy from waste facility will depend on the individual local authority and what facilities are already in place. A large authority or a group of authorities may decide that they would like one or two larger facility whereas a smaller authority may want a smaller facility. One size does not fit all though as an authority may decide that several smaller facility is the right option. Facilities will vary from around 1-4Ha in size. Current facilities in the UK accept anything from 60,000 tpa to over 500,000 tpa.

Where does this fit in?

This treatment will not act as a stand-alone treatment and will need other types of facilities such as recycling facilities to form part of the whole picture. These treatment facilities can either be built on a site on their own or can be positioned next to each other on a larger site.

The location and type of facility that your local authority chooses will be dependent on a number of factors including available land, transport access, how close the site is to local houses and how much it will cost.



Photo: Isle of Man EfW facility

Advanced Thermal Treatments

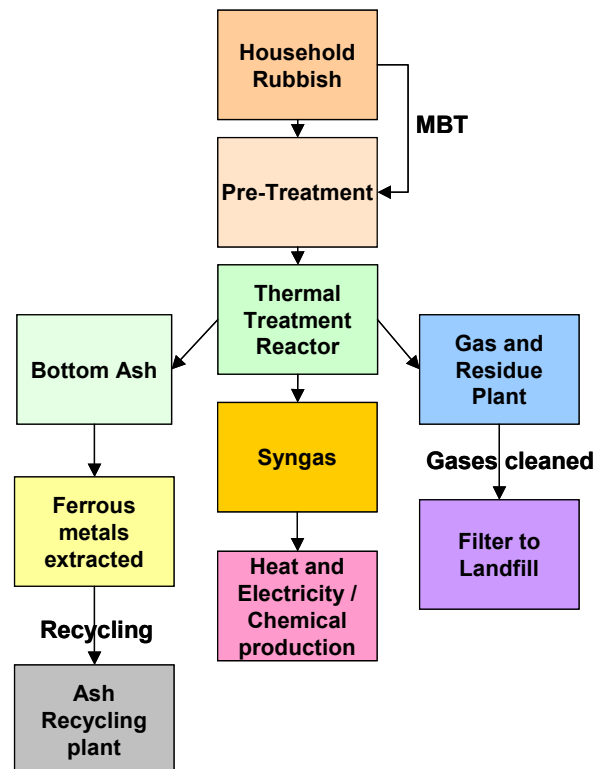
Advanced Thermal Treatments (ATT) are technologies that use heat to treat household rubbish. The two main types of treatment are called Gasification and Pyrolysis. These technologies have previously been used in the UK to produce fuels such as charcoal, coke and producer gas. Charcoal and coke are produced by pyrolysing wood and coal, and producer gas is a burnable (combustible) gas produced by the gasification of coke in the presence of air and steam.

Pyrolysis and Gasification

Pyrolysis and Gasification are very similar processes. The main difference between them is that Gasification occurs with a limited amount of oxygen and Pyrolysis occurs with no oxygen.

The Process

The flow diagram below illustrates the general operation of a Pyrolysis or Gasification facility.



Collection and Pre-Treatment

Both technologies prefer waste that has already been pre-treated so that all the non-burnable (combustible) materials such as metals and glass have been removed.

When your rubbish arrives at the Pyrolysis/Gasification facility it will be in the form of either mixed rubbish (after some materials have

been removed for recycling) or as 'Refuse Derived Fuel' (RDF) which had been pretreated. This is a high energy fuel made from rubbish and can be burnt in the same way as mixed rubbish in a Pyrolysis/Gasification facility to produce heat and/or electricity.

Preparation

When the rubbish arrives it is tipped into a thermal (heat) treatment reactor. In a Pyrolysis facility the rubbish is heated to around 500°C.

Gasification occurs at a higher temperature than Pyrolysis of around 1000-1200°C. Water is added to form hydrogen and oxygen (gases) which reacts further with the organic (carbon containing – green waste, plastics and paper/card) portion of the waste.

Products

Both processes produce Syngas, oils, and solid char and ash. The Syngas can either (after cleaning) be burnt to produce heat and power or can be used to produce some chemicals such as ammonia.

The oils produced can have different properties depending on what rubbish went into the plant. For example, higher levels of plastics will produce oils that have a higher heating value.

The ash produced comes from the solid material such as glass and stones that were not removed during pre-treatment. After treatment this can be used as aggregate for road building.

The carbon char is sand like, material that can be used as a coal replacement, or disposed of. The char often has a high heating value and can be subjected to gasification producing a fuel gas that can be mixed with the Syngas produced earlier in the process.

As part of the Defra demonstrator programme, a company called Novera are going to build a Gasification facility at the Ford motorcar plant in Dagenham, Essex. The plant will take 90,000 tonnes of refuse derived fuel (RDF) from the nearby MBT plant and will provide Ford with the equivalent of approximately £4 million per annum worth of electricity.

Gasification and Pyrolysis Impacts

Any new house or industrial facility constructed will have some impact on the environment. This section considers some of the potential environmental impacts that Gasification and Pyrolysis facilities might have.

Environmental Impacts and Benefits

Gasification and Pyrolysis facilities would be considered as one piece of the jigsaw when considering what to do with your rubbish. After everything that can be recycled and composted they provide a method of disposing of rubbish that is not in Landfill and that can produce useful energy in the form of electricity and heat and useful products such as Syngas that can be used in chemical production.

Odour / Dust / Litter

All waste treatment facilities are strictly regulated and will have systems in place to limit odour. Gasification and Pyrolysis facilities are enclosed and fitted with ventilation and filter systems to prevent odour and dust from escaping. As with all waste treatment facilities the Environment Agency strictly monitors operation and good practise during operation and good design of the plant during the planning stage can stop odour, dust and litter at the site.



Photo: A virtual image of an Advanced Thermal Treatment Plant

Noise

The main noise coming from these facilities will be produced from vehicle movements and from the mechanical processing of the waste and air ventilation systems. As with all industrial facilities hours of operation will be limited to times of the day that will not cause a nuisance to the local community.

Vehicle Movements

During the planning stages for the facility the number of proposed vehicle movements will be taken into consideration and the access to the site and its impact on the local community will also be considered. Vehicle movements from the site could be reduced if the facility was located with other waste management treatment facilities such as an MBT plant or an operation that might be able to use one of the end products from its operation such as a manufacturing plant. For an average sized plant that would accept 50,000 tonnes of waste per year Defra have estimated

that up to 20 refuse collection vehicles per day would be anticipated.

Emissions & Health

Virtually all combustion processes produce hazardous or toxic emissions; they are an inevitable output of thermal processing. Such everyday combustion processes include smoking cigarettes, garden bonfires, BBQs, domestic coal fires etc, as well as industrial processes such as power generation. Only some of these combustion processes are subject to emission controls.

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Compliance with modern regulatory requirements (such as WID), should mean that there will be little contribution to the concentrations of monitored pollutants in ambient air. Epidemiological studies, and risk estimates based on estimated exposures, indicate that the emissions from such incinerators have little effect on health. The Environment Agency, not least through its role in advising Primary Care Trusts and Local Health Boards as statutory consultees for Pollution Prevention and Control (PPC), will continue to work with regulators to ensure that incinerators do not contribute significantly to ill-health.

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that although the information is incomplete and not ideal, the weight of evidence from studies so far indicates that present day practice for managing solid municipal waste has, at most, a minor effect on human health and the environment, particularly when compared to other everyday activities.



Photo: A Gasification pilot plant in Karlsruhe

Visual Impact

Large Gasification and Pyrolysis facilities can cover around 2Ha of land. The siting of these facilities will be carefully considered and will depend upon a number of factors. The site should have a good road network as refuse collection vehicles will need access everyday.

The electricity and heat generated by the plant might be used locally, if so the plant should be fairly close to either a power plant or to an industrial facility that could take advantage of the energy produced.

Planning conditions will suggest that any new facility built should be in keeping with the surrounding area whether that is an industrial estate or a rural setting. Good design of plants can help to limit their visual impact. The largest stack (chimney) height a facility would have is around 70m high but it can be made to blend in to the overall look of the facility.

Costs

If the biodegradable fraction (green waste and kitchen waste) of our rubbish cannot be diverted from landfill then the EU will fine the UK for every tonne of waste it continues to send to landfill. To avoid the fines and to find more sustainable ways of dealing with our waste local authorities are considering a number of different options to treat their waste. There is no right or wrong combination of options and each local authority might have a different set of facilities depending on local circumstances.

These facilities will cost a lot of money and it is important that all the options are evaluated when the decisions are made. The cheapest option is not necessarily the best and what seems like a

good option for the present might not be a good choice for 10 or 20 years time.

The cost of a treatment facility can be dependant on many things – the cost of land, whether the current collection system that your local authority has will need changing, what other facilities your local authority is considering and whether this option will work well with them are just a few of the considerations.

Gasification and Pyrolysis facilities are expensive and have long operating life spans but are currently used in Europe and Japan.

Size

The size of Gasification and Pyrolysis facilities will depend on the individual local authority and what facilities are already in place. A large authority or a group of authorities may decide that they would like one or two larger facility whereas a smaller authority may want a smaller facility. One size does not fit all though as an authority may decide that several smaller facility is the right option. Facilities will vary from around 0.9 -4Ha in size.

Where does this fit in?

This treatment will not act as a stand-alone treatment and will need other types of facilities such as recycling facilities to form part of the whole picture. These treatment facilities can either be built on a site on their own or better still can be positioned next to each other on a larger site. The location and type of facility that your local authority chooses will be dependent on a number of factors including available land, transport access, how close the site is to local houses and how much it will cost.



Photo: A Gasification plant, Norway

What can I do?

You are producing the waste that your local authority has to deal with and treat. To help your local authority and the environment there are a number of ways you can make a difference.

Firstly think about the rubbish that you produce at the moment, and consider how you could reduce

it? Can you recycle or compost more of your waste?

Secondly, take an interest in what your local authority is considering. They will be making some tough decisions soon about how your waste will be treated over the next 20 to 30 years. Take part in any consultation process, find out more about what they are considering and tell your neighbours!

We all produce rubbish and we need to start taking responsibility for how we dispose of it. To find out more about what your local authority are considering get in touch with them or read their proposed waste strategy. Your opinion counts!

For additional information visit:
www.wasteawarenesswales.org.uk

