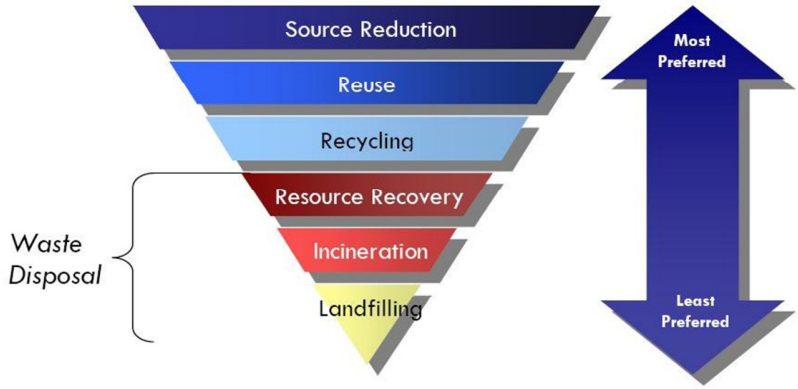
Alternative Fuel Sources – Waste-to-Energy for Combined Heat and Power

1.0 Waste Treatment in Ireland

Once collected, municipal solid waste (MSW) may be sorted to recover items for recycling, or composting, after which the remaining waste is either landfilled, or sent for further treatment processes which recover some useful materials and energy from the waste, with the remaining portion being disposed of by landfilling. The concept of a waste management hierarchy, is one in which the primary objective is to reduce the amount of waste produced, and to minimise the amount of waste which is disposed of by landfilling. Ireland has limited waste management options, which results in an over-reliance on landfill as a waste management strategy. At present 62% of all MSW generated in Ireland is landfilled, compared with an EU average of 42%.

1.1 Waste Framework Directive

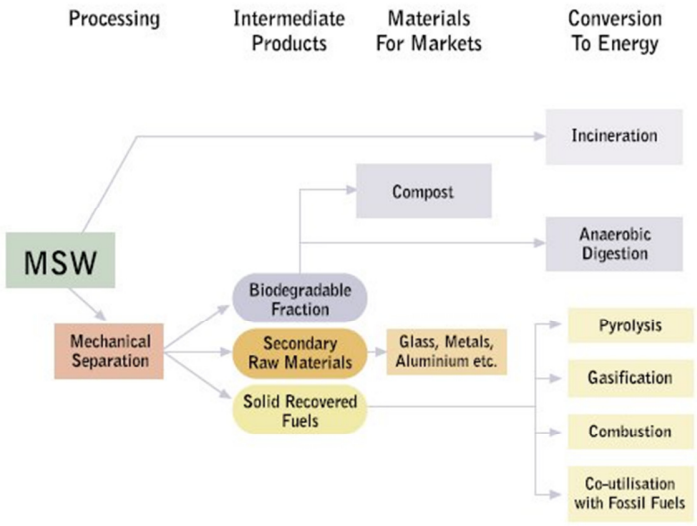
The Waste Framework Directive was implemented into Irish law in December 2010. The Directive is aimed at encouraging the greater re-use and recycling of waste materials through the implementation of a waste management hierarchy.



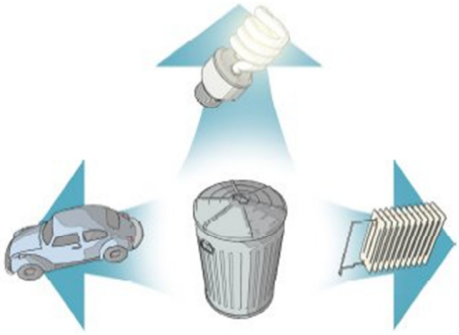
1.2 EU Landfill Directive (99/31/EC)

European legislation has been put in place to limit the amount of biodegradable municipal waste (BMW) sent for disposal in landfills. Biodegradable waste releases greenhouse gases to atmosphere when landfilled. The Landfill Directive also requires that waste is pre-treated prior to disposal in landfill.

2.0 Thermal Waste Treatment



Waste-to-energy technologies convert waste matter into various forms of fuel that can be used to supply energy. Waste feedstocks can include municipal solid waste, construction debris, agricultural waste, industrial waste, and gases that are produced naturally within landfills. Several thermal treatment technologies have been developed that make the processing of MSW for energy generation cleaner and more economical than ever before, including incineration, landfill gas capture, combustion, pyrolysis and gasification.



MSW can be directly combusted in waste-to-energy incinerators as a fuel with minimal processing. This process is sometimes referred to as 'mass burn'. Heat from the combustion is used to turn water into steam, which then powers a steam turbine generator to produce electricity. Other more advanced thermal treatment methods include pyrolysis and gasification.

2.1 Pyrolysis and Gasification

Pyrolysis uses heat to break down organic materials in the absence of oxygen, producing a mixture of combustible gases (syngas), liquids, and solid residues. Gasification in contrast to pyrolysis uses limited amounts of oxygen in the process. The syngas produced by these processes can be used in boilers to produce heat, or it can be further treated and processed and used to power combustion turbine generators and CHP plants.

The syngas from a pyrolysis process typically has a net calorific value (NCV) of 10 - 20 MJ/Nm^3, whereas gasification will have a NCV of 4 - 10 MJ/Nm^3. For reference, the NCV of natural gas is around 38 MJ/Nm^3.

It is only in recent years that pyrolysis and gasification have been commercially applied to the treatment of MSW. Large scale plants are in operation in Europe, North America and Japan. Frontline are carrying out feasibility studies on a number of sites in Ireland and the UK, with a view to developing gasification technology for waste to energy.

3.0 Combined Heat and Power with District Heating

There are significant advantages to be obtained from combining waste-to-energy recovery with cogeneration. Cogeneration is the simultaneous production of heat and power, commonly referred to as Combined Heat and Power (CHP). The heat produced as a by-product in the generation of electricity from the combustion of a fuel in an engine or turbine, is used typically to provide district heating to homes and businesses.

This heat which is normally rejected to atmosphere in conventional power generation, results in low energy conversion efficiency from the production of electricity alone. The energy efficiency can be increased from a typical electrical efficiency of 22% with incinerators generating electricity only, to an overall efficiency of up to 80% with Integrated Combined Cycle Gas Turbines. The thermal energy is recovered in the form of low grade heat and used in a district heating network, or in a process application requiring higher grade heat where available.

Modern incinerators producing electricity only operate at electrical efficiencies of typically 22%, and thermal efficiencies of around 50%. As this heat is generally not recovered, it is usually rejected to atmosphere. Because of their larger scale, this results in a significant loss of thermal energy that could otherwise be recovered. Incinerators have traditionally been regarded as a waste disposal process, rather than an energy recovery process, with a lesser emphasis on electricity generation for export.

Gasification and pyrolysis plants however can operate with electrical efficiencies of up to 27%, and thermal efficiencies of up to 34%. Pyrolysis and gasification plants are more suited to modular arrangements, offering more flexibility in their choice of location. Not only do they offer the potential to produce electricity at greater efficiencies, with their smaller scale, this

enables them to more easily find a market for the useful heat in the form of district or process heating.

Whereas incineration converts the input waste into energy on site, pyrolysis and gasification allow the production of fuel that can be transported. In addition, the gases, oils, and solid char from pyrolysis and gasification can also be purified and used as a feedstock for chemical production and other applications.

Advanced Thermal Treatment processes, such as gasification and pyrolysis have the potential to play a significant part in Ireland's future waste management strategy. With the potential to process up to 1.5 million tonnes of MSW per annum by 2025, this reduces the amount of MSW that would be otherwise diverted to landfill, or treated by additional incineration capacity.

By treating 1.5 million tonnes of waste with ATT processes, this results in a potential energy export of 2.7 TWh per annum of heat and electricity, which equates to CO_2 emissions savings of almost 1 million tonnes per annum.