Waste to energy technology

The purpose of this paper is to outline issues that should be considered in advance of the construction of a waste to energy plant together with a summary of existing related practices within Hampshire.

Introduction

Each person in the UK throws away on average 400kg of waste a year. Only some of this waste can be recycled or reused and the remainder goes for treatment or disposal. Waste quantities are continuing to rise and with an average of 6.8 years left of landfill capacity in the UK, we are running out of waste disposal options. In addition, countries outside the UK, such as China, are restricting our waste exports, so we cannot always send it away. This is where technologies such as waste to energy plants using combustion, often called incineration, could be considered as part of the solution, where waste is used as a feedstock to produce energy to power and/or heat our homes.

In 2014, the UK Government published the paper 'Energy from Waste: A guide to the debate'[1] (the 'Defra EfW Guide'), intended as a discussion paper regarding the role that energy from waste might play in managing waste. Although now out of date in places, this contains much that it still of relevance, and we have drawn upon it where appropriate below.

Household waste management in Hampshire

In Hampshire district our green bin waste is brought to two Material Recovery Facilities (MRFs) for sorting and recycling. These MRFs can accept 157,000 tonnes of recyclables annually.

The non recyclable waste (or residual waste) in our black bins is sent for treatment or landfilled. There are three energy recovery plants currently in Hampshire that accept non recyclable waste and burn this waste (the treatment) to create 50MW electricity to power 53,000 homes. Hampshire County Council (HCC) currently sends less than 10% of household waste to its one remaining landfill. More details can be found here.

What is a waste to energy facility?

Typically residual waste is taken by lorry from households, businesses and industry and delivered to an enclosed unloading area where it goes into a furnace and is burned at high temperature around 2000°F (1093°C) releasing steam which is used to power a turbine to generate electricity, often supplying the national grid. The combustion of waste can also provide heat in the form of a district heating scheme or heat supplied to industrial or commercial businesses. Making use of this heat is an essential part of maximising the benefits of waste to energy[2], but this is dependent upon a suitable use for the heat being available onsite or nearby,

[1] https://www.gov.uk/government/publications/energy-from-waste-a-guide-to-the-debate
[2] Defra EfW Guide page 10

which is often a significant challenge. Pyrolysis, which is the processing of waste without the presence of oxygen, and gasification are other forms of thermal treatments of waste. The emissions from a typical combustion plant include particulates, acids, greenhouse gas, dioxins, heavy metals and ash residues. These emissions are controlled by chemicals in the process, such as ammonia and lime, filters and scrubbers, monitored and regulated by a permit from the Environment Agency.

There are both advantages and disadvantages of using waste to energy facilities. Whether or not they are appropriate at a given location will depend upon the local situation and circumstances at the time, but also on how waste streams are expected to evolve in the future.

Benefits of waste to energy technologies:

Ideally we should all be aiming to reduce, reuse and recycle more and eliminate waste as much as possible from our lives following the waste hierarchy in the diagram below. Until that time we need to ensure that it is treated and disposed of in the most environmentally friendly way. Waste to energy provides part of the solution to waste management as using waste as a fuel to produce energy maximises energy recovery from waste, which would otherwise be lost if disposed of in a landfill.

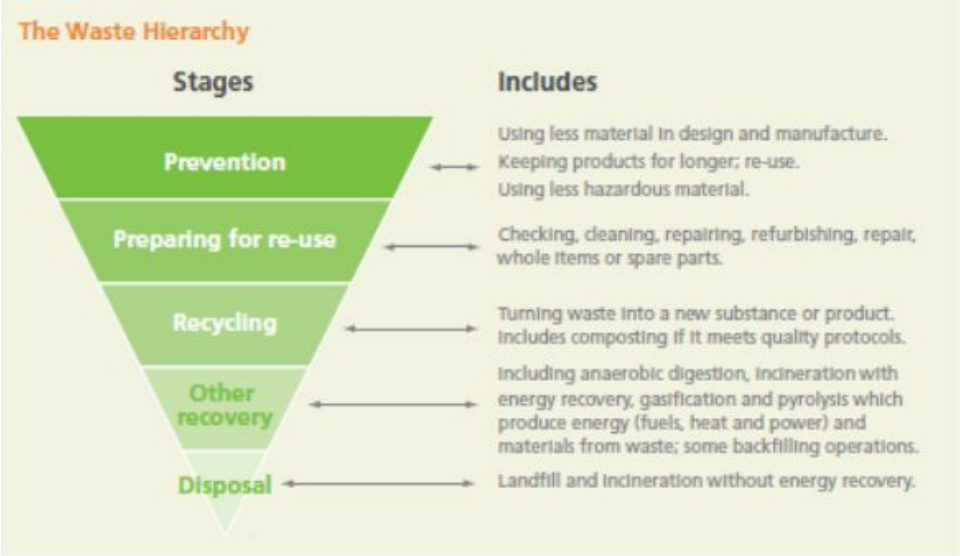


Figure 1: The Waste Hierarchy, Defra EfW Guide

Diverting this waste from landfill prolongs the life of existing landfills and frees up areas, potentially set aside for future landfill. This technology also does not produce methane which would have been generated from the breakdown of landfill waste. Methane is a potent greenhouse gas, and although it is captured (so far as possible) when waste is landfilled, there will still be uncaptured fugitive emissions, and the impact of these is typically greater than the

carbon emissions that would result from burning the waste[3]. This is a significant effect, and means that adopting waste from energy rather than landfill will normally lead to a net reduction in the warming effect of greenhouse gas emissions.

The residual waste used by an energy from waste plant will be a mixture of different materials, including both plastics and biodegradable matter (such as food, paper and wood). Because this feedstock includes some biodegradable material, the Defra EfW Guide considered the energy produced from this residual waste to be partially renewable, and a low carbon source of energy[4]. However, residual waste also contains some fossil fuels (e.g. in the form of plastics), which are burned when the plant is operating, and whether an energy source is low or high carbon depends on what it is being compared with (i.e. with the alternative energy source that would be used instead). The Defra EfW Guide compared energy from waste with gas-fired generation, a relatively high carbon source[5], but this guide was written in 2014, when most of the UK was powered by fossil fuels. Now that there is much more low carbon and zero carbon generation in the UK, the comparison with gas may not be appropriate. In addition, it should be borne in mind that the plant will operate for at least 20 years, and that during this time its fossil fuel content may rise (due to greater recycling) while the carbon content of the alternatives continues to fall. Without further analysis, it is therefore unclear whether or not the current proposal represents a low carbon form of energy.

Within the Waste Hierarchy, waste to energy plants that meet the required efficiency levels are generally considered to be inferior to recycling, in environmental terms, but superior to disposal through landfill or combustion without energy recovery[6]. This is based largely upon the net impact they have on greenhouse gas emissions[7]. However, it should be noted that their efficiency levels of 15-27% (unless also combined with heating) are lower than those for most other power generation (e.g. modern gas fired plant has around 60% efficiency), due to the nature of the waste burned[8].

It should also be noted that flexibility of operation may be required, allowing local waste volumes processed to fall if there is greater local recycling. However, this may involve importing waste of appropriate composition from other areas, as such plants require minimum waste volumes to be financially viable[9]. The impact of any additional transport required on carbon emissions would therefore need to be considered. Plants also need to be flexible to adapt to advances in technology which may not have been available at construction.

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[3] Defra EfW Guide page 22, sections 42 and 43
[4] Defra EfW Guide page 2
[5] Defra EfW Guide page 21, section 41
[6] Defra EfW Guide page 19 section 31, and page 23 sections 47-50
[7] Defra EfW Guide page 20 section 37
[8] Defra EfW Guide page 28 sections 73 and 74
[9] Defra EfW Guide page 26 section 63

In providing a secure source of energy, this process has a reliable supply of feedstock in the near future and is a proven technology contributing as part of the mix of energy generating technologies needed to meet demand. However, even though the population is expected to increase for some time, it is hoped that energy demand will gradually reduce, and also that waste arisings will reduce as lifestyles become more sustainable. Careful consideration must be given to the need for such a facility in the medium term, and as to how reliable its fuel supply might be.

With the closure of a number of power stations expected over the next few years in the UK and growing pressure to halt investment and use of fossil fuels, there is an urgent need to address future demand by investing in alternative power technologies. This will mainly be provided by large scale generation such as offshore wind and combined-cycle gas-fired power stations, but smaller installations such as waste to energy plants also make a contribution to ensuring the lights stay on.

Challenges of waste to energy technologies

Waste to energy plants rely on a constant supply of waste as a feedstock. With promotion of waste prevention, increased recycling and improved technologies, this supply could be at risk. This technology should never compete with recycling but complement it.

As a low carbon renewable technology the waste content will need to consist of an optimal mix of biodegradable material to ensure efficient combustion within the process. Any disruption to this feedstock mix will have a knock on negative effect.

Public perception of waste to energy plants or incinerators can be a significant concern. A plant, depending on location, can be visually intrusive and operate 24 hours a day with consequent transport, noise, dust and lighting issues. Emissions such as dioxins, heavy metals and greenhouse gases to air and water can have potential health implications for humans and the environment, if not controlled. However, it should be noted that there are standard procedures for reducing and monitoring these emissions, and Public Health England have concluded that the health effects are likely to be small, and not detectable[10].

In considering waste management options focus on combustion of waste with energy recovery should be compared with other options including combining heat and power and siting plants to allow for this combination in order to maximise the energy output. As electricity production has decarbonised and will continue to do so in the future a clear case for a waste to energy plant must be justified over other technologies in particular when considering the lowest carbon option.

Summary

[10] Defra EfW Guide page 5

We have a waste management problem. Technologies that recover energy from waste can play a part in addressing this problem. Whether or not they are appropriate at a given location will depend upon the circumstances, and how local waste streams are expected to evolve over time. In all solutions the waste hierarchy should be followed and local, regional and national waste management strategies and plans incorporated.

All waste developments should aim for zero waste to landfill. Waste arisings and use, treatment and disposal should be kept local. A change in residual waste mix, sourcing and quantities should be accounted for over the life of any plant. Circularity should be promoted where plant waste should be used as a resource and treatment plants should use best available technologies sited in optimal locations and where possible include combined heat and power.