ENERGY FROM WASTE

The Cold Truth

Holger Franke, head of development at MVV Umwelt, looks at the cold hard truth facing the future of energy from waste in the UK

Energy recovery from household waste has, for a long time, been seen as a pariah technology for waste management. In recent times attitudes have softened and, increasingly, local authorities are becoming more receptive to the idea of thermal treatment as a legitimate response to the call for reductions in landfill. Many waste management companies are now promoting variations of energy from waste (EfW), with the most popular being common or garden "mass burn". That is good, but is it good enough?

As waste management facilities EfW plants are very efficient at diverting biodegradable municipal waste (BMW) – the target, amongst other things, of the EU's Landfill Directive – away from landfill. But when looked at from the other end of the telescope the story is not so good. A key part of the argument in favour of EfW is that it produces electricity that would otherwise be generated by fossil fuels. The reality is that when compared to modern coal or gas power stations, EfW plants are often not very efficient at recovering the energy locked in the waste.

In a tonne of average residual waste there is about 2.5MW hours of energy waiting to be used. Unfortunately, the laws of science mean that we cannot capture all of it in a useful form and, in the average UK energy from waste plant, typically around 22 percent of the energy is converted into electricity.

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The newly enacted Waste Framework Directive now puts greater emphasis on the efficient recovery of EfW with a new formulaic approach – new plants with an "R1" coefficient (allowing certain energy efficient EfW installations to obtain recovery status) of less than 0.65 not being considered as recovery. So what can be done to achieve R1?

The Impact Of CHP

CLEARLY, COMBINED heat and power (CHP), in the form of industrial steam supplies or district heating, can significantly improve the carbon footprint of EfW plants.

Significant improvement in overall thermal efficiency can come from using some of the energy liberated directly in the industrial process for heating purposes. The energy in the waste is generally used to raise high temperature and pressure steam in a boiler. Normally this steam is fed into a turbine generator that produces electrical energy; a very convenient and flexible form, that can be transmitted to the end user a considerable distance away.

As noted above, in the UK only about 22 percent of the original energy is converted to useful electricity, often less. However, by bleeding some of the steam off, either before it gets to, or as it passes down, the turbine producing rotational energy, the overall efficiency of the EfW plant can be significantly increased. The extracted steam can then be used to displace steam otherwise raised by gas or oil firing. In terms of carbon dioxide emissions, the savings (in terms of emissions eliminated from the conventional fossil fuelled steam) can be significant.

It sounds too good to be true and therefore begs the question: why is CHP not used in more EfW plants?

In reality, for CHP to work, the economic value of the steam supplied to the end user has to be at least the same value as the lost electrical power. In the energy world you don't get something for nothing, and by supplying steam directly to an end user you have less energy going into the turbine, hence less electrical power coming out of the generator. Contrary to popular belief, there is little usable waste heat in a normal UK EfW plant; the large amount of heat that is not turned into electricity is low-grade heat and useless for any sensible purpose.

A Steamy Subject

ON TOP of the loss in power generation, you also have the capital and operating costs of the steam pipe to consider. Depending on the location of the steam host this can be considerable. In Mannheim, MVV Umwelt operates an extensive CHP steam network 15km in length transporting 80 tonnes per hour of steam, at up to 18 bar pressure, to 15 customers up to 2km away. The total operating and maintenance costs amount to some □300 000 annually.

Moreover, to achieve the best economies, the steam demand should be as constant as possible on a 24/7 basis. For industrial customers this is often the case and lends itself to maximising the potential use of heat. To further assist the economics, the Government has, since 2005, allowed Renewables Obligation Certificates (ROCs) to be earned on power produced from EfW plants operating in CHP mode, provided they meet the threshold of Good Quality CHP. Whilst the rules are understandable, they are not the easiest to get to grips with. Moreover, ROCs are only given on the proportion of power that is attributable to the organic fraction of the waste, and so far the system that OFGEM employs to measure the organic content has not been fully developed. Nor is it necessarily going to be practicable given the heterogeneous nature of household waste. To add to the misery, the rules to assess if a scheme achieves Good Quality CHP were adjusted last year with the effect (perhaps unintended) of making it harder for EfW schemes to get ROCs. Depending on the price paid for the steam, CHP in this form can be less viable than plain power generation… despite the significant reduction in CO_2 emissions, compared to fossil fuels.

The MVV Offenbach plant in Germany, which processes 250 000 tonnes of waste

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And what of other forms of heat load? Often mentioned by clients and bidders in PFI tenders is the desire for, and the willingness to provide, district heating. This is where heat is supplied (perhaps as hot water rather than steam) via a network of pipes to buildings. Significantly in use in continental Europe, the networks were almost totally built and funded by city authorities, rather than commercial undertakings. Due to high operating costs and variable heat demand even newly built systems need to be subsidised directly or indirectly.

But has government done enough, fast enough, to make district heating economics work for EfW?

District Developments

THE COLD truth (pun fully intended) is that without some kind of real economic support from central or local government, district heating is unlikely to see much further development in the UK. This is because the nature of domestic and commercial heat demand is not constant, making it hard to achieve the Good Quality CHP criteria. On top of this, there is the high capital cost of building and operating the district heating network.

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To its credit, the Department for Business, Enterprise & Regulatory Reform (now replaced by the Department of Energy and Climate Change) has undertaken a significant amount of work on a Renewable Heat Obligation (RHO) designed to provide support, just as the Renewables Obligation does for renewable electrical power[1] and the granting of ROCs to CHP schemes does provide some limited support. However, with the current wave of PFI projects, it is of great concern that no form of RHO will be in place in time to enable such schemes to build in district heating as part of their base economics.

Of course, it makes sense for the EfW plant to be located close to a potential heat load, even if that heat load does not, at the time, want the energy offered. But if there is genuinely no heat load near to the proposed EfW plant, what then can be done? Industry can take steps to increase the amount of electrical energy that is recovered from the waste, although in the UK that is not something that has been done too well… so far.

Recovering more useful electrical energy can be achieved, such as through higher boiler steam pressures and temperatures, greater use of air pre-heating, further economiser units downstream of the air pollution control system and higher efficiency steam turbines. Of course, all these technologies will cost more to build and operate and they have to be paid for, but in today's environment of higher electricity prices, they can be justified. The real trick is in the know-how of implementing such systems without any unpleasant side effects.

MVV has already operated some of its boilers at pressures of up to 120 bar (typical UK EfW boilers operate at 40 bar). Higher temperatures bring the risk of higher corrosion and erosion rates, and whilst these can be cured to some extent with the use of highly resistant coatings (such as inconel), operating at higher pressures can accelerate the rate of boiler leakages. The trick is, therefore, to ensure the boiler's internal design minimises the hot spots where such leaks can occur.

Recovering lower grades of heat at various points in the steam cycle for use in the process, such as air pre-heating, can increase the thermal efficiency of the plant. Since this really means less of the energy going to atmosphere as low temperature heat, it can have side effects such as lower flue gas temperatures, which can mean more occasions when a plume of white water vapour can be seen coming from the chimney. In continental Europe this is not often considered a problem, but unfortunately, in the UK, such a vapour plume is often associated – quite wrongly – with pollution. Perhaps more education is required?

MVV believes that, in the UK, white plumes are seen, instantly, as pollution, whereas in Europe this is not the case

Making use of more heat in the form of higher pressure and temperature steam is one thing; making use of it as electrical energy is another. Turning the steam into mechanical energy through a turbine is a very specialist skill. The nature of steam turbines is such that they are the most inefficient part of the whole EfW conversion process, but there are turbine suppliers who have developed machines with a very much higher efficiency.

Increased Efficiencies

THE END result of all these efforts is to potentially increase the electrical efficiency of the EfW plant from a typical 20 percent to closer to 27 percent, and achieve the magic R1 coefficient of 0.65. On an EfW plant of around 300 000 tonnes per annum capacity, this could mean an extra 3MW or more – enough power for an additional 5 600 homes.

To make serious improvements in the efficient use of the energy potential of waste, CHP is definitely the way forward. To achieve this, substantial support, speedily provided, will be necessary from Government to build up the required district heating infrastructure. CIWM

References

[1] **http://www.berr.gov.uk/whatwedo/energy/sources/renewables/policy/renewable-heat/page15963.html**