Why energy from waste?

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1. What is energy from waste?

‘Energy from waste’ has been defined in a number of ways over the decades and with many nuances from place to place around the globe. Essentially, all energy generation processes, be they for steam, heat, gas or diesel, that use waste as its feedstock fuel can fall within this definition. This can include traditional mass-burn incineration, advanced thermal treatment technologies such as gasification, pyrolysis and plasma arc processes, anaerobic digestion for gas production, biomass facilities using low-grade feedstocks, and even methane extraction from landfill. However, more often than not, when we talk about energy from waste, or EfW, we refer to thermal combustion processes operating at various levels of oxygenation (oxygen content). With a legacy in municipal waste ‘destruction’ dating back to the 19th century, combustion technologies now operate at high degrees of efficiency with ever decreasing levels of emissions. EfW, together with materials recovery, is the waste management process of choice in many areas of the world, including Europe. The United Kingdom’s Department for Environment, Food and Rural Affairs describes EfW as “the process of creating energy – usually in the form of electricity or heat but also potentially biofuels – from the thermal treatment of a waste source via technologies such as incineration, Anaerobic Digestion, Gasification or Pyrolysis”.[1]

Waste generation around the world continues to rise, despite significant prevention steps taken by several European countries. Waste is largely an urban challenge and world urban populations are growing. Almost 3 billion people lived in cities at the turn of the century and this is likely to double by 2025. Urban populations produce over 3 million tonnes of waste every day,[2] by some estimates as much as 1.3 billion tonnes every year,[3] and as affluence grows so will the disposable materials consumed by urban societies. This needs treatment and what cannot be easily or economically recycled has traditionally become a feedstock for local energy (or heat) production facilities in major urban areas. Vienna, Paris, Malmö, Venice, London and Rotterdam all use EfW solutions and there are many more examples around the world.

1 “Energy from waste: A guide to the debate”, February 2014 (revised edition), p 68.
2 Nature 502, 615–617 (October 31 2013).
3 Hoornweg, D and Bhada-Tata, P, “What a Waste – A Global Review of Solid Waste Management”, World Bank, March 2012, Urban Development Knowledge Series No 15.

2. What are the drivers for EfW?

Two main drivers lead societies, municipalities and businesses to opt for EfW in the context of expanding waste streams.

The first driver is a growing worldwide recognition that landfills are a sub-optimal solution at their best and a sanitary disaster at their worst. Where landfills are engineered, properly lined and regulated, generating methane through decomposition, they are still the final disposal destination of potentially valuable materials. The EU Waste Framework Directive (2008/98) encourages the treatment of waste in accordance with a preferential hierarchy, where landfill disposal is the last option. Recovering the energy potential of highly combustible calorific waste streams is a clear priority over the much less efficient methane generation from biodegradables in landfill. However, most lower income countries, which are facing the greatest challenges from urban growth, dispose of waste in unsanitary and uncontrolled open dumps. David Newman, President of the International Solid Waste Association, has likened these vast expanses of the remnants of economic growth to Dante's circles of hell[4] that are creating a planetary emergency. The World Bank estimates that over 70 million tonnes of waste are disposed of annually at such sites.[5] Improving the quality of existing landfills is a key priority for international waste managers; however, driving waste up the hierarchy must also be a priority. Efficient recovery technologies, where appropriate, can provide strong alternatives for developing countries, offering solutions to the waste problem, but also contributing to energy and heat production, which can be a key local benefit.

The second driver is the energy potential inherent to most waste streams and how to extract and utilise it optimally. With increasing pressure on energy supplies and prices in much of the world, waste can be a significant contributor to non-fossil fuel energy generation. For example, if optimally utilised, waste could contribute to about 10% of the total UK energy need.[6]

Steve Lee, Chief Executive Officer of the Chartered Institution of Wastes Management, has frequently called (on social media) for an energy generation hierarchy,[7] alongside a waste management one, where waste as an energy source could be recognised and have a clear policy position. Frequently, the negative impact of attractive energy recovery options on optimising recycling is raised. The consultancy Eunomia has recently calculated that plans for EfW infrastructure carry the "danger of limiting how far we can go with recycling in England".[8] According to the waste hierarchy and ambitious targets of some countries and regions, maximising recycling at any cost is preferable to recovering the energy potential of waste through combustion. However, very rarely is a true life-cycle approach applied to these decisions. Recycling some materials, such as film plastics, low-grade textiles or mixed

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4 *D-Waste News*, June 26 2012, available from: http://d-waste.com/d-waste-news/item/11-david-newman-s-outlook-on-brazil-s-waste-management-issues.html.

5 Hoornweg, D and Bhada-Tata, P, see note 3 *supra*.

6 Author's analysis based on data from DECC UK Renewable Energy Roadmap Update 2013, URN: 13D/259.

7 https://twitter.com/CIWM/status/377750521970708480.

8 Adam Baddeley, "Eunomia Residual Waste Infrastructure Review" press release, November 2013, available from www.eunomia.co.uk/.

low-grade paper can have large energy demands and produce low-quality products.

Although the incineration of such materials for energy recovery can seem counterintuitive in 'closed loop' terms, the positive energy balance can mean a much more appropriate solution in life-cycle thinking.

The development of EfW facilities around the world is a complicated picture. Globally, more and more facilities are coming online, at a rate of about 3 million tonnes of new EfW capacity every year since 2000.[9] However, zooming in on particular regions, the landscape may look very different. In Northern Europe, early development of efficient EfW facilities has been a challenge for the waste management sector. With significant gains made in recycling and waste prevention, many facilities can no longer secure optimal levels of feedstock for their efficient operation – there is simply not enough local municipal solid waste for them to process. Consequently, international trade in waste (ie, fuel) is on the rise, with minimally processed municipal solid waste travelling across European borders to benefit from the low gate fees at EfW facilities in countries such as Germany, the Netherlands, Sweden and Latvia. The wider impact of this situation is that EfW facility delivery is slowing down elsewhere, as export becomes an attractive solution (or at least a more attractive option than significant capital investment in new plants). The United Kingdom is a case in point: concerns over future feedstocks as a result of prevention, recycling and export growth have undermined the significant delivery pipeline of EfW projects. EfW facilities at early development stages have reduced by between 25% and 30% since 2010, more through project withdrawal or mothballing than through progress to commissioning and delivery.

Many larger developed countries, however, have created only limited EfW infrastructure. In the United States, the absence of strong legislative drivers to divert waste from landfill means that EfW has not been as widely adopted as in Europe. Facilities are mostly confined to the large East Coast conurbations where land availability and price sets the scene against landfilling and in favour of EfW infrastructure. However, increasingly, other drivers such as energy security and resource scarcity are starting to emerge on the US waste treatment agenda.

Australia similarly has an abundance of space and resources; therefore, landfill remains relatively cheap, although costs are reported to be increasing by as much as 50% each year.[10] Nevertheless, there are still landfill diversion and carbon reduction targets to meet, so EfW is very much on the policy agenda. However, low energy and disposal prices mean that any significant shift away from landfill will come only through direct policy intervention. Several states are developing their own strategy for the development of EfW, including New South Wales, Western Australia and Queensland.

In lower income countries, EfW projects have faced very different challenges. Conventional technology solutions are quite specific in terms of the calorific value of the feedstock that they process. The higher organic fraction of municipal waste in

9 Nickolas J Themelis, "Thermal Treatment Review", *Waste Management World*.

10 www.environment.gov.au/system/files/resources/2e935b70-a32c-48ca-a0ee-2aa1a19286f5/files/landfill-cost.doc.

developing countries can often cause technical difficulties for new facilities. This has led to high-profile technology failures, such as the Lagos incinerator in Nigeria, which could not cope with the composition of the local waste stream. However, coupled with growing affluence and urbanisation, waste feedstock composition in these countries will also continue to change to higher paper and packaging content, unless rigorously controlled by legislation. This means that in the medium term, EfW facilities are likely to become more and more appropriate for these countries.

Besides policy and economic drivers, there are often regional drivers promoting the uptake of EfW, which reflect the geography and environment of a particular country. For example, Japan treats over 40 million tonnes of waste through EfW due to the lack of space for landfill. The Netherlands also largely relies on incineration, as its high water table does not allow for extensive safe landfilling. Similar trends are emerging in Lebanon, where the extensive coastline and mountainous terrain creates land scarcity, which has led the government to seek to shift almost entirely to incineration over the next two to three years, as open dumps have become unacceptable to the population and controlled landfills need the sort of space that the country lacks.

Within these complex trends, global waste management continues to shift further up the waste hierarchy, with significant volumes of waste going through thermal treatment.

3. EfW technologies

Waste has been burned for hundreds of years, sometimes providing heat in the process (and, over time, energy), but frequently simply as a means to reduce its volume, before the ash residues were deposited on land. The first such 'destructor' in the United Kingdom was built in Nottingham in 1874. Many plants in the 20th century recovered energy or heat, but with limited efficiency and varying levels of emissions clean-up. In the late 1980s, the European Union began to adopt legislation that essentially outlawed incineration and mandated efficient energy or heat recovery alongside stringent emissions controls.[11]

Given the long operating history of combustion facilities, constant technical developments have improved both their efficiency and environmental performance. These include the way that waste is introduced onto the combustion grate and the design of the grate itself, so that the waste is constantly tumbling as it descends to ensure complete fuel burn-out.

A key concern always cited in opposition campaigns to proposed EfW facilities is the health impacts of expected atmospheric emissions, with specific claims linked to dioxins and particulates. However, whatever links may have been established between health impacts and older incinerators have not been demonstrated for the

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11 Directive 89/369/EEC on the prevention of air pollution from new municipal waste incineration plants, Directive 89/429/EEC on the reduction of air pollution from existing municipal waste incineration plants and Directive 94/67/EC on the incineration of hazardous waste; these three directives were replaced by Directive 2000/76/EC on the incineration of waste (the EU Waste Incineration Directive), which has in turn been replaced by Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (the EU Industrial Emissions Directive).

newer facilities developed since the implementation of the EU Waste Incineration Directive. Step changes in the clean-up of emissions are being made all the time as EfW technologies improve. This is reflected in England by the firm stance of Public Health England (previously the Health Protection Agency) in its 2009 statement that no evidence exists to suggest that well-managed modern combustion facilities carry a risk to public health, and that their contribution to air pollutants is negligible.[12]

Later reviews of this advice concluded that any potential negative effect on health from modern, well-managed incinerators are "likely to be very small, if detectable", and not substantial enough to warrant studies of public health in their vicinity.[13] Currently, Public Health England intends to review this guidance, taking into account the latest research, but is not aware of significant reasons to change its advice.

The EU Waste Incineration Directive (now EU Industrial Emissions Directive) emissions limits forced the retirement of many older European plants in the 1990s and facilities built since then have had to meet the limits laid down in that directive. To illustrate this, a rule of thumb suggests that between 25% and 40% of capital investment for a new plant goes on the emissions control equipment. Electrostatic precipitators, catalytic convertors, reagent systems and bag filters are all used to remove potentially harmful components from the flue gas before it can be released into the atmosphere.

Part of the difficulty faced by developers can be in trying to put actual emissions into some sort of tangible context to reassure the public. An example of addressing concerns over emissions during the consultation process for the Viridor-Grundon Lakeside facility (just west of London) included a comparison of the plant's annual emissions against those from a 50-mile stretch of the neighbouring M25 London Orbital Motorway. Polluting elements were a fraction of those generated by traffic, with mono-nitrogen oxides at 10% of the motorway figure, PM10s (particulate matters under 10 microns in diameter) at 3.5%, and carbon monoxide and volatile organic compounds at around 1% of those emitted by passing traffic.[14]

As with all established technologies, there is also the cutting edge of EfW, where new ideas are being developed or proven technologies are implemented in new ways. This is an area where some critical technical issues can arise.

This is an extract from the chapter 'Why energy from waste?' by Adam Read in Energy from Waste, A Practical Handbook*, published by Globe Law and Business.*

12 Health Protection Agency (2009), "The Impact on Health of Emissions to Air from Municipal Waste Incinerators", available from www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1251473372218.

13 Health Protection Agency (2010), "The Health Impacts of Emissions to Air from Municipal Waste Incineration", available from www.hpa.org.uk/ProductsServices/ChemicalsPoisons/IntegratedPollutionPreventionControlIPPC/ippcIncineration/.

14 Viridor Grundon Lakeside presentation (2011), available from /www.ciwm.co.uk/web/FILES/LondonandSouthernCentre/Lakeside_EfW_CIWM_-_Nov_11.pdf.