Future-proofing energy recovery

As the energy-from-waste sector continues to grow and evolve in the UK, ***Roberto Vogel*** and ***Timothy Byrne*** review the fate of the UK's first generation of plants, what we can learn from their demise and what has changed

Thermal waste treatment in the UK has changed a lot since the late 1970s, driven by the implementation of the directive on the reduction of air pollution from existing municipal waste-incineration plants (89/429/EEC) in December 1996. This directive required all plants with a nominal capacity of more than six tonnes per hour to meet the same conditions as those that were imposed on new-build plants in 1989 (89/369/EEC).

Most of the plants that existed before the 1989 legislation were referred to as "waste destructors". They focused on reducing the mass and volume (by 70% and 90% respectively) of the waste before it was sent to landfill, with little thought for resource or energy recovery.

The two directives signalled the end of these traditional waste-destructor facilities without energy recovery and substantial flue-gas treatment.

Survivors

Of the 45 plants operating in the mid 1980s, only four were still operating with the basic original combustion plant design by 1996. The other 41 plants were not retrofitted to meet the new requirements and were decommissioned.

All but one (Bolton) of the four plants that ran past 1996 continued operating with only small changes to the combustion system and retrofitted end-of-pipe gas abatement. The most likely reasons why these plants were able to avoid being decommissioned were that they recovered energy from the flue gas; did not incorporate rocking grates and had higher than average throughput because they were in metropolitan areas.

Why did so few of the old incineration plants manage to transition to modern energy from waste (EfW) plant designs after 1996? The three main reasons were environmental impact; political will from the operator, owner or local authority; and financial viability in operating and investment terms.

Environmental record

The traditional waste destructor had a poor environmental record, with a reputation of bringing loud noise, bad smells and air pollution to the local area.

The air pollution produced in a thermal treatment plant is limited by abatement in two distinct stages. Primary abatement is characterised by the quality of combustion and post combustion that defines the levels of carbon monoxide, volatile organic compounds and nitrogen oxides in the flue gas. This depends on the design and operation of the plant's combustion process and can only be significantly changed by replacing the grate, furnace and gas conditioning, such as in a boiler, post combustion or water spray tower.

Secondary abatement removes contaminants such as particulates, sulphur dioxide, hydrochloric acid and hydrogen fluoride from the flue gas. This is achieved by end-of-pipe measures, including filtration and scrubbing. These processes can typically be retrofitted to existing front-end combustion plants.

The plants that transitioned past 1996 were built in such a way that the primary combustion system was suitable, or easily adapted, to meet the 1989 directive requirements, although Bolton needed the retrofit of a heat recovery boiler and a flue-gas treatment plant to be granted an operating permit and to be financially viable for the long term.

Political will

Most of the 45 incinerators operating in 1980s were waste destructors without an energy-recovery facility and were run by the local authority, making them easy targets for environmental pressure groups. When the authorities were forced to privatise the incinerators by the Environmental Protection Act (1990), some of the councils formed local authority waste-disposal companies (LAWDCs), which took over some of the responsibilities.

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Once the thermal-treatment plants were taken out of direct council control, the political will to take over and maintain what was perceived as a dirty industry was low.

The few exceptions were those facilities whose environmental and economic performance made the investment to convert them to more modern EfW plants attractive enough for LAWDCs. Larger units with higher-quality combustion and substantial energy recovery were associated with the larger metropolitan centres in London, the Midlands and the north-west. Presumably these authorities had more clout and will to invest in plants.

The general stigma of being environmentally unfriendly is still associated with the EFW industry today, with many environmental groups opposing the construction of new plants.

Economic feasibility

The main aim of waste destructors was to reduce the volume of waste sent to landfill; they had little interest in using the waste they received to create profits. Both resource and energy recovery were typically ignored, along with the potential to generate income. As a result, many of the old-style plants had no heat-recovery technology installed and no way to retrofit it into their design.

The cost of replacing the combustion section in addition to the end-of-pipe flue gas plant retrofit required considerable capital input. And there was no income from electricity and heat sales.

Based on environmental, political and financial considerations decommissioning most of the plants in 1996 made sense.

Technology choices

So, as EfW capacity is continuing to grow in the UK at present, what are the lessons from the ageing fleet of first-generation EfW plants? Although estimates for plants being planned at the moment vary, many of those who make decisions for waste-management firms will have to choose which technologies to incorporate into the new plants.

For 1990s plants, energy recovery was mainly a commercial consideration, acting as a secondary income for the facility after gate fees. Most of the plants that made the

Early EfW plants were known as 'waster destructors', with energy recovery a secondary concern

transition used a design for energy recovery that allowed for combined heat and power.

Today, high-efficiency energy recovery is essential, and the inclusion of combined heat and power offtakes is becoming a greater priority, for economic reasons as well as for increasing environmental considerations. Resource recovery is being driven by the same reasons.

A high-quality grate technology translates into real-world availability. In the 1980s, the entire plant's availability was largely defined by the reliability and robustness of the grate, with some rocking-grate designs requiring weekly shutdowns for cleaning.

In the present day, high-quality, proven grate/combustion systems are able to guarantee more than 8,000 hours of availability. Additionally, circular-economy initiatives are introducing new requirements for systems that can recover bottom and fly ash from the process to allow for enhanced metal recovery.

While plants were scaled to utilise favourable economies of scale in the 1990s, this has become more difficult, and the planning process for large new plants can now be a major hurdle before building can begin. However, the scale of a plant is still an important factor in determining its viability.

Planning process

In the 1990s, political will to keep valuable waste-treatment infrastructure alive was an important question for large municipal authorities. In the present climate, political will is ebbing away, with many authorities taking a "not in my back yard" approach to energy-from-waste plants.

Planning applications need to be produced carefully, incorporating the environmental advantages and the benefits to the local community of a new plant. These points need to be communicated effectively to local residents. With the increase in awareness of the circular economy these principles also need to be included in the planning process.

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This will mean the EfW plant cannot be seen in isolation of the overall waste-management landscape and the environmental benefits they convey, for example replacing traditional fuel use with district heating. When choosing a technology the decision-makers must take into account the wider environment in which the plant will operate.

New criteria

Priorities have changed since the 1980s and 1990s. While some of the old reasons for choosing one technology over another have remained the same, there is a growing awareness of environmental best practice that has started to impact the decision-making process.

There is a new focus on the environmental impact, global warming and the role EfW plants can play in the circular economy. In future, the primary areas to focus on when selecting a boiler technology are:

- Thermal efficiency above financial efficiency
- Materials recovery beyond the 'easy' materials (such as bulk ferrous metal)
- Consumption of materials (such as flue gas reactants) and in-house power consumption
- Boiler availability (plant reliability, online cleaning/maintenance).

An additional point is the need for plant flexibility. Volumes and compositions of waste material can be difficult to predict, which can have a large impact on plant performance. Any new plant must be able to continue running efficiently while dealing with a wide range of feedstocks and throughput volumes.

Finally the ability and financial incentive to extract more than the 'easy' material from the residue stream as a valuable resource stream are part of an ongoing discussion. While the cost argument has prevailed in the UK to date, other countries in Europe are more adventurous, for example building in dry incinerator bottom-ash extraction and enhanced materials recovery. Where the balance will fall ultimately in the UK, only the future can tell. ■

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