GSIA visit to Gloucestershire Energy from Waste Facility, Javelin Park, Gloucestershire

Stephen Mills December 2022

Like many of us, I had driven countless times past the Gloucestershire Energy from Waste Facility close to the M5 on the outskirts of Gloucester. I often wondered how it worked and what went on inside, but on the 16th November, along with 19 other GSIA members, I found out courtesy of an introduction and tour of the plant.

Javelin Park waste-to-energy plant (courtesy UBB)

There are mixed opinions on the plant's 'modernist' appearance, and early in the planning process, the project caused much local controversy. The planning application was initially rejected in 2013 by the local planning authority, however, following an appeal by the developers (Urbaser Balfour Beatty - UBB), in 2015, the then Secretary of State for Communities and Local Government (Eric Pickles) gave his approval. The plant was subsequently built and now manages much of Gloucestershire's waste left after recycling and reuse.

The process

The Gloucestershire Energy from Waste Facility takes in around 130,000 tonnes of municipal waste each year. It has a capacity of 190,000 tonnes, so some commercial wastes are also accommodated. After arriving via refuse collection lorries or HGVs, each carrying up to 25 tonnes, wastes are first deposited in a reception bunker that can hold approximately 10,000 tonnes. From here, overhead cranes lift the required amount to the top of an inclined moving grate (this is the bit where the 'magic' happens). Waste travels slowly down the grate - the first few meters essentially dry the incoming materials, followed by the actual combustion process that takes place at around 1,000°C, encouraged by pressurised air from above and below (underfire and overfire air). Air for the combustion process is pre-heated through a heat exchanger, using steam that has passed through the turbine. Finally, the last section of the grate handles the residual ash, before feeding it into a quench bath. The whole journey takes about an hour.

The heat from the combustion process is used to generate steam in a boiler at 282°C – this is superheated to 427°C using flue gas, before being fed to the turbine at a pressure of 60 Bar (6 Mega Pascals, or 870 psi). The turbine drives an electricity generator rated at 16.5 MW, although it regularly generates up to 19 MW; around 2.9 MW is consumed running the plant, with at least 14.5 MW of electricity exported to the national grid. This is stepped up from 11 kV to 33 kV via an on-site transformer, providing enough energy to power the equivalent around 25,000 homes. Once the steam has passed through the turbine, it is condensed back to water using large air-cooled condensers, before circulating back to the boiler for reuse.

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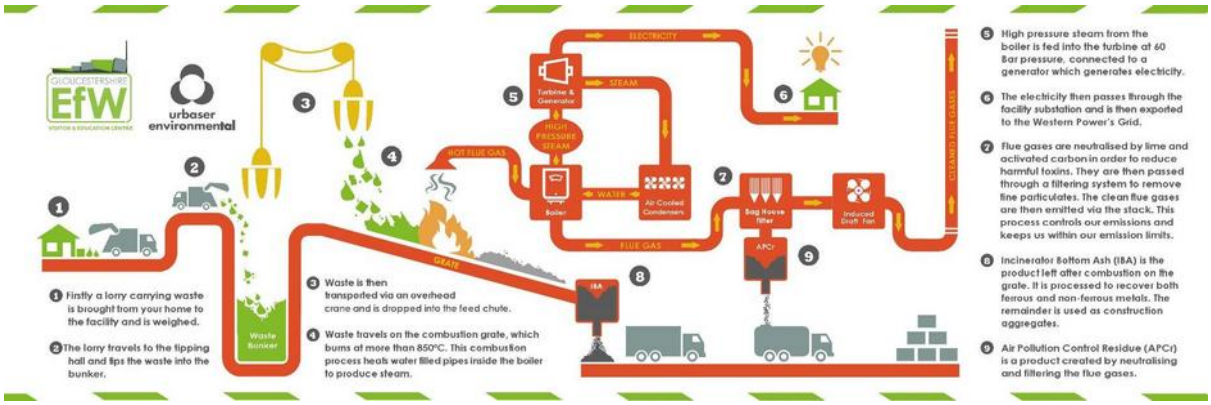

Process flow sheet

How clean is the plant – what does it emit?

Understandably, this was a question raised by a number of the GSIA party. Apart from the occasional whiff of steam from the plant's stack, there never appears to be any visible emissions. The flue gases generated from burning the waste are quenched in a conditioning tower, after which they are scrubbed using a mixture of lime and activated carbon – this neutralises any acidic species present; for example, burning PVC contained within the waste stream can create hydrochloric acid.

The gases then pass through a series of long bag filters (a bit like the old-fashioned Hoover bags) to remove particulates. There are no less than 900 individual bags arranged in six banks of 150 - these have a lifetime of around 5 years. As the gases pass through the bags, a crust of particulates, lime and activated carbon ('filter cake') forms on the outside. Sensors measure the pressure drop as the cake thickens, and when too low, a jet of air is pulsed into the individual bag, causing the cake to detach and fall to the bottom for collection.

After cleaning, flue gas is finally exhausted through the stack. Emissions must meet stringent regulated levels imposed by the Environment Agency, in accordance with the Industrial Emissions Directive. Levels are monitored constantly using a Continuous Emissions Monitoring system that operates around the clock. This measures levels of nitrogen oxides (NOx), carbon monoxide, sulphur dioxide, hydrochloric acid, and dust. It also checks for volatile organic compounds – these can be formed during the combustion of a wide range of materials such as paints, disinfectants, adhesives, carpets, and upholstery. Fortunately, emissions from the plant fall below permitted levels for all of the above.

What's left at the end?

Given the range of materials that can find their way into the incoming waste stream, it would be surprising if there weren't some solids left at the end of the process. There are two main streams, one of which is known as incinerator bottom ash or IBA. This is made up of inert aggregates,

ceramics, glass, clinker, and metals – the latter are recovered for recycling, and the remainder used as construction aggregate, suitable for road bases etc.

The other solid stream consists of the residues from the flue gas cleaning process, mainly spent lime and particulates - Air Pollution Control residues (APCr). Because of their alkaline nature, this material is classed as a hazardous waste and is disposed of in specialised landfills. Each year, the plant recovers around 37,000 tonnes of IBA aggregates, 3,000 tonnes of recovered metals, and produces 5,000 tonnes of APCr.

Overall, only around 2.5% of what arrives at the Gloucestershire Energy from Waste Facility ends up in landfill, a good thing as most local landfills such as the one at Hempstead, have now been closed and capped. But even here, historical buried waste is making a useful contribution, as landfill gas (LFG) is being recovered and used to produce electricity. LFG is composed of roughly 50% methane and 50% carbon dioxide.

Final thoughts

When it comes to the provision of affordable, sustainable energy, there are undoubtedly difficult days ahead, and any process that can generate electricity and feed it into the national grid is to be welcomed. Waste-to-energy plants take unwanted, troublesome materials and turn them into something useful, in the process, eliminating much of the need for landfills with all their attendant problems. In the case of the Gloucestershire Energy from Waste Facility, because of the organic content of the incoming waste, around half of the energy produced can be classified as renewable – Ofgem check and certify this.

One area we haven't mentioned is that of carbon dioxide (CO_2) a major greenhouse gas. There are now a number of technologies commercially available capable of capturing CO_2 from plant flue gas, although most efforts have focused on larger point sources such as fossil fuel-fired power stations and industrial applications. However, this might become a necessity for waste-to-energy plants at some point in the future. There are several waste-to-energy projects underway around the world examining this. For example, at Twence in the Netherlands, Klemetsrud in Norway, and Saga City in Japan.

Around much of the developed world, volumes of municipal solid waste continue to rise. Historically, much of this has ended up in landfills, an option that is becoming increasingly environmentally unsustainable and uneconomic. Although waste-to-energy plants are not universally loved, they nevertheless play a vital role in transforming the world's growing mountains of detritus into useful products such as electricity, heat and building materials. They also obviate much of the need for often unsightly landfills, another major bonus. Fortunately, modern plants are much cleaner and more efficient that some of their predecessors. It was encouraging to see just how effective plants such as the Gloucestershire Energy from Waste Facility can be in minimising environmental impacts and helping meet the world's ever-growing demand for energy.