

As the world fights to reduce the high volumes of waste dumped at landfill sites, the environmentally damaging gases given off are being used as something a little more useful

One man's trash is every man's treasure

by **Keeley Downey**

Landfills are not only an eyesore but also a significant source of pollution. In 2006 landfills were the second-largest source of man-made methane, producing over 22% of the total output. When the waste dumped at landfills begins to decompose through the process of anaerobic digestion, landfill gas (LFG) is produced. LFG consists of about 40-60% methane, with the remainder being mostly carbon dioxide (CO₂). The methane emitted by decomposing biomass is around 20 times more potent than CO₂.

Wasting waste

The EU landfill directive was implemented in 1999 with the aim of minimising the amount of waste being sent to landfills by enforcing stringent requirements for both waste and landfill.

The UK alone produces over 434 million tonnes of waste annually. The Landfill Directive aims to dramatically reduce this figure by 2020 through the implementation of certain targets. By the end of this year 25% less biodegradable municipal waste will be dumped at landfill sites, compared with that in 1995. In 2013 the UK must reduce its biodegradable waste landfilled to 50%, while in 2020 this figure will reduce to 35% of



The Surrey plant is currently producing 5,000 tonnes of LBM annually

that produced in 1995.

But while the Landfill Directive aims to cut the amount of waste turning up at landfill sites, the waste that is there will stay for hundreds of years, sometimes even longer. The methane given off creates global warming problems and poses health risks to residents living nearby. As a result companies are installing gas collection systems at both operational and closed landfills to prevent these problems associated with gas migration.

In the US landfilling is the main method for disposing

of municipal and household wastes, with around 40% of the nation's 1,000 largest landfill sites having installed LFG collection systems.

Quick and easy disposal

Once landfill gas has been collected it can be disposed of by flaring. Burning the methane decreases its percentage of greenhouse gases by approximately 95% by converting it into CO₂.

Combustion is the most popular method for managing gas produced at landfills. Most effective when treating

landfill gas consisting of 20% methane or more, open or enclosed flares can be chosen for the combustion process. Open flame flares consist of candles or pipe flares and are the simpler of the two flares; gas is pumped through a pipe and a pilot light is used to spark it. Enclosed flame flares on the other hand are more complex and expensive, employing numerous burners sheltered by flameproof walls, reaching higher than the flare.

Despite being the most widely chosen way to use landfill gas, converting the gas to energy has the ability to



2G Cenergy's CHP unit

further reduce greenhouse gas emissions by replacing non-renewable sources. By flaring the gas landfill operators are destroying valuable energy.

Electric central

LFG can be converted into vehicle fuel or renewable heat or electricity. While producing vehicle fuel is an exciting concept it is a very immature market.

'In order to take landfill gas and convert it to vehicle fuel you need a very, very large landfill operation to make it economically worthwhile,' says Michael Turwitt, CEO and president at 2G Cenergy, a company dedicated to the production of advanced clean energy technology. 'You need enormous quantities of gas because the purification systems are extremely expensive.' For those who do not wish to risk investing in a green vehicle fuel plant, LFG-to-biopower is a tried and tested method of waste gas utilisation.

2G Cenergy manufactures unique all-in-one cogeneration system packaging for a number

of different gas applications, including LFG, biogas, sewage gas, natural gas and syngas. The company's 2G LAN-TEC equipment is specifically designed to convert LFG into electricity and heat, ranging in size from 100kW to 1.6MW. Talking about the 2G LAN-TEC Turwitt says: 'We have taken all of the different technology components and we have designed our own complete connection ready modules and that is pretty new for the landfill operators.'

Incentives

Over 300 landfill sites are now extracting the gas and converting it into biopower in the UK. The Renewable Obligation (RO) mechanism is the main support scheme for renewable electricity projects in the UK and requires electricity suppliers to source a percentage of their energy from renewable materials.

In simple terms the Renewables Obligation makes Licensed Electricity Suppliers source an increasing proportion of their electricity from renewables, or else

pay a financial penalty called the buy-out.

The RO annual quotas are set annually starting at 3% in England, Wales and Scotland and rising to 15.4% in 2015-16. For every MWh that the suppliers fall short of their quota, the buy-out is £30 (€36) (increasing annually, index linked to the RPI since 2002). The buy out money is recycled back to suppliers in proportion to how much renewable electricity they supplied.

Suppliers meet their obligations by submitting green certificates known as Renewables Obligation Certificates (ROCs). One ROC is issued for every MWhr of electricity generated by the supplier from renewable sources. At the moment it is expected that the use of the RO will continue until 31 March 2027.

Biopower in the UK

UK recycling company SITA UK owns close to 40 LFG generation plants with a total capacity of 92.5MW. One of its most recent projects, completed earlier this year,

is a 1.5MW facility on the Hill of Tramaud landfill site, near Aberdeen, Scotland and cost £1 million to construct.

In October last year Northern Ireland's second landfill gas-to-electricity plant opened. Built on the previous landfill site of North Foreshore, today known as Giant's Park, the plant generates a yearly output capacity of 5MW of electricity. A joint venture between Renewable Power Systems and Belfast city council, the facility generates electricity from the 10 million tonnes of waste dumped at the site since the 1970s.

Across the Atlantic

The US tells a similar story as a growing number of landfill operations are turning LFG into biopower. According the Environmental Protection Agency (EPA) the number of LFG projects operating throughout the nation reached 519 in 2009, a significant increase from the 399 operations recorded back in 2005.

Methane Power is one of these companies making use of this waste gas. A North Carolina-based renewable energy firm specialising in landfill gas to energy projects, it currently owns nine landfill projects on the Eastern Seaboard, seven of which convert the LFG into biopower. The company's most recent project is located in the city of Durham, North Carolina, US, and began converting methane from landfill into a renewable source of electricity in November last year. Costing \$4.5 million (€3.5 million) to build, the plant generates 3.3MW of electricity from methane collected from a closed landfill site and provides it to utility company Duke Carolinas.

Elsewhere in the US King County Solid Waste Division formed a joint venture with renewable energy company Ingenco, Bio Energy Washington, extracting LFG

from the Cedar Hills Regional Landfill in Maple Valley, Washington. The LFG processing facility, designed, built and now operated by Bio Energy Washington, was completed last year and features a quarter-mile pipeline for transporting the gas to Williams Northwest Pipeline and Puget Sound Energy's natural gas-fired power plants.

One step forward, two steps back

However much energy can be produced from landfill, most people in the industry agree it is better for the environment to recycle or re-use waste rather than disposing of it.

'In the long term tips will no longer be used as a fuel source but rather as a depository for materials that have no recyclable or energy content,' says James Voss, president and CEO of Methane Power.

According to Voss the production of gas at a closed landfill will decline at approximately 3-4% each year and he goes on to explain that LFG is but a tiny fraction of the total energy content



Methane Power's plant in Durham city utilises three GE Fenbacher engines to generate 3.3MW of electricity

present in all waste. 'Probably less than 1%,' he predicts.

With this in mind Stuart Hayward-Higham, technical director for SITA, foresees a market push towards designated anaerobic digestion sites. Anaerobic digesters act in the same way as a landfill site, breaking down biodegradable material without oxygen. However an

anaerobic digester produce conditions that encourage the natural breakdown of matter so biomass breaks down faster than usual. The gas produced also tends to have a higher methane content and less nitrogen - making the cleanup process cheaper.

But whether the answer to sustainable green energy lies with anaerobic digestion

or not, LFG as an energy source is here to stay for the foreseeable future. Doug Leaf, development manager at Gasrec, Europ's first commercial producer of liquid biomethane (LBM) says: 'If you were to stop landfilling in the UK tomorrow, the gas available in those landfill sites is enough to keep plants running for the next 50 years.' ●

Landfill gas for transportation fuel

IN 2009 Houston-based waste collection firm Waste Management (WM) formed a joint venture with petrol engineering company Linde to build a LFG-to-LNG plant in California.

Linde designed and now operates the facility, which is located close to Waste Management's Altamont landfill near Livermore, California.

The plant purifies and liquefies LFG that WM collects from the natural decomposition of organic waste in the landfill.

Since September last year the refinery has produced approximately 200,000 gallons of LNG, although it has a capacity of 4 million

gallons a year, or 13,000 gallons every day. This would be sufficient to fuel 300 of WM's rubbish trucks while at the same time reducing GHG emissions by around 30,000 tonnes a year.

WM and Linde are now developing their second LFG-based facility for fueling natural gas vehicles, applying \$11 million in California Energy Commission money to develop a plant in Simi Valley, between Los Angeles and Santa Barbara.

UK-based Gasrec is Europe's first commercial producer of LBM, a green version of LNG which consists of 98% methane and 2% nitrogen.

Liquefied by chilling it to the same temperatures as LNG -162°C, LBM is a clean burning fuel with around 70% more greenhouse gas (GHG) saving than fossil fuels, with a 90% reduction in particulate production, a 50% reduction in nitrous oxide and a 30% reduction in sulphur dioxide.

It is also between 20 and 30% cheaper than diesel and can be utilised in any vehicle that is designed to run on LNG or compressed natural gas (CNG). 'It can run effectively in a high performance sports car right up to a great big 40-tonne HGV with a trailer on the back,' explains Leaf.

Gasrec is one of a very

small number of companies producing this green vehicle fuel in the world. The company upgrades a number of different gas streams, including LFG, before liquefying it and converting it to LBM. In 2008 Gasrec and SITA UK opened the nation's first large-scale LBM plant in Albury, Surrey, which is today producing 5,000 tonnes of liquid fuel a year - enough to power 500 LGVs for a whole year. Leaf explains: 'That's not massive amounts of fuel but it is certainly a significant enough quantity to make a big difference to several key commercial organisations that we're dealing with.'