INFORMATION FOR MEMBERS
FROM THE
PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY

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# LANDFILL GAS - PUBLIC HAZARD OR VALUABLE RESOURCE?

The problem of landfill gas (LFG) hit the headlines in 1986 when a house in Loscoe exploded. Her Majesty's Inspectorate of Pollution (HMIP) have reports of over 100 incidents involving LFG in England and Wales. DoE's recent evidence to the Commons Environment Committee estimated that there are some 1400 landfill sites in England and Wales which might be emitting enough gas to carry a risk of fire or explosion. Clearly LFG is a national problem. On a more positive note, the gas has potential to become a significant energy source. Most of the waste generated in the UK is landfilled, and the gas produced each year could amount to 5% of the annual production of British Gas.

***This Briefing Note addresses the processes underlying the generation of landfill gas and describes some of the options available for its control and use.***

## WHY IS LFG GENERATED IN THE FIRST PLACE?

When biodegradable wastes are landfilled, they are attacked by microbes, which feed on the waste and break it down to simpler substances. Many of these lead to contamination of water leaching through the site, requiring the control measures described in HMIP's Waste Management Paper 26. Other products are gases. If oxygen is present, carbon dioxide is the main gas produced. Without oxygen, anaerobic bacteria flourish and methane is generated too. Household and commercial wastes are primarily responsible for gas production, but many industrial wastes also contribute.

The breakdown processes are complex. Both the types of bacteria involved and the start and rate of methane production vary widely depending on the conditions in each site. Methane production can start from within 2-12 months and may continue for periods of 15 years or more after closure. Since some sites are in use for as much as 50 years, the potential lifetime of a gas generation project can be 65 years. During this time, up to 25% of the waste may be converted into gas.

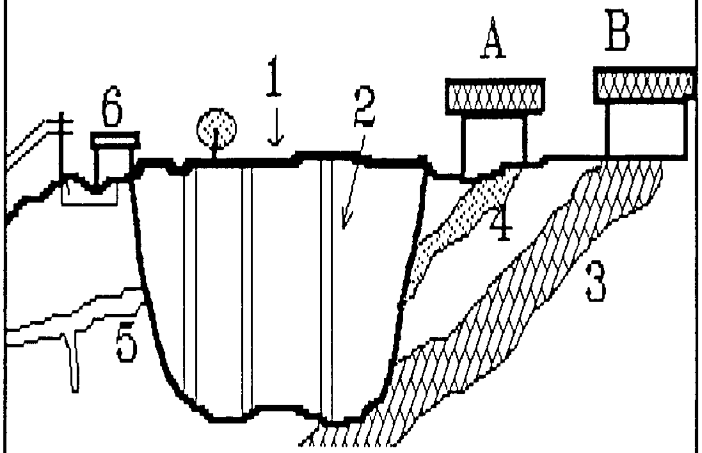
## HOW DOES THE GAS MOVE?

Once generated, gas can migrate along the paths of least resistance. These may be deliberately engineered pathways, or existing channels within the landfill itself or the surrounding strata.

Good landfill practice recommends the use of a low permeability domed cap to cover the site on completion. This controls leachate, but unless special provision is made for gas, the cap will force the gas to migrate from the site in an uncontrolled manner. The gas may enter porous strata, man-made passages (eg from mining), underground service ducts (sewers, cable ducts, land drains etc) as well as some of the service structures on the site itself. Where these pathways lead to buildings, dangerous accumulations of gas may develop. Gas has been known to migrate 300-400m or further from the site through porous geological strata. Figure 1 illustrates the more common pathways involved.

FIGURE 1

POSSIBLE PATHWAYS OF GAS MIGRATION




KEY

1 Site capping
2 Monitoring probe
3 Fissured rock to house B
4 Porous strata to house A
5 Into caves, mines etc
6 Into service ducts

## WHAT ARE THE POTENTIAL DANGERS?

Methane is explosive or inflammable when its concentration in air is between 5 and 15%. Since LFG typically consists of around 55% methane and 45% carbon dioxide, it has caused explosions and fires. High concentrations of LFG in houses could also suffocate. Less serious, but still a source of nuisance is its offensive odour. The gas can also kill vegetation, by seeping upwards through the soil and depriving the roots of oxygen.

## MEASURES TO CONTROL AND USE LFG

HMIP's Waste Management Paper 27 is the main source of guidance for controlling LFG. A Code of practice was also considered, but constraints on time and knowledge prevented it being drafted. A Code could, however, be included when the paper is revised in 1990. Currently HMIP state that 'All sites, whether operational or closed should be assessed for landfill gas'. In doing so, the Waste Disposal Authority(WDA) should carry out a desk study of each site, considering its geology, the wastes involved, the location of houses and other developments, followed by a field study if the desk study so indicates. These studies provide the information needed to control problems on an existing site or design control systems for a new one.

There are a number of possible options for controlling the problems posed by LFG generation;

***Controlling the microbes.*** If methane production could be 'switched off', then LFG problems could be easily solved. Although research is being carried out on this, at present the only way to prevent methane production is by keeping the degrading rubbish in an oxygen-rich environment. This, however, is practical only for the shallowest and smallest of sites. Moreover, it would be incompatible with long-term restoration of the site which requires a cap thick enough to control leachate and allow regrowth of vegetation.

A more profitable method of microbe control may be to **encourage** methane production, through controlling the site environment to maximise gas production ( the right moisture, temperature and acidity are important) and then to use the gas. Research commissioned by the Dept of Energy is aimed at a threefold increase in gas generated from a given amount of waste through this approach. Some companies offer design and operating services to optimise methane production from the beginning of the site - Arpley near Warrington is one such example.

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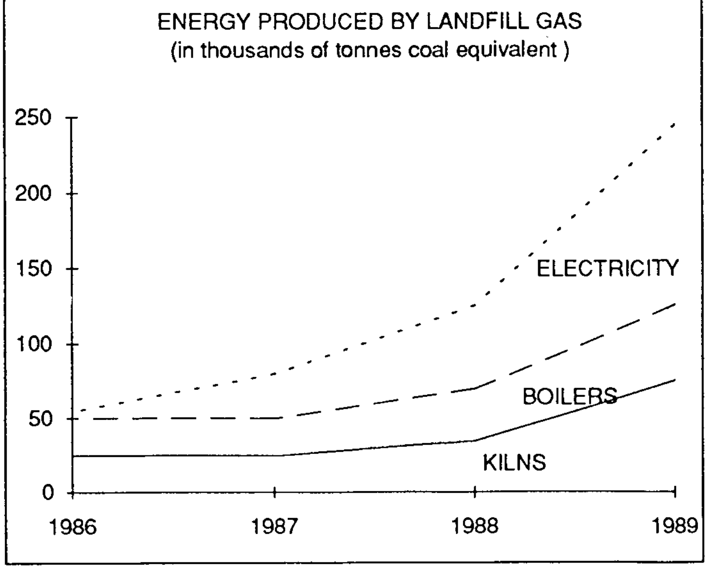
***Venting/Flaring.*** The minimum requirement for a site generating significant amounts of gas is an engineered system to collect the gas and vent it to the atmosphere or flare it. Underground barriers are constructed to prevent gas migrating outside the site. Venting trenches, gas drains, wells and pumps collect and remove the gas, either direct to atmosphere or through a burner.

***Commercial exploitation.*** The LFG schemes currently operating in the UK all use the gas on or near the site due to the cost of piping it further afield. Direct use of the gas to fire kilns, boilers or furnaces, using all the heat productively, is the best option. Where local consumers are not readily available, the gas may be burnt to produce electricity for use on site or export. Though in some cases gas cleaning (necessary to remove trace contaminants) may add to the cost, several such schemes have enjoyed success and LFG is expected to be increasingly used to generate electricity. See Figure 2.

***Monitoring.*** With or without the application of one of the above solutions, monitoring is essential to determine whether LFG is likely to constitute a hazard or nuisance. This should continue until methane concentrations drop below levels stipulated by HMIP. Measurements taken beyond the site perimeter will ascertain whether the gas control system is working effectively.

**FIGURE 2**



# CURRENT ISSUES

## *Reducing the hazards - is enough being done?*

Information supplied by the WDAs in 1988 led HMIP to conclude that 'whilst many WDAs had carried out extensive field work, many others had only undertaken a desk study to consider any risk'. The report earlier this year by the House of Lords Select Committee on Science and Technology pointed out that the 'problems of management associated with landfill gas are only slowly being recognised and overcome'. In recent months however, the rate of review of sites for LFG hazards has increased, relying on external consultants. HMIP believe that all active landfill sites have now been assessed, as well as most of the sites closed since 1976. Sites closed before 1976 are being assessed as resources are released from the higher priority sites. Consultant availability appears to be the rate limiting factor at present.

This anecdotal evidence suggests that rapid progress is being made in controlling the hazards from LFG. Though no quantitative figures are yet available, the results of a recent HMIP survey on the position in each WDA should be completed soon.

After the site is closed, the landowner becomes responsible for dealing with any LFG measures. The task of confirming and assessing the results of any monitoring lies with the local Environmental Health Authority (EHA). The decision on the allowable uses of the land rests with the local Planning Authority. Effective liaison after site closure between the WDA, the EHA and the planning departments is therefore vital.

The high costs of proper control technology can make it difficult to ensure that landowners discharge their legal responsibility. Other problems have arisen from building on or near a reclaimed site where the excavations or pilings have released LFG. In view of this, it is expected that provisions in next session's 'green bill' will assign to the WDA the responsibility for ensuring proper care after site closure, and require that the proper consultations take place between the planning and waste disposal authorities.

Another criticism of current arrangements is that HMIP's advice has no statutory backing. Such backing is also expected to be included in the 'green bill'.

> ***'In recent months, the rate of review of sites for LFG hazards has increased'***

## *Reducing the environmental impact further afield*

Current controls are based on avoiding local danger and nuisance (smell etc). However, since both carbon dioxide and methane are greenhouse gases, LFG will have a wider environmental impact. Its magnitude will depend on how the gas is managed.

Venting methane to the atmosphere makes the larger contribution to the greenhouse effect since methane is 27 times more effective at trapping radiation than carbon dioxide. There is thus an environmental benefit to flaring, which converts the methane to carbon dioxide. There is an added bonus if the energy of the burning gas can be used in place of other fuels which would otherwise make their own contribution to the greenhouse effect.

Currently there are no guidelines to WDAs or site operators on minimising this aspect of the environmental impact.

## *Improving utilisation of LFG*

Although some financial assistance was available for innovative projects from the Department of Energy's Energy Efficiency Demonstration Scheme, subsequent LFG utilisation projects must be economically viable. Consequently it is crucial that

a) the utilisation scheme should only have to pay for costs over and above those of the properly designed gas management system which HMIP and the WDAs require to be installed on all sites, and

b) the optimum price be available for the energy produced from the LFG.

Once an effective gas collection and management system is installed and operating, the foundations for an exploitation system are laid. Accordingly it is anticipated that the progressive application of HMIP's advice on LFG will assist the development of economic schemes. There are however differences between the design of a gas extraction system for safety reasons and that for exploitation. This necessitates close cooperation between the regulatory bodies and the gas user from the outset if full advantage is to be taken of the potential gas.

Currently there are 24 sites which exploit LFG. 8 more are under construction and a further 18 are at the planning stage - a very low proportion of the 1400 sites mentioned earlier. This is partly explained by the difficulties of exploiting LFG on closed sites which are often small, and unlikely to be economic if they have to bear the full cost of abstraction and utilisation. Also, the amount of waste still capable of producing methane and therefore the site's potential yield cannot be estimated accurately. Lastly, planning authorities can be reluctant

'These factors serve as major disincentives to the exploitation of LFG'

to allow development on what may now be reclaimed open space, often near houses.

Nevertheless, there may be as many as 450 sites which have the potential for commercial exploitation. The LFG industry thus has considerable scope for expansion, but this will depend to a great extent on the price paid for the energy recovered. The most advantageous uses of LFG (direct combustion in kilns, boilers etc close to the site) have already been exploited, so the key to further growth will lie increasingly with electricity generation on site and sale to the Area Boards.

Operators make the point, however, that independent generators receive a lower price under the 1983 Energy Act than traditional power stations. They also pay much higher rates. These factors serve as major disincentives to the exploitation of LFG. Certain sites continue to flare large quantities of gas, since it is not yet commercially attractive to use it for electricity generation, and there is doubt whether the growth in electricity generation forecast in Figure 2 will actually materialise under current conditions.

The **rating** on electricity generation is currently under review and this anomaly should be removed from April 1990. Significant changes in **pricing** may result from provisions in the Electricity Bill. These specify an Obligation to purchase a minimum amount of power from renewable sources, at prices determined by competition. There is an expectation that such prices will be higher than at present, encouraging exploitation of LFG.

Some operators, however, remain sceptical. Since the larger LFG projects can each produce up to 20-30 Megawatts, their potential as a source of power is substantial. The size of the non-fossil Obligation reserved for renewable sources was recently announced as 600 Megawatts by the year 2000, with the initial tranche of 50 Megawatts available in 1992. Some fear that this may be too low to encourage both a diversity of non-fossil supply and effective utilisation of LFG.

A final option for gas use is connection to the gas mains, as is done at a number of sites in the USA and in Santiago. LFG, however, has a lower calorific value than mains gas. It is also wet and contains a number of contaminants. At present, it is too expensive to clean LFG to the standards required by British Gas, but development of cheaper methods of cleanup in the future could change this. Development work on cleaning LFG to provide a fuel for vehicles is also underway.

To conclude, LFG could be a significant national resource. LFG currently contributes the energy equivalent of 0.25 million tonnes per year of coal. With a more favourable climate for exploitation and with the anticipated application of higher standards of waste management, LFG has the potential to contribute the equivalent of 2 million tonnes of coal by the mid 1990's - enough to generate 400-500 Megawatts of electricity. According to the latest estimates, this could rise to 3-4 million tonnes equivalent if a way can be found to exploit all the gas which is technically recoverable.

## FURTHER INFORMATION

Additional details and background information are available from POST, 16, Great College Street, Westminster (222-7085).

The PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY has been set up by the Parliamentary and Scientific Committee to inform Parliamentarians on scientific and technological matters underpinning current issues.