

# Energy from Waste

BECAUSE THEY ARE REGENERATED THROUGH NATURAL CYCLES, ANIMAL MANURE, SEWAGE AND CERTAIN HOUSEHOLD AND COMMERCIAL WASTES SUCH AS SCRAP FOOD AND WASTE PAPER CAN BE REGARDED AS RENEWABLE RESOURCES. MOREOVER, BECAUSE THEY CONTAIN CARBON, THESE WASTE STREAMS CAN BE USED AS ALTERNATIVES TO FOSSIL FUELS FOR ENERGY PRODUCTION. THIS LEAFLET FOCUSES ON THE USE, FOR ENERGY PURPOSES, OF BIOGAS GENERATED FROM THE DECAY OF ORGANIC WASTE AT LANDFILL SITES AND IN PURPOSE-BUILT ANAEROBIC DIGESTION UNITS.

## Waste Treatment in Ireland

Until recently in Ireland, the recovery of energy from waste was limited to a handful of anaerobic digestion plants in the food, farm and sewage treatment sectors. From an environmental perspective, however, energy recovery - along with reuse and recycling - is increasingly being viewed as an important element in sustainable waste management strategies and, in the last couple of years, the Alternative Energy Requirement (AER) has provided an economic incentive to energy recovery.

Under the AER scheme, potential generators are invited to tender for contracts to sell electricity generated from alternative energy sources, including waste, to ESB. The first of these competitions saw the development of landfill gas recovery projects totalling almost 12 MW at four sites in Dublin and one in Cork, as well as the installation of a small anaerobic digestion unit at a farm in County Wexford. A contract has been awarded for the construction of a 30 MW waste-fuelled electricity generation plant in Dublin under a second competition, AER2, and there are targets to acquire a further 7 MW generating capacity from biomass/waste through a third competition, AER3.

## Municipal Solid Waste

Municipal solid waste (solid waste collected from households, commercial premises etc.) typically contains a range of materials, including paper/cardboard; fermentable waste such as scrap food, lawn cuttings etc.; and plastic, glass and metal. Of these, paper, food and lawn/garden wastes

can be regarded as renewable resources because they derive from products that are regenerated through natural cycles. On the other hand, glass and metal wastes are derived from finite resources, and thus are regarded as being non-renewable.

## Treatment

### ENERGY RECOVERY AT LANDFILL SITES

Currently, over 90 percent of the 1.4 million tonnes of municipal solid waste collected every year in Ireland is disposed of directly to landfill. Under the partially anaerobic conditions of a landfill site, bacteria cause the organic fraction of deposited waste to decay, producing a biogas. This gas has many properties similar to natural gas. It is made up of roughly one part carbon dioxide to two parts methane, with other compounds present in small quantities.

Locally, methane can cause asphyxiation of vegetation and represents a significant fire and explosion hazard, and, on a global level, it is one of the main greenhouse gases implicated in global warming. The emission of landfill gas can, however, be minimised through recovery systems and used as a valuable fuel.

Landfill gas technology is mature and well established. Essentially, the gas is taken from the landfill through a series of vertical wells, drilled into the body of the waste. The well heads are connected by pipework, and gas flow is

facilitated by the application of suction pressure to the wells. The collected gas can be burned in a spark ignition engine, which can range in size from a few hundred kW to several MW. At larger sites, dual fuel engines or gas turbines may be employed.

## Economics

The capital costs for landfill gas energy recovery systems, which include site development, construction, connection to the electricity network and decommissioning, are typically in the range of £750 to £1,250 per kW installed. Operating costs include labour and maintenance. The typical plant operating life is 15 years.

Rough estimates indicate that landfill sites would require a minimum operating capacity of 50,000 tonnes per annum to offer a practicable resource for energy conversion to electricity. Thus, the technology could be applied most economically in Ireland's cities and larger towns.

## Alternative Treatment Processes

It may be possible to maximise the efficiency of energy recovery and minimise environmental impact by incorporating source separation, recovery, recycling and other technologies into the municipal solid waste treatment process. Examples of possible options include

- Recovery and recycling of inorganic, nonrenewable material such as metal and glass.
- Anaerobic digestion of the wet waste 'fermentable' fraction alone or in combination with sewage sludge. This process yields a methane-rich biogas, which can be used as a fuel, and by-products, which can be used for soil compost and conditioning.
- Combustion of the 'bulky' including paper, cardboard and wood wastes. Heat can be recovered from this process to produce hot water and steam for local heating and electricity generation. Waste is reduced to a sterile inert ash, and the volume of material to be disposed of ultimately at landfill is minimised.

## Environmental Impact

The recovery of energy from waste is viewed as an important element in an environmentally sustainable waste management strategy. Landfill gas utilisation has a crucial role to play in greenhouse gas abatement also.

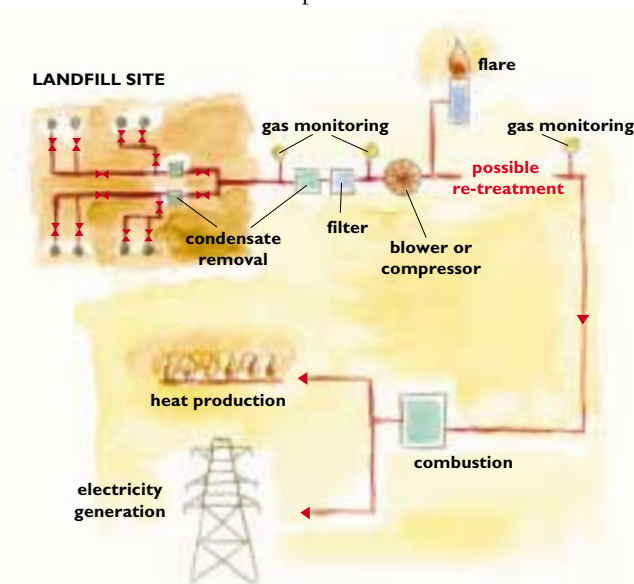
Carbon dioxide and methane - the major products generated when organic waste decays - are among the main greenhouse gases implicated in global climate change. Because methane is several times more potent than carbon dioxide in terms of global warming potential (GWP), it is particularly important that emissions of this gas are minimised.

When landfill gas is recovered and burned in a spark ignition engine/turbine, its methane content is largely converted to carbon dioxide and water; thus, its GWP is greatly reduced. Moreover, by generating useful energy, this process reduces the need to burn fossil fuels thus preserving these finite resources and avoiding further emissions of carbon dioxide and gases that can cause acid rain and air pollution.

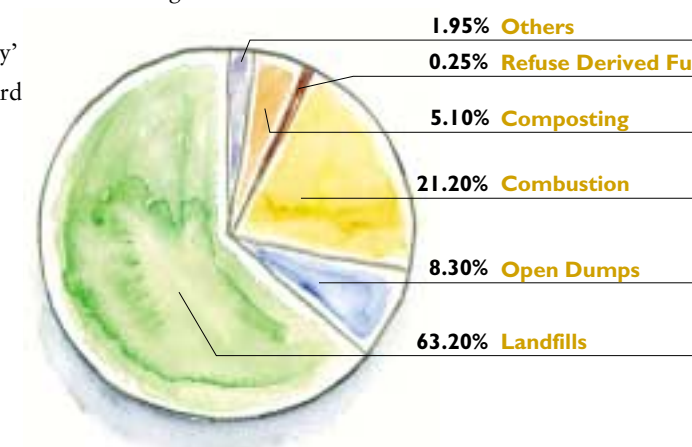
## Sewage Sludge and Agricultural Waste

### ANAEROBIC DIGESTION

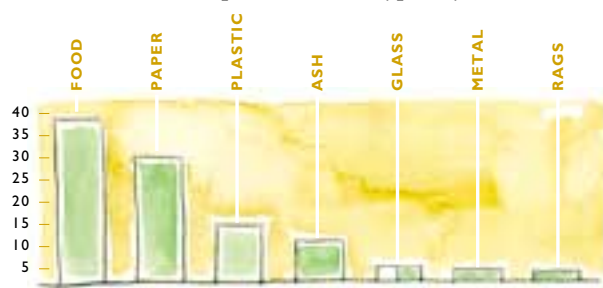
In the anaerobic digestion process, organic waste material is broken down by bacteria in special purpose-built reactors where oxygen/air is excluded, to produce a biogas that is similar to landfill gas. A conversion rate of up to 60 percent is achievable, and the remaining sludge from the process can be separated into a liquid fraction, which can be applied as a land fertiliser, and a solid component, which can be used either as a soil conditioner or further processed to produce a higher value organic compost. Material suitable for anaerobic digestion includes sewage sludge from sewerage treatment plants, sludges from food-based industries and agricultural slurries from pigs and cattle.



2 LANDFILL GAS EXTRACTION SYSTEM

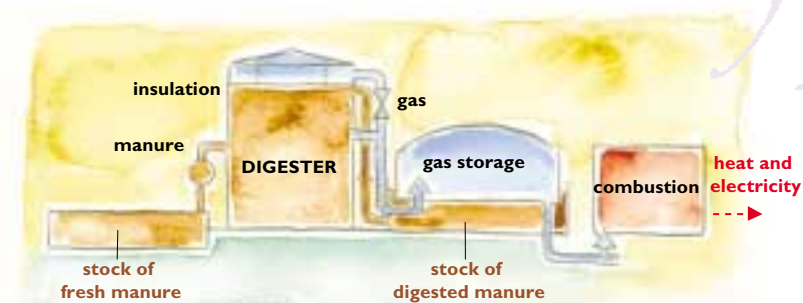


3 BREAKDOWN OF TREATMENT PROCESSES of Domestic Waste in the EU (Excluding Austria, Sweden and Finland)



1 MUNICIPAL SOLID WASTE IN IRELAND Typical Composition

# Energy from Waste



## 4 ANAEROBIC DIGESTION OF MANURE

### SEWAGE SLUDGE

Sewage sludge is a by-product of wastewater treatment. Only a handful of sewage sludge anaerobic digestion processes operate in Ireland at present - the majority of coastal towns and cities discharge effluents into rivers and the sea with little or no treatment, and while most inland towns do have sewage treatment systems, they generally produce untreated sludges.

A new EU directive regulating the treatment of sewage, however, will result in an almost fourfold increase in sludge quantities to an estimated 130,000 tonnes by 2013. A further directive limits the disposal of untreated sewage sludge to agriculture, and stipulates further treatment before the sludge can be disposed of in this way. Moreover, sewage sludge disposal at sea will no longer be possible from 1999.

In parallel with these regulations, the Department of the Environment has proposed that a number of hub towns could provide the location for central sludge treatment facilities, taking untreated sludge from surrounding wastewater treatment centres within that region.

### TREATMENT

The anaerobic digestion of sewage sludge is carried out in tanks that typically are heated to accelerate the digestion process over a period of 15-20 days. The biogas product can be used to fuel combined heat and power (CHP) schemes at the treatment works, where it is burned in modified engines or gas turbines to generate electricity, and the heat recovered from the engines is used to maintain the digestion tanks at the required operating temperature of about 35°C. At smaller sites, the gas may be burned directly to heat the digestion tanks, with any excess gas being flared.

### AGRICULTURAL WASTE

An estimated 31 million tonnes of agricultural waste are generated every year in Ireland. Of these, the wet wastes - cattle and pig manure - are generally suited to anaerobic digestion processes, but drier material such as chicken litter and spent mushroom compost can generally be treated more efficiently through combustion processes.

The anaerobic digestion technology used for animal manure is similar to that for sewage sludge. Farm digesters are commonly of the plug flow, buried cylindrical tank type, mixed by recirculating the collected biogas through the tank. The technology is well developed and a range of reactor sizes is available.

## Environmental Impact

Biogas projects provide environmental benefits similar to landfill gas projects in terms of decreasing global warming potential, preserving fossil fuels and reducing polluting emissions. An additional advantage is that the volume of the solids content in the waste stream is reduced - by as much as 30 to 50 percent, for example, in the case of sewage sludge. Moreover, offensive odour from landspreading is avoided - digested wastes have an earthy, humus-like smell.

Digested material also has an enriched nitrogen content and reduced disease-causing potential, making it more useful as a soil conditioner and fertiliser. In addition, the biochemical oxygen demand (BOD) of the waste stream is reduced - an important benefit in view of the serious effect an accidental spillage of stored slurries can have on aquatic life.

## Economics

The economics of biogas production depend on a number of factors including the capital cost of the digestion plant, the cost of existing waste treatment or handling systems and the proximity of suitable heat loads or access to the local distribution grid. The ultimate factor, though, that may determine the viability of the project is the size of the resource.

For sewage sludge digestion with conventional technology, a population in the region of 50,000 would be necessary to generate an economically viable resource; however, there is evidence to suggest that with advanced technology and processes, a population threshold as low as 10,000 to 20,000 may prove viable.

In terms of agricultural waste, on-farm digestion may be an attractive option with larger herds where animals are farmed intensively and housed indoors for a significant portion of the year. Where a number of smaller farms are located within a reasonable distance, a practical resource may be generated through the establishment of hub sites, to which wastes could be transported from an economic radius. There are several successful centralised digestion facilities currently operating in Denmark, and although there has been little interest in the concept here, it is possible that tougher environmental regulations could force producers to reassess this option.

## The Future

Environment and security of supply issues are likely to increasingly drive the development of alternative energy sources, including waste, well into the next century.

In terms of landfill gas, the Environmental Protection Agency, which is the licensing body for waste treatment facilities, now stipulates the installation of technology for methane recovery and energy production at all new landfill sites over a specified size.

In the area of sewage treatment, new EU directives will result in a dramatic increase in the quantities of sludge requiring treatment. In parallel with this, the proposed hub town concept will mean that, through economies of scale, anaerobic digestion will become a viable option at a number of sites.

With regard to agricultural waste, while at present there is little incentive - except on larger farms - to consider anaerobic digestion, a radical reassessment of disposal practices may be required in the light of changing public perceptions and increasingly tough legalisation.

### For Further Information

- ~ locations of waste energy projects around the country
- ~ advice on environmental and financing issues
- ~ and a list of useful contacts

is available from the Irish Energy Centre, Renewable Energy Information Office.



## ENERGY FROM WASTE



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