# Municipal Solid Waste Incineration as part of Ireland's Integrated Waste Management Strategy

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## 1. Introduction

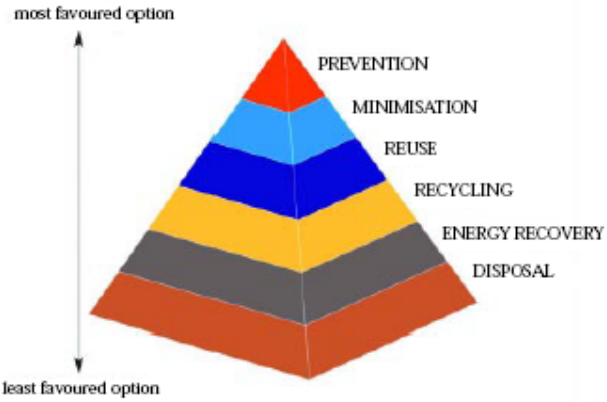
Within Ireland's national waste management strategy, prevention, minimisation, reuse and recycling are the most favoured choices in the hierarchy of waste management options. More emotive issues, but still clearly stated waste management options, are incineration with energy recovery and landfill. Ireland is unique among EU member states in that almost 80% of household and commercial waste goes to landfill. Traditionally large-scale incineration of municipal waste has not been undertaken in Ireland. However, the majority of local and regional waste management plans have included incineration with energy recovery as an integral component of their future waste management strategies. The purpose of this paper is to outline Ireland's integrated waste management strategy for municipal solid waste and consider the issues related to incineration within the context of that strategy.

## 2. National and EU Waste Policy

Much of the framework for Irish waste management policy is based on EU legislation. For instance, Directive 75/442/EEC on waste established the principles of proximity and self-sufficiency in waste management. In 2002 the EU's Sixth Environment Action Plan reiterated the point that waste should be handled as closely as possible to the place of its generation.[1] The Action Plan's key objectives with respect to waste include achieving significant reduction in waste generation through waste prevention initiatives; achieving significant reduction in waste going to disposal; and encouraging re-use.

Similar policies and priorities are defined in national waste management policy. The government's waste management strategy was most recently stated in *Waste Management - Taking Stock and Moving Forward* (2004), which sets targets for increased prevention and minimisation, encourages reuse and gives preference to recovery and especially recycling. The document also addresses policy with respect to incineration with energy recovery and achieving minimum levels of landfill disposal.

**Figure 1. EU Integrated Waste Management Hierarchy**




Government initiatives to minimise residual waste include the recently launched National Waste Prevention Programme, which will attempt to reduce material use and

[1] Decision No. 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Plan.

break the link between economic growth and waste generation.[2] A Market Development Programme for recyclable materials has been finalised and a Recycling Consultative Forum will be established before the end of 2004. A National Biodegradable Waste Strategy, to be published by mid June 2004, will set out measures to achieve the requirements of the Landfill Directive (1999/31/EC), including that biodegradable waste going to landfill be reduced to 75% of 1995 levels by 2006, to 50% by 2009, and to 35% by 2016.[3] Since 1998 collection of dry recyclables has been extended from 70,000 to 564,000 households, while 52,000 households now have segregated collection of organic waste. The number of Bring Banks for recyclables has also increased from 837 to over 1700 in 2004.

Despite the positive results achieved in recovery and recycling, efforts to minimise, prevent, re-use and recycle waste streams have not precluded the need for disposal options. Municipal waste generation increased by 47% between 1995 and 2002. The government's commitment to waste management policy also encompasses the need to address the residual wastes remaining after prevention, minimisation, reuse and recycling, including examination of a more efficient means of meeting the demands of waste management and external pressures that are mentioned below.

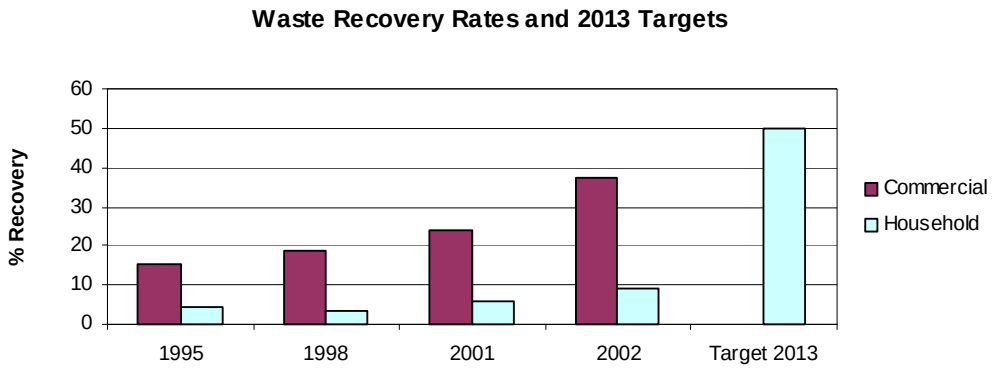
In the area of waste incineration the Waste Incineration Directive (2000/76/EC) has been transposed into Irish law.[4] This has introduced new stringent operating conditions and has set minimum technical requirements for waste incineration. The main aim of the Directive is to prevent and limit negative environmental effects of emissions into air, soil, surface and ground water, and reduce the risks to human health.

### 3. Municipal Solid Waste Generation, Recovery and Disposal[5]

In 2002 some 2.7 million tonnes of municipal waste were generated in Ireland compared to 1.8 million tonnes in 1995. Municipal waste, which includes household, commercial and street cleaning waste accounted for 16% of all non-agricultural waste. Household wastes account for some 1.5 million tonnes, which is equivalent to 1.15 tonnes per household or 375kg per person. The annual growth rate of household waste was 6% in the four years to 2002. A key target of waste management policy is to reverse the recent high growth in municipal solid waste and decouple waste generation from economic growth.

Just 9.3% of household waste and 37.5% of commercial waste was recovered in 2002 with the balance disposed of in landfills. Recovery rates have improved since 1995 but there is considerable progress to be achieved to reach Government waste management targets. In 2002 approximately 79.3% of municipal waste (90.7% for household and 62.5% for commercial waste) was landfilled.

[2] www.epa.ie/waste/NWPP
[3] Irish targets under the directive are that biodegradable waste disposed in landfill fall from 1.12 million tonnes in 1995 to 393,541 tonnes by 2016.
[4] Implemented by the European Communities (Incineration of Waste) Regulations 2003, S.I. 275.
[5] The statistics in this section are drawn from the National Waste Database Reports.




## 4. Waste Targets

High rates of disposal to landfill are unsustainable and at odds with EU policy and practice. *Waste Management – Taking Stock and Moving Forward* outlines policy targets to be achieved by 2013, which will help reverse our current unsustainable reliance on landfill as a waste management option. National targets include:

- Diversion of 50% of household waste from landfill
- Minimum 65% reduction in biodegradable waste consigned to landfill
- Recycling of 35% of municipal waste

Other initiatives to reduce waste generation, reduce packaging waste and increase recycling and reuse will also help reduce our reliance on landfill.

## 5. Disposal Options

At present levels of waste generation and recovery the prospect of a 'Zero Waste Ireland' is still some distance away. Zero Waste itself is discussed below but faced with the current practicalities of waste management in Ireland we require the capacity to manage residual wastes post minimisation, recycling and reuse. There are two primary disposal options available; landfill and incineration with energy recovery.[6] This paper addresses the latter option.

A detailed discussion of the incineration process follows later in the paper including issues surrounding the health and environmental risks posed by incineration. The next section looks at an alternative strategy to reliance on landfill and incineration disposal options.

## 6. Zero Waste

The premise of Zero Waste is that everything we buy is made from materials that can be repaired, reused or recycled. Given current production and consumption practices Zero Waste is not a feasible policy at present in most societies, however, considerable effort is already underway to achieve the Zero Waste target, especially so for household waste in some parts of the world. For example, Bath and North East Somerset Council was the first UK local authority to adopt Zero Waste as part of their waste management strategy. Milton Keynes has also adopted a Zero Waste vision in

[6] Incineration with energy recovery is categorised in some instances as recovery and in other cases as disposal.

their waste strategy. Internationally, New Zealand is the first country to set a national target of being Zero Waste by 2020. The definition of Zero Waste varies but generally it is a target to focus efforts towards more sustainable waste management practices. Generally, the target of zero is not absolute as no system is 100% efficient.

Achieving existing national policies of increased recycling and reuse of wastes is a necessary precursor to Zero Waste. Besides being more sustainable Zero Waste has economic benefits. Recycling and recovery activities are job rich compared to landfill and incineration, though many of these jobs have low skill requirements. At present over 150 companies are involved in the recycling business in Ireland and employ several hundred people.[7] Increased recycling would further increase employment levels in the sector.

## 7. Thermal Treatment/Incineration[8]

Thermal treatment is a broad term used to describe a range of heating or combustion technologies. Incineration involves the controlled burning of wastes at high temperatures for a sustained period. There are two types of resultant ash from incineration. Bottom ash comes from the furnace and is mixed with slag, while fly ash comes from the stack and contains more hazardous components.

In municipal waste incinerators, bottom ash is approximately 10% by volume and approximately 20 to 35% by weight of the solid waste input. Fly ash quantities are much lower, generally only a few percent of input. The proportions of solid residue vary greatly according to the waste type and detailed process design.

Emissions from incinerators can include heavy metals and dioxins, which may be present in the waste gases, water or ash. The EPA currently has licensed incineration activities on 7 industrial sites where liquid and solid hazardous wastes are handled. Emission limit values are set in the licences in accordance with legislation and international guidance to ensure that emissions do not result in any environmental pollution. Continuous monitoring of process parameters and emissions and sampling of emissions for heavy metals and dioxins are carried out to ensure the effective operation of the plants.

The following table notes the numbers and capacities of municipal waste incinerators in other EU member states. It is evident that countries have varied their strategies concerning capacity and number of incinerators. The majority of countries incinerate roughly one-third or less of their municipal solid waste and therefore incineration forms only part of an integrated waste management strategy.

[7] Recycling Directory of Ireland - www.irelandrecycling.ie

[8] Statistics in this section relating to incineration technology are taken from "Working Paper on the Assessment of Environmental Pressures and Potential Environmental Impacts from Waste Management," 2004, Prepared by European Topic Centre on Waste and Material Flows for the European Environment Agency.

**Table 1: Municipal Solid Waste (MSW) management and MSW incineration plants in EU Member States[9]**

| Country | MSW generated $10^6$ tonnes | Year of data | % landfilled | % incinerated | Number of MSW incinerators | Average MSW incinerator capacity k tonnes/year |
|---|---|---|---|---|---|---|
| Austria | 1.32 | 1999 | 51 | 35 | 3 | 178 |
| Belgium | 4.85 | 1997 | 42 | 35 | 17 | 141 |
| Denmark | 2.77 | 1996 | 15 | 56 | 32 | 114 |
| Finland | 0.98 | 1997 | 77 | 2 | 1 | |
| France | 48.5 | 2000 | 55 | 26 | 210 | 132 |
| Germany | 45 | 2000 | 30 | 29 | 59 | 257 |
| Greece | 3.2 | 1993 | 93 | 0 | 0 | |
| Italy | 25.4 | 1995 | 85 | 8 | 32 | 91 |
| Luxembourg | 0.3 | 1995 | 24 | 48 | 1 | |
| Portugal | 3.48 | 1999 | 65 | 25 | 3 | 390 |
| Spain | 17 | 1997 | 85 | 10 | 9 | 166 |
| Sweden | 3.8 | 1999 | 24 | 38 | 30 | 136 |
| Netherlands | 7.95 | 1997 | 20 | 62 | 11 | 488 |
| UK | 27.2 | 1999 | 85 | 6 | 17 | 246 |

## 8. Types of Municipal Waste Incinerators

Municipal solid waste can be incinerated in several combustion systems. The most common and commercially viable are grate and fluidised bed systems. Grate systems involve a system of moving grates to facilitate the movement of the waste through the combustion zone, which allows the provision of adequate supplies of air to guarantee complete combustion of the waste. Fluidised bed technology requires waste to be within a certain particle size range, which usually requires some degree of pre-treatment and/or the selective collection of the waste. With fluidised bed combustion, a bed of sand is placed in the combustion chamber and brought to its operating temperature before waste is added. It is then fluidised by supplying combustion air. Such a system has a 50% higher power demand than the moving grate.

Municipal waste can alternatively be processed into a fuel product for co-incineration with other fuels in cement kilns or power generation plants. Incineration of waste within such plants must also comply with requirements of the Directive (2000/76/EC) on the incineration of waste.

Other thermal treatment technologies are also feasible. Pyrolysis technology is extensively used in the petrochemical industry and can be applied to municipal waste treatment where organic waste is transformed into combustible gas and residues. Gasification is another alternative somewhat similar to pyrolysis except quantities of air or oxygen are admitted to the reactor. Gasification normally operates at a higher temperature than pyrolysis. While both pyrolysis and gasification are feasible

[9] Draft Reference Document on the Best Available Techniques for Waste Incineration, March 2004, European Integrated Pollution Prevention and Control Bureau.

technologies to handle municipal waste, commercial applications of either technology have been limited.

## 9. Human Health and Incineration

Research studies of possible health outcomes in populations living close to incinerators have not given clear indications of the presence or absence of an effect. Although many studies have produced evidence of association between a health outcome and an environmental pollutant, they cannot, by themselves, demonstrate a cause and effect relationship. The studies examining possible health effects are frequently retrospective and employ routinely collected data such as cancer registrations, birth and death records which do not allow conclusive interpretations. The Health Research Board's 2003 review of the international literature draws similar conclusions, finding that there is some evidence that incinerator emissions may be associated with health effects (e.g. respiratory morbidity, respiratory symptoms, reproductive effects, cancers) but concluded that results conflict and are inconclusive.[10]

The most recent UK review of research on health impacts associated with incineration[11] "looked in detail at studies of incineration facilities, and found no consistent or convincing evidence of a link between cancer and incineration." In addition the UK review concluded that there is little evidence that emissions from incinerators make respiratory problems worse and that in most cases incineration contributes only a small proportion to local levels of pollutants.

The majority of the studies refer to incineration facilities whose emission profile is significantly different from today's modern incinerators as most of the studies are associated with incinerators in operation between the 1960s and 1990s, most of which have since closed or have been upgraded to meet the requirements of the new EU Directive on the incineration of waste.

## 10. Dioxins

Dioxin is a generic name used to describe a family of 75 polychlorinated dibenzo-p-dioxins (PCDDs) and a family of 135 similarly structured compounds of polychlorinated dibenzofurans (PCDFs), of which 17 are of toxicological concern. At elevated levels dioxins are associated with developmental and reproductive effects and are a probable human carcinogen. The World Health Organization (WHO) has concluded that the carcinogenic effect of dioxins does not occur at levels below a certain threshold.[12] Significantly, dioxin levels in Ireland remain below this threshold.

Dioxins and furans are unintentional by-products of combustion processes and are generated from a wide range of activities (e.g. domestic cooking, burning coal, fires, etc.) to such an extent that dioxins emitted to the air from UK municipal waste

[10] Health and Environmental Effects of Landfilling and Incineration of Waste – A Literature Review, Health Research Board, Dublin. 2003.
[11] Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes, Department for Environment, Food and Rural Affairs, London, 2004.
[12] Solid Wastes - Waste Incineration, 1996, World Health Organisation Regional Office for Europe.

management, which includes 12 municipal waste incinerators, accounts for less than 1% of the dioxins experienced by members of the UK public.[13]

If all the municipal waste incineration capacity proposed in the local and regional waste management plans were in operation in Ireland by 2010, their contribution to the dioxin load to the atmosphere would amount to roughly 2% of the total load, which is considerably lower than the predicted 84% load associated with uncontrolled and backyard burning.[14] Consequently, the health and environmental risks associated with dioxin emissions from uncontrolled and backyard burning of wastes would greatly exceed the risk associated with emissions from incinerators.

Dioxins are highly resistant to degradation processes and may be taken up in the food chain, e.g. by ruminants and by fish, where they can accumulate in fatty tissues. As humans are the ultimate receivers in the food chain, there is a possibility that dioxins may accumulate in human tissues as a result of exposure via food.

Independent analysis undertaken on behalf of the EPA shows that dioxin levels in Ireland including at locations in the vicinity of incinerators are among the lowest measured in Europe.[15] The Food and Safety Authority of Ireland[16] (FSAI) has monitored cows' milk in the Cork harbour region since 1991 finding a marked reduction in dioxin levels in the period 1991-94, coinciding with the introduction of the EPA's Integrated Pollution Control licensing system, and since then finding comparably low dioxin levels compared to other EU countries. The FSAI has also concluded that exposure to dioxins from the consumption of Irish farmed and wild fish is well below the established safe limit, and that levels of dioxins in human breast milk are low when compared to levels in other EU countries. In its March 2004 Report into dioxin levels in eggs for human consumption the FSAI concluded that the level of dioxin like PCBs does not present a risk to the health of the Irish population.[17]

The aforementioned EU Directive 2000/76/EC on the incineration of waste directs that incinerators be operated in such a manner so as to minimise the conditions under which dioxins can be formed and sets legally binding monitoring and limit values for emissions. The implementation of the directive is expected to result in a 99% reduction, relative to the 1993-1995 period, in emissions of dioxins from waste thermal treatment across the EU.

**11. Incineration Residues**

The incineration process produces significant volumes of solid residues. The amount of residue depends on incinerator technology, pollution control technology and composition of waste incinerated. The average bottom/fly ash and pollution control

[13] [13] Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes, Department for Environment, Food and Rural Affairs, London, 2004.
[14] Marnane, I. and F. Hayes, Inventory of Dioxin and Furan Emissions to Air, Land and Water in Ireland for 2000 and 2010, EPA ERTDI Research Report No. 3
[15] Dioxin Levels in the Irish Environment - Second Assessment (Summer 2000) Based on Levels in Cows' Milk, EPA
[16] Report on waste incineration and possible contamination of the food supply with dioxins, Food Safety Authority of Ireland, Dublin, 2003.
[17] Investigation into levels of Dioxins, Furans, PCBs and come elements in Battery, Free-Range, Barn and Organic Eggs, 2004, Food Safety Authority of Ireland.

residues for 12 municipal waste incinerators in Belgium was 25.1% by weight.[18] Bottom ash is generally non-hazardous. However, fly ash is hazardous and air pollution control residues may also be hazardous. Storage or further processing of these post-incineration residues is a considerable problem for waste management. It is possible that the solid residues can be recovered or reused. For instance, valuable metals such as cadmium, mercury, lead, and zinc can be recovered and bottom ash could be a viable construction in-fill material. Generally incineration residues are landfilled.

The composition of incinerated municipal waste has important implications for both the economics of incineration and also the disposal of residual wastes. For instance, pre-processing to remove hazardous wastes can lead to lower heavy metals loads, and therefore, lower toxicity in solid residues, whereas removal of organic wastes, glass and metals increases the calorific value of wastes incinerated and therefore improves the efficiency of the plant.

**12. Heavy Metals**

Municipal solid wastes typically contain many metals, including metals such as copper, zinc, and molybdenum, which are essential at low concentrations for normal growth and development in either plants or animals, but become toxic at high concentrations. Municipal waste also contains heavy metals, such as mercury, chromium, cadmium, and lead, as well as arsenic and selenium. These metals can damage living things and have a tendency to accumulate in the food chain. The waste incineration Directive specifies air emission limit values of all potentially polluting metals.

**13. Economics of Incineration**

Traditionally landfill was the cheapest waste management option in Ireland due to the availability of low cost landfill sites.[19] With the advent of waste licensing and more stringent environment controls on landfill construction and operation, landfill costs have increased considerably. Increased landfill costs have indirectly supported other waste management options, e.g. recycling, providing an economic incentive to divert waste from landfill to cheaper alternatives. For the same reasons incineration in Ireland is now becoming a commercially viable waste management option, though it has been so in Europe for decades. High reliance on landfill will necessitate the continual need to develop land for landfill purposes, land that has only limited use after landfill closure. Among the economic advantages of incineration with energy recovery are that, unlike landfill, there are generally no recurring land acquisition costs and more energy is recovered.

Waste incineration investments presume a steady fixed stream of waste to ensure financial viability, which in turn leads to suspicions that improvements in recycling and reuse would eventually be overturned by the need to feed waste to incinerators. International experience suggests that a high rate of recycling is not incompatible with incineration of municipal waste. Between 1990 and 2000, Switzerland increased municipal recycling from 26% to 46%. At the same time, the incineration of municipal waste decreased from 57% to 48%, while the percentage that went to

[18] Draft Reference Document on the Best Available Techniques for Waste Incineration, March 2004, European Integrated Pollution Prevention and Control Bureau.
[19] Barrett, Alan and John Lawlor, 1995, The Economics of Solid Waste Management in Ireland.

landfill decreased from 15% to 7%. In Sweden municipal waste recycling rose from 19% in 1994 to 39% in 2000 while incineration over these six years decreased slightly from 41% to 39%. The Netherlands incinerates roughly 38% of its municipal waste yet has relatively high rates of recycling of municipal waste at approximately 25%.[20, 21]

From a policy perspective the growing momentum of national and EU legislative commitments and policy targets relating to improved recycling, reuse, and sustainable waste management generally will continue to exist regardless of the availability of waste incineration capacity in Ireland. The government's commitment to waste prevention, increased recycling and re-use is clearly reflected in policy and is independent of waste incineration capacity.

From an economic perspective incineration is not a cheap alternative due to its high capital and operating costs. Therefore, recycling will continue to be a favoured option. In the event that recyclables are diverted to incineration a financial penalty could be levied, similar to the landfill levy, to maintain financial incentives to recycle wastes.

**14. The EPA's licensing role**

The EPA is not involved in the physical planning process; that is the function of planning authorities. The EPA operates a licensing system in line with all relevant national and EU legislation. Under the EPA's mandate it must ensure that all standards are complied with and that any decision to grant a licence is based on the merits of a licence application covering issues such as operation and use of best available techniques. The EPA attaches conditions to licences it grants to ensure both that facilities are properly managed and that risk of pollution is minimised. A licence to incinerate waste, if granted, would be conditional on appropriate abatement and monitoring of all relevant parameters so as to demonstrate and ensure the safe ongoing operation of the incinerator consistent with environmental protection.

**15. Summary**

The purpose of this paper has been to look at incineration with energy recovery in the context of Ireland's integrated waste management strategy. Prevention, minimisation, reuse and recycling continue to be the most favoured options in the waste hierarchy but despite successful efforts to implement these, waste volumes requiring disposal are increasing. The paper comments on trends in waste disposal and studies disposal in the context of landfill and incineration with energy recovery. It gives a synopsis of the incineration process and comments on research pertaining to possible health effects from this method of disposal.

October 2004

[20] Waste Generated and Treated in Europe – Data 1990-2001, 2003, Office for Official Publications of the European Communities.

[21] Greenalliance, *Creative policy packages for waste: Lessons for the UK*, October 2002.