

Incineration as a Sustainable Municipal Waste Management Option for Dublin

by

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This project is submitted in part fulfilment of the Institute of Technology, Sligo
requirements for the award of MSc. Environmental Protection.

June 2008

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Abstract:

The management of Dublin's municipal waste is currently undergoing a period of transformation, as landfill is no longer the cheap and acceptable option that it has been for many years. Changing our Ways, DoELG (1998) recognised that one of the key priorities for Ireland's waste management regime was to reduce its reliance on landfill as it "limited the development of integrated waste management approaches (and) inhibited waste recovery and recycling options". Since 2001, Ireland's performance in waste management has improved, with recycling levels tripled and a recycling waste collection service in operation during that period.

However, landfill is still the only method of disposal of municipal waste utilised in Dublin and Ireland with this resulting in a chronic strain on the landfills accepting waste. Landfill is at the bottom of the waste management hierarchy, and this should be reflected in how Dublin's waste is managed. The scope of this dissertation is to focus on the management of municipal waste in the Dublin region, and to determine whether the introduction of incineration as a management tool will be sustainable and beneficial to the region.

The management of waste is a key factor in sustainable development. Sustainable waste management has many impacts and these need to be considered in terms of the role incineration can play in the Dublin region.

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Introduction:

Dublin, the capital of Ireland, covers an area of 92,227 ha (1.3% of the state) and despite its relatively small size, is home to 28% of the state's population, 1,187,176 people, CSO, (2007). Dublin has over 420,000 households each averaging a weekly waste generation of 24kg. This amounts to 1.2 millions tonnes of municipal waste requiring disposal every year. Currently, Dublin relies on landfill as the sole method for disposal of waste and this monopoly cannot be sustained. This is driven by Irish & EU legislation and increased public awareness, Rudden, P.J., (2006).

The Landfill Directive, 1999/31/EC, was transposed into Irish law on the 2nd of July 2002 with the adoption of the Waste Management Licensing (Amendment) Regulations 2002 and European Communities (Amendment of Waste Management (Licensing) Regulations 2000) Regulations 2002. The aim of this legislation is to improve standards of landfilling across Europe by setting specific requirements for the management of landfills, and also for the types of waste that can be accepted in landfills.

The Dublin Regional Waste Management Plan 2005-2010 recognised the need to make the best use of residual municipal waste (waste that has the recyclable fraction removed) by extracting thermal energy. The plan proposed to treat 25% of Dublin's waste by incineration with energy recovery.

Incineration is a costly process that must operate for quite a number of years in order to recoup its high initial cost and operational costs. Sustainability of an incinerator in Dublin may seem to be in direct conflict with the waste hierarchy that is an integral part of the Waste Management Plan. Wastes destroyed in an incinerator will be replaced and this will involve using new raw materials, manufacturing and transport etc. In contrast to this option, reduction, reuse and recycling may represent a more successful choice as waste is diverted from disposal.

The EU Directive 2001/77/EC 'Renewable energy: the promotion of electricity from renewable energy sources' recognises the role of incineration in sustainable waste management and the significant contribution it can make to the provision of renewable energy by recovering energy from waste where such a process does not undermine the waste management hierarchy.


The purpose of this study is to investigate the waste generation trends of Dublin and whether these waste streams can sustain an incinerator in Dublin for the forthcoming future. Incineration requires high calorific waste to function at optimum levels but high-energy wastes are also those being targeted for increased levels of recycling, Petts, J., (1994). Research in Europe has shown that a high level of incineration can exist in conjunction with increased levels of recycling but it needs to be determined whether the same statistics can be reproduced by Dublin.

SECTION 1 LITERATURE SURVEY

1.1 Waste Management in Dublin and Ireland

Incineration as a plausible municipal waste management option has been gaining momentum in Ireland over the last 10 years. Since Ireland's first waste policy document in 1998, *Waste Management - Changing Our Ways*, one of the major priorities and focus for waste management has been to reduce Ireland's reliance on landfill

The national recovery rate for household and commercial waste in 1998 was 9% (166,684 tonnes) with 91% (1,685,766) consigned to landfill, DoELG, (1998). This document recognised that "there is an urgent need, in line with Government policy and the new framework of the Waste Management Act, 1996, to modernise waste management practice and secure the provision of environmentally efficient infrastructure". Landfill is the least favoured option for managing waste according to the waste hierarchy as it has the greatest environmental impacts and generates no recovery of materials from the waste. Landfill will continue to have a role in future waste disposal in Ireland but this role must be of a lesser importance so that landfill becomes a subsidiary element of an integrated waste infrastructure. This role will be to cater for the disposal of residual waste which cannot be prevented or otherwise treated, and where the primary focus is on methods higher in the waste hierarchy, namely prevention, recycling and recovery. Recovery of waste involves the use of incineration where energy can be recovered from waste and used to provide electrical energy for households and also the option of providing heat energy for households in the vicinity of the incineration plant. The waste



licensing system, brought into legislation through the Waste Management Act 1996, meant that all landfills must be licensed by the EPA and that tighter regulations will control the use of landfills. Up to the period of 1996, many landfills were unregulated and their usage was undesirable. This 1996 Act also recognised the necessity to introduce the “polluter pays” principle whereby producers of waste must fund the treatment of the waste and thereby have a greater responsibility of their waste generation. Receiving no capital from the public in order to deal with their waste generation was unsustainable as local authorities were often left with a shortfall as landfill gate fees were not equal to the capital required to fund waste disposal and landfill management.

In 1998 the figures for recycling of waste were very low, 9%, and it was recognised that this situation must change dramatically with more emphasis to be put on diverting waste to alternative recycling, recovery or treatment options. Incineration was now being viewed as a possible option for providing an alternative to landfill with the added benefits of energy recovery. No single solution can address the waste crisis that is being faced by Ireland so a sustainable integrated approach is the only working solution, DoELG, (1998).

1.2 Impacts on Recycling

Waste to Energy plants, coupled with materials recycling, has been part of an integrated approach to waste management in Europe for many years. In general, materials recycling and WtE (Waste to Energy) incineration are fully compatible in an integrated approach to waste management once there is full support from the public and waste collectors. While landfill disposal of residues will always be required, mass burn WtE is effective in diverting over 70% of municipal waste away from landfill and has a considerably lower environmental impact than landfill if properly regulated and monitored. Recovery of energy is lower down in the waste hierarchy than reuse and recycling, but where the “recycling sector cannot reasonably be expected to cater for the volumes of waste diverted from landfill in accordance with EU or national targets, WTE could prove to be a beneficial option” DoELG, (1998). It is of great importance however to ensure that the use of a WtE plant would not have a negative impact on recycling levels and be seen as the “easier” option of dealing with all municipal waste.

Generally, evidence suggests that the volumes available for incineration can decrease significantly as recycling policies are implemented in the community. Waste streams with high calorific values also include those waste streams that are targeted for recycling such as plastics and paper wastes. In the Dublin Region there are now 9 recycling centres in operation, which accept a wide range of both non-hazardous and hazardous household items. In addition there are 11 community bring centres which are similar to recycling centres but serve a smaller community and accept fewer waste types, Dublin


Local Authorities, (2008)¹. Recycling centres accept everything from glass, cans, paper, plastics, and textiles to fridges, mobile phones and batteries and for the most part materials are accepted free of charge, Dublin Local Authorities, (2008)¹. There is increased awareness of their value as a recyclable commodity in the public domain. Countries that have more experience in recycling policies, such as The Netherlands and USA for example, have shown that high recycling rates can successfully co-exist with high waste to energy incineration rates as part of an integrated waste management policy, Petts, J. (1994). A survey of waste management options in the USA indicated that those communities served by an incineration facility had general recycling rates higher than the national average. A concern regarding the proposed incineration plant in Poolbeg, Dublin is that recycling rates may be affected, Gormley, J., (2006), but going from experience in other experienced countries, this should not be the case with proper support and involvement from the government and local authorities.

1.3 Legislation, Regulation and Directives

The replacement Waste Management Plan 2005-2010 aims towards achieving the following targets 16% landfill, 25% thermal treatment and 59% recycling. The proposed thermal treatment plant in Dublin's Poolbeg peninsula will be developed in a Public Private Partnership between the Dublin City Council (acting on behalf of the four local authorities in Dublin) and Elsam, a Danish company. An Bord Pleanála has approved a 600,000 tonne per annum waste capacity as applied for by the council despite the recommendation of their inspector, Pádraic Thornton to cap the amount of waste the facility could burn at 500,000 tonnes per year, Thornton, P., (2007).

The Landfill Directive (1999/31/EC), which was adopted by the European Union on July 16th 1999, is a major driving force behind the targets stated in the Waste Management Plan. The Landfill Directive was transposed into Irish law on the 2nd of July 2002 with the adoption of the Waste Management Licensing (Amendment) Regulations 2002 and European Communities (Amendment of Waste Management (Licensing) Regulations 2000) Regulations 2002. The aim of this directive is to improve standards of landfilling across Europe, through setting specific requirements for the design, operation and aftercare of landfills, for the types of waste that can be accepted in landfills and for the volumes of waste that can be sent for landfill.

The Directive also sets targets for the reduction of the amount of biodegradable municipal waste sent to landfill to 75% by 2006, 50% by 2009, and 35% by 2016, of the total levels



of biodegradable waste produced in 1995. Ireland, because of its heavy dependence on landfill, has been given a four-year derogation. This means our first target will have to be reached by 2010. Specific national targets are defined by reference to 1995; meaning land filling of biodegradable municipal waste would need to fall from 1.12 million tonnes in 1995 to 393,541 tonnes by 2016. Given that overall municipal waste generation, including biodegradable municipal waste, has increased substantially since the benchmark figure in 1995, the actual tonnages of biodegradable municipal waste that will need to be diverted over the period to 2016 represents a huge challenge to the Irish waste industry. This will require urgent, concerted and sustained efforts all round to meet the Directive's targets and is not a target that can be achieved easily.

It is doubtful that municipal waste generation in Ireland will decrease dramatically; in fact, the Waste Management Plan 2005-2010 targeted an increase in household waste generation from 1.21 million tonnes per annum in 2003 to 1.25 million tonnes per annum from 2006, with this level remaining constant from this period onwards. This figure was shown to be an inaccurate forecast of waste generation in Dublin; the amount of waste generated per household has decreased from 1.21 tonnes per annum (2003) to 1.12 tonnes per household (2006), RPS, (2008). However, despite the fall in waste generated per household, the number of households in Dublin is increasing rapidly resulting in an overall increase in total municipal waste generated.

1.4 Municipal Waste Treatment

According to the waste hierarchy pyramid, energy recovery (incineration) lies second from the bottom of waste management options, favourable only to landfill. Recycling, as an option, is more preferable than incineration or landfill but recycling cannot deal with putrescible wastes or residual wastes. Residual waste is often described as “black bin” waste that remains after waste prevention, reuse and recycling. Although residual waste usually has little mineral value, it still has an energy value that can be recovered in waste-to-energy plants. Waste to Energy plants are used in the majority of European Member states for the treatment of residual waste, only Ireland and Greece from the original 15 EU states do not currently utilise waste to energy as a waste management technique, CEWAP Ireland, (2007)¹. Waste to Energy plants will also comply with the proximity principle, defined by the European Environment Agency as “the principle of proximity implies that waste should generally be managed as near as possible to its place of production, mainly because transporting waste has a significant environmental impact”.

When comparing the sustainability of waste to energy plants against landfill and mechanical biological treatments, waste to energy plants are a far more effective and sustainable solution; waste-to-energy both avoids the production of methane and more efficiently recovers energy from waste than landfill gas flaring or Mechanical Biological Treatment (MBT), CEWAP Ireland, (2007)². Much of this energy is renewable, coming from the biodegradable fraction of waste, which makes up 70% of residual waste in Ireland. Metals and other materials can also be recovered in waste-to-energy plants for

recycling CEWAP Ireland, (2007)². The Intergovernmental Panel for Climate Change (IPCC) report, Climate Change 2007: Mitigation on Climate Change, found waste-to-energy to be a more energy efficient waste treatment method than landfill, composting, mechanical biological treatment (MBT) or anaerobic digestion. Waste-to-energy can therefore support Irish energy policy in meeting energy efficiency and renewable energy targets, CEWAP Ireland, (2007)².

Dublin is currently relying on 3 landfills for the disposal of its waste – Arthurstown in Kill Co, Kildare, Balleally, Fingal, Co. Dublin and the KTK private landfill in Co. Kildare. As these landfills are all nearing closure, waste to energy will have to play a part in the future of Dublin’s waste management scheme. Landfill does have a role to play in Dublin’s waste management system but its dependency must be decreased. As outlined in Changing our Ways, (1998) a heavy reliance on landfill has the ability to inhibit recycling and the implementation of an integrated waste management system, one in which incineration can play an important role. In 2006, the landfill gate fees in Ireland were averaging at €120 landfill gate fee per tonne coupled with a €15 landfill gate tax, Forfás, (2006). The Waste Management Plan assumes that gate fees for the proposed incinerator in Poolbeg will be in the region of €90-€110 per tonne of waste accepted.

1.5 Incineration in Europe

Flanders in Belgium has used incineration as a waste treatment system for many years, significantly decreasing their dependence on landfill. Flanders process the bulk of their waste using waste to energy (WTE) and recycling treatment options, Forfás, (2006). To compare Flanders against Dublin County, Dublin has a higher population density with 4,304 persons/km², CSO, (2007), as opposed to Flanders with 441 persons/km² but a smaller area; 921 km² compared to 13,599 km² in Flanders. In 2005, Ireland produced 717kg municipal waste per capita whilst Flanders produced only 549kg per capita, Forfás (2006). Landfill gate fees in Flanders in 2006 were €58 gate fee plus a €82 landfill gate fee tax, Forfás (2006). It may be noted that in Flanders, the tax on the landfill gate fee is greater than the landfill gate fee, the opposite of Ireland's situation. Flanders is among many countries that use significant landfill taxes to keep landfill costs artificially high as incentives to use preferred treatment solutions such as recycling and WTE. The gate fee on WTE plants in Flanders is €93 plus a €15 tax, Forfás (2006). This is comparable to the figure for an Irish WTE plant as assumed in the Waste Management Plan; however, a figure for tax was not published.

The emergence of prosperity has come at a price in Belgium leading to waste management problems and disposal issues. As affluence has grown, so has the country's waste mountain, a problem that is being felt by the Irish Government.

Since 2005, the population of Flanders has increased and the region has grown richer, but the total amount of waste generated has stayed the same. In economists' terms, Flanders

has "decoupled" waste from economic growth, and has impressive statistics to prove this, Unwin, S, (2007). Flanders' recycling rates of 72% in rural areas and over 60% in urban areas are among the highest in the world and are in stark contrast to the Irish 2006 figures.

The quantity of waste being recycled in Ireland continues to grow at a significant pace but is still low when compared to international averages, DoELG (1998). In 2006, the quantity of municipal waste recycled increased by 18%, household waste by 14%, packaging waste by 8% and biodegradable waste by 26% from 2005 figures. These results demonstrate that Ireland is increasingly adopting a recycling culture and that if householders and businesses are provided with the appropriate incentives, services and knowledge, recycling will be part of a household waste management plan. Some 36% of municipal waste is now recycled and this exceeds for the first time the 2013 national target of 35% recycling, DoELG (1998). While the actual quantity of municipal waste recycled increased by 18%, the quantity landfilled increased by 8%. This means that the recovery rate for municipal waste only increased marginally from 34% in 2005 to 36% in 2006. It is clear that continuing strong increases in recycling and recovery remain overshadowed by increased waste generation and landfill, EPA (2008)¹.

Flanders utilises a system whereby the public have to pay to dispose of the waste they generate. A system like this is currently in operation in each of the 4 Dublin council boroughs. Waste Collection, segregation, recycling and disposal services are provided to householders by the Dublin Local Authorities. The new recycle based management

system is based on the 'polluter pays' principle. Each local authority has introduced a specific household environmental charge across the region that varies slightly from council to council. Dublin City Council introduced a pay-by-volume/use system for all householders in 2005 using both the wheeled bins and bags for their waste in the hope that householders would be encouraged to reduce the amount of waste they produce and recycle more. Fingal have had a similar system in place since 2002, Dun Laoghaire-Rathdown since 2005 and South County Dublin since 2004, Dublin Local Authorities, (2008)².

Under the current system in Flanders, citizens in the city of Ghent can have recyclable goods collected for free on separate well-publicised days for each type of material. Similar to Ireland, households have to pay to dispose of the waste they do not recycle. In Ghent, the price is €1.30 a sack for any rubbish that cannot be recycled, Unwin, S, (2007).

Flanders avoids landfilling largely because it burns most of its waste. The local incinerator in Ghent was refurbished in 1996 and takes 100,000 tonnes of waste a year. The incinerator proposed for Poolbeg, Dublin, has been approved for 600,000 tonne per annum waste capacity, Thornton, P., (2007). In 2006, the incinerator in Ghent started to recover energy as steam, using it to heat the university hospital 1km away, via a pipeline. Flanders' planning laws, designed to phase out landfill, do place strict limits and quality standards on incineration. But while Ghent has a state of the art "energy from waste plant", incineration is still considered controversial by environment groups and there is no avoiding that there are problems with it, Unwin, S, (2007).

The OVAM institution in Flanders is responsible for waste management and soil remediation in the Flanders region. OVAM's taxes and local authority subsidies are the extension of the principle that the polluter pays. OVAM stands for Openbare Afvalstoffenmaatschappij voor het Vlaams Gewest (Public Waste Agency of Flanders) and is a public Flemish Institution, established after the decree of July 2nd, 1981 covering waste management and prevention, OVAM, (2006).

1.6 Sustainability of Poolbeg Incinerator

For an incinerator to be sustainable, it should be consistent with the widely accepted definition of sustainable development outlined in the World Commission on Environment and Development report “Our Common Future” (1987), Bruntland, G. (ed.), (1987), that “humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs”. The Dublin Waste to Energy project was assessed for sustainability on three levels, environment, economy and community, Elsam, (2006).

For the topic of environment, projected emissions from the Dublin WtE facility were compared against the estimated total greenhouse gas emissions in Ireland for the baseline year 2012. The contribution of green house gasses (GHGs) from the Dublin WtE facility, treating 600,000 tonnes of waste (as per license) in the absence of power generation, is 0.19% of the estimated total greenhouse gas emissions in Ireland in that year. This will be a minor source of GHGs. This compares favourably against the contribution to the total greenhouse gas emissions from landfilling 600,000 tonnes of waste (ignoring the generation of power). The corresponding GHG level from landfill is 0.25% of the total greenhouse gas emissions in Ireland in 2012, Elsam, (2006). Landfill is the main disposal route for MSW in Ireland and the main source of GHG emissions in the waste management sector. Studies have found that landfills generate the highest volumes of greenhouse gas of all the available waste options and the National Climate Change Strategy Review has recognised the contribution that WtE facilities can make to the

reduction of greenhouse gas emissions, Indavar, (2006). During incineration of MSW, emissions arise from the combustion of fossil derived waste and from N₂O (nitrous oxide) generated during the combustion process. These are largely offset by the energy generated from the combustion of biodegradable waste and exported to the electricity nation grid or a community heating scheme. With MSW currently consisting of approx 70% biodegradable waste, incineration of MSW would contribute to GHG abatement, Indavar, (2006).

During the incineration of waste at the Poolbeg WtE facility, the thermal energy generated by the burning of waste will be recovered and offer a net electrical output of 60 MWe for export to the national grid. Thus, the export of 60 MWe from the WtE plant will give a direct benefit in terms of the greenhouse gas emissions that would have been released due to the production of 60 Mwe from power stations using fossil fuels. The production of power for export transforms the WtE plant from being a producer of GHGs to having a net positive annual impact on GHG emissions of the order of 0.11% of the total greenhouse gas emissions in Ireland in 2012. This will result in a positive impact for Ireland under their obligations for GHG abatement under the Kyoto Protocol, Elsam, (2006).

However, failure to include one of the alternatives to incineration when comparing greenhouse gas emission, anaerobic digestion of non-recyclable putrescible waste, gave a misleading characterisation of the benefits of incineration, Gormley, J., (2006).

Thus, incineration emits less GHGs than landfill, but may not be the most efficient treatment method available.

The combustion of 600,000 tonnes of waste, generating a net power output of approximately 60 MWe, is equivalent to the typical power requirement of circa 50,000 homes. If the Dublin WtE facility were operated fully on gas oil as opposed to MSW, it would require approximately 20 tonnes of diesel (a fossil fuel) per hour in order to generate 60MWe electricity, Elsam, (2006). In this sense, the incineration of waste is shown to be a sustainable technique as it can continuously produce heat energy and electrical energy from residual waste that would normally be left to decompose in a landfill with little or no benefit.

The policy of the Waste Management Plan for Dublin is to make the best use of residual waste – that is waste collected by the grey/ black bin collection or otherwise not suitable for recycling – by extracting thermal energy at the proposed Poolbeg incineration site. The policy of using only residual waste for incineration would imply that maximum possible rates of recycling or other recovery would have been achieved before the incinerator comes on stream, Gormley, J., (2006). However, progress on increasing recycling levels by 2006 indicated this target would not be reached by the time the incinerator starts treating Dublin's MSW. If this is the case, the Poolbeg plant will treat not only residual waste but waste that should have been diverted from the incinerator stream by recycling. It is the opinion of J. Gormley that “once the incinerator is in place, there will be no further incentive to divert this waste via recycling, and the plant will

continue to process “non-residual waste” throughout its lifetime”. Apart from hopes and aspirations to increase recycling levels in the Dublin area, there are no specific proposals or plans to remove recyclable wastes from the waste stream before delivery to the incinerator for treatment. Therefore, if householders choose not to recycle, or feel they have inadequate facilities in which to do so, any waste they dispose of via incineration will be accepted by the Poolbeg plant regardless of whether it is residual or not.


The EU Directive 2001/77/EC ‘Renewable energy: the promotion of electricity from renewable energy sources’ recognises the role of incineration in sustainable waste management and the significant contribution it can make to the provision of renewable energy by recovering energy from waste where such a process does not undermine the waste management hierarchy. Undermining the waste hierarchy means that options high up the hierarchy pyramid are being overlooked in favour of less advantageous options such as recovery and disposal. The replacement Waste Management Plan 2005-2010 aims towards achieving the following targets 16% landfill, 25% thermal treatment and 59% recycling which is consistent with the significance of environmental sustainability promoted by the waste hierarchy. By including incineration as a treatment system in the management of Dublin’s MSW, the Dublin region is striving to implement a sustainable waste management system that is based on the principles of the EU waste hierarchy and current National and European policies regarding the treatment of municipal waste, RPS Consulting Engineers, (2008). This policy statement implies that it is the intention of the Dublin councils to pursue policies and strategies that will prioritise the prevention, minimisation and reuse of waste over the options further down in the waste hierarchy,

namely recovery and disposal. Specific targets are proposed in the waste management plan for the less favourable options such as recovery, disposal and recycling along with specific measures to be implemented in order to meet these targets. However, most importantly, “no such targets or measures are specified for waste prevention or minimisation”, Gormley, J., (2006).

1.7 Incineration Residues

The Dublin WtE facility will divert 600,000 tonnes of waste from landfill and will result in approximately 147,000 tonnes of residues (bottom ash, boiler ash and flue gas residues) during the operation of the facility. Thus, the volume of waste leaving the facility post-incineration will have been reduced by over 75%. Efforts have been made to minimise the emissions arising from the residues and to ensure best practice is applied in their treatment and disposal. Bottom ash will make up 80% of the total residue after the incineration process is complete. The bottom ash is kept on site in a bunker until there is sufficient quantity and then it is transported to Dublin Port for shipping to the UK or the Continent for processing and eventual recycling. This solution has been chosen as presently there are no standards or regulations in Ireland that sets out a regime for bottom ash from waste incineration to be recycled. Transport to Dublin Port for shipping will also avoid the transport of ash through Dublin city centre, CEWAP Ireland, (2007¹).

Following export, bottom ash may be used in road construction or as railway ballast, in place of virgin aggregates thus promoting the reuse element of the waste hierarchy. It is expected, based on experience elsewhere in Europe, that the boiler ash will be non-hazardous. It may be incorporated with bottom ash and reused. Flue gas treatment residues will be classified as hazardous waste for disposal and will require export abroad for treatment, Elsam, (2006). These hazardous wastes will have to be disposed of in a controlled and environmentally conscious manner. Sludge from flue gas cleaning products is normally treated as fly ash and often mixed in with fly ash or lime for disposal



at a hazardous waste landfill with dryness of 65% dry matter. Wastewater must be fed into a wastewater treatment plant, usually part of the overall plant's facilities, Crowe, M. *et al.* (2002). With regard to the use of recyclable products from incineration, the following products can be recycled at various locations: washed slag/clinker can also be used in the cement industry as a filler material as well as use in road construction projects. The inert slag/clinker can compete with existing gravel pit slag at about €0.5 per tonne. Grit, glass and ceramics can also be recycled for back filling in dams and quarries. The value of the mixture is estimated at about €2 per tonne and mixed coloured glass at roughly €1 per tonne. Ferrous metal can be recycled to an iron smelter for about €10 per tonne and non-ferrous metal, for example copper and aluminium, can be recycled for smelting. The value would be dependent on the amount of impurities, e.g. chrome. Recovered metals could be sold on to the local scrap market at market price but only if the materials are considered to be of a sufficiently high marketable quality. Finally, chemical bulk such as CaSO₄ for gypsum board production can be recovered post-incineration as well as HCl for acid production, Crowe, M. *et al.* (2002).

Although the shipping of ash overseas has been implied to be a temporary measure until the conditions exist for its re-use in Ireland, in reality there is no alternative but to export this residue to Europe where it can be used in construction or railway ballast, following further treatment in an ash recycling plant. At present there is no demand within Ireland for the re-use of this material and there is also no ash recycling plant, or plants for a future ash recycling plant, within the State, Gormley, J., (2006). The export of residues equivalent to almost 25% of the original volume of waste incinerated represents a serious

violation of the EU proximity principle that requires member states to manage waste as close as possible to where it was originally generated. “The proportion of waste which emerges as ash following incineration is significant enough for the proposed incinerator to be fairly characterised as a pre-treatment facility for waste to be exported to other member states”, Gormley, J., (2006). This is a process not in line with the proximity principle that has also been endorsed and included in Irish waste management policy. Potential issues may arise in terms of the bottom ash and fly ash produced by the incinerator. Transfer of this material out of the country may present problems if recipient countries refuse such waste in the future, Bostock, Dr. A, (2005).

1.8 Sustainability of Recycling in Ireland

Recycling is a more favoured option to incineration but again, recycling in Ireland does not always comply with the proximity principle and can result in an unsustainable cost. Due to the lack of facilities, the majority of Ireland's recyclable materials are exported for further treatment. Transport costs can add €25 to €50 per tonne to the cost of waste treatment, depending on the material, and this is not always a favourable price when put on the international markets as many markets for recyclable commodities are extremely competitive. The volume of recycled materials from municipal waste reprocessed in Ireland in 2005 decreased by 25 percent compared to 2004 as Ireland becomes increasingly dependent on foreign recycling infrastructure with 83 percent of municipal recyclable materials exported, Forfás, (2007). In 2006, 530,590 tonnes of waste was recycled in Ireland, representing 25% of all Irish waste recycling. 75% of Irish recyclable waste was exported in 2006, with the UK being the principal destination for recyclable waste, EPA, (2008)¹. As at 2006, there was only one plant for the recycling of glass and one plant for the recycling of plastic. No plant or industry exists in Ireland for the recycling of paper or cardboards Forfás, (2007). When high levels of recycling are set as targets to be achieved in the waste management plan, it is hard to understand why more emphasis is not being put on the expansion of the recycling industry in Ireland. Ireland compares very badly with countries such as Scotland, with a similar population and area, which has 2 glass, 14 paper/cardboard, 4 plastic and 3 metal recycling facilities, Forfás, (2007).


1.9 Calorific Values of Municipal Waste Streams

Most of the waste streams targeted for increased recycling are also those that have a high calorific value. The efficiency of the incineration combustion process is dependent on the composition, and thus the calorific value, of the waste. Efficient combustion will reduce some pollutants, such as carbon monoxide, particulates and total organic carbon (including dioxins, furans and PCBs). Dry waste with a high calorific value will promote an efficient combustion process. Therefore, waste consisting of a high proportion of paper, card, textiles, and plastics, promote complete combustion and heat generation and is the type of waste favoured for an incineration plant to run efficiently. The recovery of this heat (energy) is increasingly being used to generate electricity and/or heat buildings and this provides an additional revenue stream to the incinerator operator. For these reasons, the incinerator operator will seek to ensure that the composition of the waste meets these requirements. Also, to recoup the capital investment costs and make a profit, the operator seeks to run the plant continuously at, or near, its nominal operating capacity, Bostock, Dr. A., (2005).

It is the opinion of Dr. Bostock that "...more raw materials, and more fossil fuels, will have to be mined and processed to produce, and transport, similar products again. Given the Earth's finite resources, this is not a sustainable process". His paper on waste incineration state that the requirements of incineration, or energy recovery, are effectively in conflict with any strategy that seeks to reduce, re-use or recycle. This statement is in agreement with the submission made to An Bord Pleanála by John Gormley that asks for the hierarchy of waste management options to be upheld and for the Poolbeg incinerator

plant to be rejected. If a waste management strategy, such as the prevention, re-use and recycling, reduces the high calorific feed of waste to the incinerator then a conflict arises. This may result in either: the progress of the waste reduction strategy has to be stopped; the incinerator has to shutdown; or both the waste reduction strategy and the incinerator continue by importing additional waste into the area. However, the importing of waste would be in violation of the proximity principle, which aims to reduce the transport of waste by processing waste locally, Bostock, Dr. A., (2005).

Thermal treatment supporters agree that WtE captures a wasted resource by utilising its calorific content to generate energy and replace other forms of polluting energy like coal and other fossil fuels, Morawski, M., (2007). It is the view of many that municipal waste is a renewable resource and that it is senseless to bury it in landfill without extracting its potential energy. In opposition to this view is the reasoning that this issue is about a “disposal” challenge but rather a matter of sustainability. By making waste disappear by burning may partially solve a disposal problem but it strengthens the illusion that we can continue consuming natural resources as we do currently. Recycling waste results in significant energy savings as the need to extract primary raw materials is avoided. Advocates of WtE argue that high recycling and thermal treatment are compatible, “but as recycling success moves beyond 60% it will impact the fuel (waste) used in a thermal facility”, Morawski, M., (2007). Morawski argues that if increased separation of waste achieves values of higher than 60%, the waste stream will lose its high calorific value. In response to this, “...experience in the US and Europe shows that the removal of low calorific value recyclables (such as yard waste, food waste, metal and glass) and high



calorific value material (such as paper and plastics) offset each other, causing the higher heating value of the residual waste to remain about the same”, Foden, J., (2007). There is sufficient contaminated waste left in the municipal waste stream after recycling initiatives have been performed, to provide sufficient energy for thermal recovery, Foden, J., (2007). Ms. Morawski contests that to run an incineration plant is extremely expensive and relies heavily on electricity sales revenue to counterbalance the high capital and operating costs of a WtE plant. Included in the costs of running a WtE plant efficiently and within its licence are the expensive yet necessary pollution abatement equipment and landfilling costs for the residual ash. Yet documented experience in the US shows that the costs involved in running a WtE plant for solid waste disposal is often comparable to traditional landfills, Foden, J., (2007).

Incinerators require specific calorific waste values for it to run efficiently. The plant specification for the proposed Poolbeg incinerator prescribes a design heat value of the waste of 11.5 MJ/kg but requires the plant to be able to handle waste in the range of 8-15MJ/kg. The system will automatically adjust itself to changing calorific values, Kjaer (2004). The EIS for the Poolbeg incinerator describes the principal design objectives for the Dublin WtE facility as providing two identical WtE lines, each with capacity of 35 tonnes per hour at a lower calorific value of 10.5 GJ/tonne, Elsam (2006). A feasibility study for the Limerick/Clare/Kerry region assumes the calorific value of waste for thermal treatment will be within a range of 7-15MJ/kg. Such a calorific range is considered to be readily achievable from the municipal waste stream, RPS-MCOS, (2005).

1.10 Waste as a Valuable Resource

A sustainable development approach requires an emphasis both on waste as a resource and also on the conservation of energy and materials (*Zsigraiová Z. et al*). A sustainable approach to waste management requires that decisions made on the processing of waste consider the technologies that will maximize the useful recovery of both materials and energy from waste prior to any disposal. Therefore, incineration as a method of MSW management has a significant importance in resource recovery within an integrated waste management system that utilizes the combination of source reduction, separation, reuse, recycling, composting and landfill, *Zsigraiová Z. et al. (2005)*.

Sustainable waste management requires an integrated waste management system coupled with government policies that encourage waste prevention, reuse and both materials and thermal recycling. Eventually, landfills will only be used for stabilised materials, *Zsigraiová Z. et al. (2005)*. This statement agrees with the targets stated in the Waste Management Plan 2005-2010 and also the Landfill Directive (1999/31/EC).

“Society's task is not to perfect the destruction of our waste, but to find ways to avoid making it”, Connett, P., (1998). It is argued that burning waste can be used to recover energy, but the reality is that reusing and recycling objects and materials can save more energy, than can be recovered by burning them. Dr. Connett states that both incineration and raw waste landfilling attempt to bury the evidence of an unacceptable throwaway lifestyle and that “...every incinerator built delays this fundamental discussion by at least 20 years”. Every time waste is burned in an incinerator, or dumped in a landfill, the raw

materials have to be replaced. This goes against the principle of sustainability, Connett, P., (1998).

1.11 Municipal Waste Characterisation

In order to measure progress towards national waste prevention, reduction, and recycling goals, it is important that detailed, accurate and up-to-date information regarding the composition of municipal waste is maintained, RPS Consulting Engineers, (2005). An on-going campaign of waste characterisation is required so that the data is continuously updated and improved.

In the period between August 2005 and May 2005, a national study was performed by a consultancy team from RPS-MCOS and CTC (Clean Technology Centre) with the aim of improving the level of knowledge available on municipal waste and to report on the findings. The methodology used required surveying the entire waste generation in a given premises over a week-long period, with separation and measurement of waste within the premises prior to waste collection, RPS Consulting Engineers, (2005). Fingal was studied as a 2-bin city location.

It was determined that for household waste surveys, each of the 34 Irish local authorities should carry out 2 surveys every 2 years. These 68 surveys will give a precision of 10% at 95% confidence level for Irish household waste. The surveys will include mandatory characterisation of mixed residual waste samples and also characterisation of mixed dry recyclables and organic separate collections where the service is available. The waste composition surveys are to be reported using a standard document and the information

received should be input by the EPA in a database and this detailed information made available online, RPS Consulting Engineers, (2005).

The most common method used to characterise household waste is the analysis of waste in bulk from a Refuse Collection Vehicle (RCV), even though this method increases contamination due to mixing.

In 1996, the EPA published a methodology for carrying out waste characterisation surveys, which has been the methodology followed in Ireland to date. The methodology is based on the premise that households of similar socio-economic characteristics are likely to have similar behavioural, purchasing and lifestyle characteristics, which will be reflected in the quantity and composition of waste they produce or recycle, RPS Consulting Engineers, (2005).

The EPA is currently developing a national programme of municipal waste characterisation surveys in consultation with local authorities. Regular waste characterisation surveys at local level provide up to date information on the composition of household and non-household waste. In order to have accurate information on the amount and type of household and commercial waste that needs to be managed, it is important to carry out regular waste composition surveys. Their results help to measure progress towards waste prevention, reduction and recycling, and allow realistic priorities and targets to be set, EPA, (2008)².

SECTION 2. MATERIALS AND METHODS

Two methods were employed in order to research the sustainability of incineration in the Dublin area.

Firstly the waste management habits of a cross section of the Dublin population were determined through the circulation of a questionnaire.

The questionnaire was also designed to include questions to determine the opinions of a group of Dublin householders on the proposed introduction of incineration and whether it would be welcomed as a waste management tool.

Secondly, the volume of waste generated by one household in a Dublin County Council Borough was quantified over a period of one calendar month (01 March 2008 to 01 April 2008) by using a waste log and a standard household scales.

2.1 Questionnaire

2.1.1 Introduction

A questionnaire was devised in order to determine a clear snapshot of waste management habits in Dublin households. The aim of the questionnaire was to obtain information on location and number of people living in each household and to determine methods of waste disposal available to each household. Levels and interest in recycling was quantified along with each household's opinion and comments on the introduction of incineration in Dublin as a waste management option.

2.1.2 Distribution

The questionnaire was drafted to be clear, concise and relatively short in order to make it attractive to the population under review. The questionnaire was one page long and multiple choice, with an optional comments section for opinions on incineration and general comments on waste management in the Dublin area.

The questionnaire was distributed between the four Dublin Boroughs of Fingal, South Dublin, Dublin City and Dun Laoghaire-Rathdown.

The questionnaire was originally distributed as a paper based questionnaire on a random basis through friends, family, neighbours and work colleagues. In order to reach a more diverse population catchment, the questionnaire was re-formatted so it could be completed on-line. The on-line version was distributed via email and a wider catchment area was surveyed through this method. The questionnaire is detailed below in figure 2.1.

Tick the Dublin Borough you reside in:

Fingal South Dublin CoCo Dub Laoighre/Rathdown Dublin City

How many in your household?

Do you put your bins out yourself **or Management Company**

Tick which of the following bins are available to your household:

Black bin Green Bin Brown Bin

How often does your household put the black bin out for collection?

Every week Every second week Every 3 weeks or more

Do you actively recycle?

Yes No

If yes, do you recycle using:

Green bin only Green bin and also recycling centre

Nearest recycling facility to your household:

0-1 km 2-3 km >5 km

Would the introduction of incineration have an effect on your household waste disposal routine?

More likely to recycle Less likely to recycle No change

Would you welcome the introduction of incineration as a waste management option in Dublin?

Yes No

Comments:

Figure 2.1 Incineration Questionnaire

2.1.3 Quantification of results

Distribution of the questionnaire took place over a 6-week period and was distributed to 100 respondents. A wider audience may have been captured if other forms of distribution were used such as on-line surveys or door to door surveys. The method of distribution used however did cover a high number of respondents in the time frame of the study and a broad range of views and options was obtained.

Results were quantified and displayed in graph and table format. These will be discussed in Section 3, Results.

The comments from the questionnaire will be reviewed in Section 3, Results, and Section 4, Discussion.

2.2 Household Waste Survey

2.2.1 Introduction

A survey of the waste management habits of a Dublin household was compiled over a one-month period, from 01 March 2008 to 01 April 2008.

The household surveyed was in the borough of Fingal, in the north of County Dublin. This household was serviced during this period by a black and a green bin. Black bins in Fingal during this period were collected weekly and green bins collected monthly. The household surveyed housed 2 people, both professionals' working day shifts, Monday to Friday. The household had no children.

The aim of this survey was to determine the waste streams generated by this single household, along with quantities of each stream, quantities segregated for recycling and the final calorific value of the waste stream for disposal.

Waste in Fingal currently is disposed in Balleally landfill in Lusk, North County Dublin.

In April 2008, brown bin collection was introduced in the Fingal borough of Dublin.

This survey was performed prior to the introduction of this service.

2.2.2 Method

A central waste station was located beside the main bin in the kitchen area of the household. All waste generated by the household was weighed and logged before disposal into the appropriate bin. The waste generated included glass and certain plastics, which can only be recycled at the local recycling centre; it is not collected by the local authority through a recycle bin system.

2.2.3 Materials

Salter kitchen scales, 0-5kg,

A standard kitchen scales was used to weigh the waste quantities generated. This scales is not calibrated so all waste quantities determined are approximate values, correct to the nearest 1g increment.

A waste log was designed to detail type, quantity and disposal method of waste generated. The waste log is detailed below in figure 2.2.

Waste Log

**PLEASE LOG EVERYTHING THAT IS DISPOSED AND ITS RESPECTIVE
WEIGHT**

WEIGHT (g or kg)	WASTE STREAM	RECYCLED (R) /DISPOSED (D)	DETAILS

Figure 2.2 Waste Log

2.2.4 Quantification of Results

The logging of waste started on 01 March 2008 and continued until 01 April 2008.

Waste streams were logged as:

- Food / Putrescible Waste
- Plastic waste for recycling
- Plastic waste for disposal
- Paper / Cardboard waste for recycling
- Paper / Cardboard waste for disposal
- Glass
- Steel tins / Aluminium for recycling

From these waste streams, the calorific value of waste for landfill disposal was calculated using the following values outlined in table 2.1.

These values were obtained from Cheshire Local Government Association, 2001.

Table 2.1 Average Calorific Values of Waste Streams

Average Calorific Value	MJ/kg
Garden Waste	9.01
Kitchen Waste	7.01
Building Waste	0
Metals	-0.29
Plastic	24.05
Misc/Recoverable Waste	12.21
Textiles	6.9
Glass	-0.15
Paper	13.8
Cardboard	13.42
Wood	9.01

Source: Cheshire Local Government Association, 2001

SECTION 3. RESULTS

3.1 Questionnaire

A total of 90 questionnaires were distributed and 85 questionnaires were completed and returned. This corresponds to a response rate of 94%.

3.1.1 Distribution and household information

The distribution of the questionnaires was as per figure 3.1

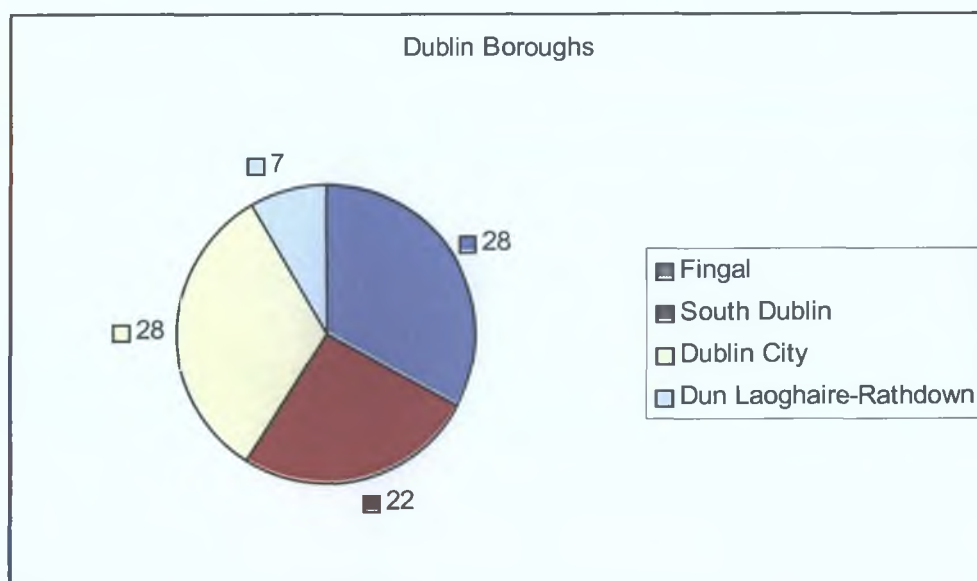


Figure 3.1 Response rate from questionnaires

An average of 2.5 people was determined to reside in each household, the most per household was 6 and the least was 1 householder.

As per data from the 2006 population census, the average number of persons per private household in Dublin was 2.7. CSO, (May 2007).

3.1.2 Management and Availability of Bins in Dublin



Figure 3.2 Management of bins in Dublin

Control of household waste bins in Dublin is by either householders or management companies. From the questionnaire results, 67 respondents put their own bins out for collection and 18 respondents have their bins controlled by management companies in their apartment block or housing complex. These results are graphed in figure 3.2.

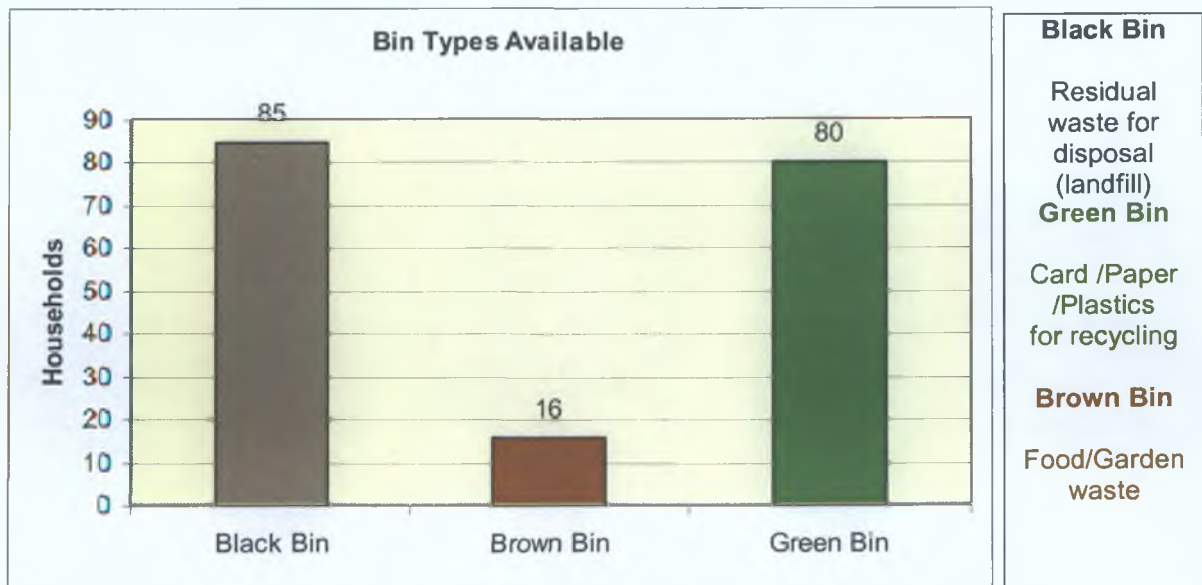


Figure 3.3 Municipal waste bins available to Dublin households

The varieties of municipal waste bins available to Dublin households are displayed in figure 3.3. The distribution of brown bins in Dublin is shown in figures 3.3 with a further breakdown of data relating to brown bins in figure 3.4. Every household questioned had a black bin for disposal of municipal household waste. Brown bins were available to 16 households and green bins were available to 80 households out of a total 85.

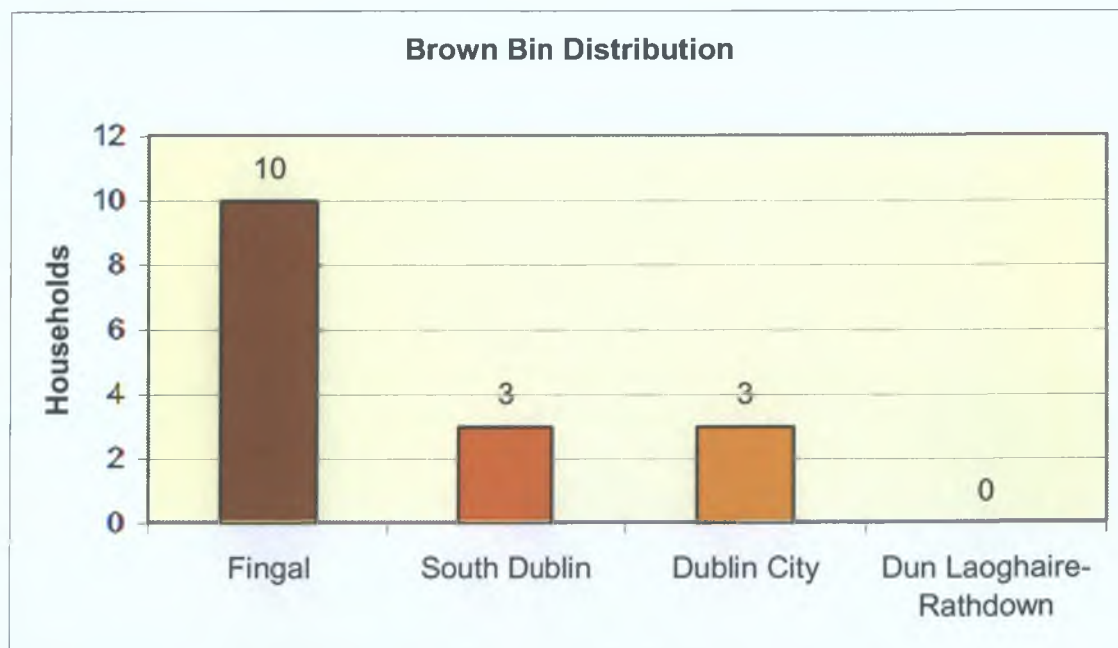


Figure 3.4 Brown bin distribution amongst respondents

Frequency of black bin collection from households is shown below in figure 3.5 and table 3.1. The impact of having a brown bin available to a household is shown on the same graph. This was done to determine if having a brown bin available reduced the frequency of black bin collection from these households.

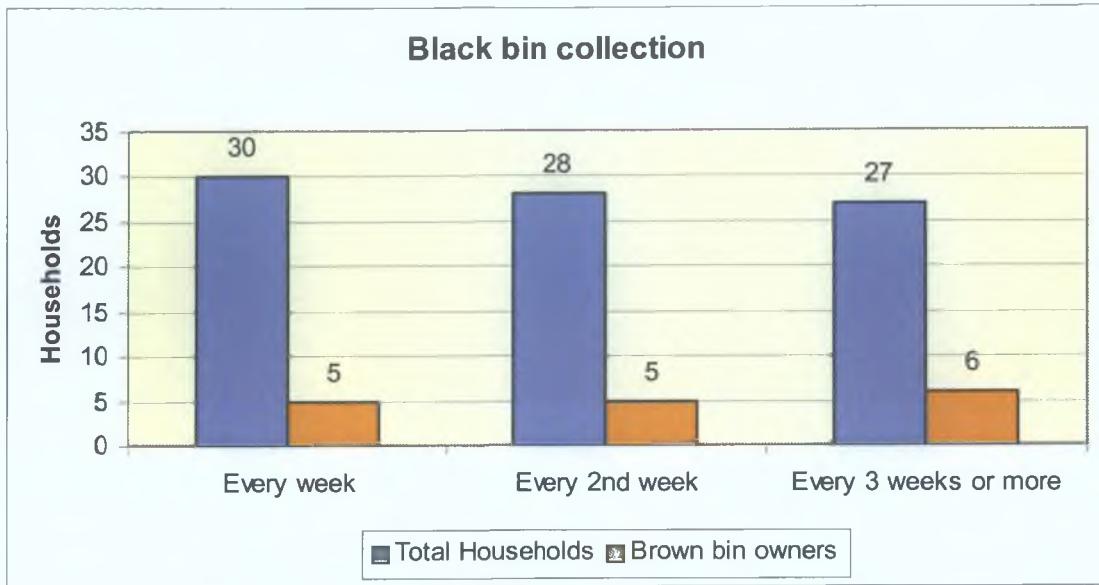


Figure 3.5 Frequency of black bin collection

Table 3.1 Frequency of black bin collection

Frequency	Every week	Every 2nd week	Every 3 weeks or more
Total Households	30 (35%)	28 (33%)	27 (32%)
Brown bin owners	5	5	6

3.1.3 Recycling within Dublin Households

A positive response to recycling within the Dublin boroughs was received, with 98% of respondents describing their households as actively recycling, compared with only 2% of households who do not actively recycle.

From the respondents who actively recycled, results were obtained for the household's methods of recycling, shown in figure 3.6.

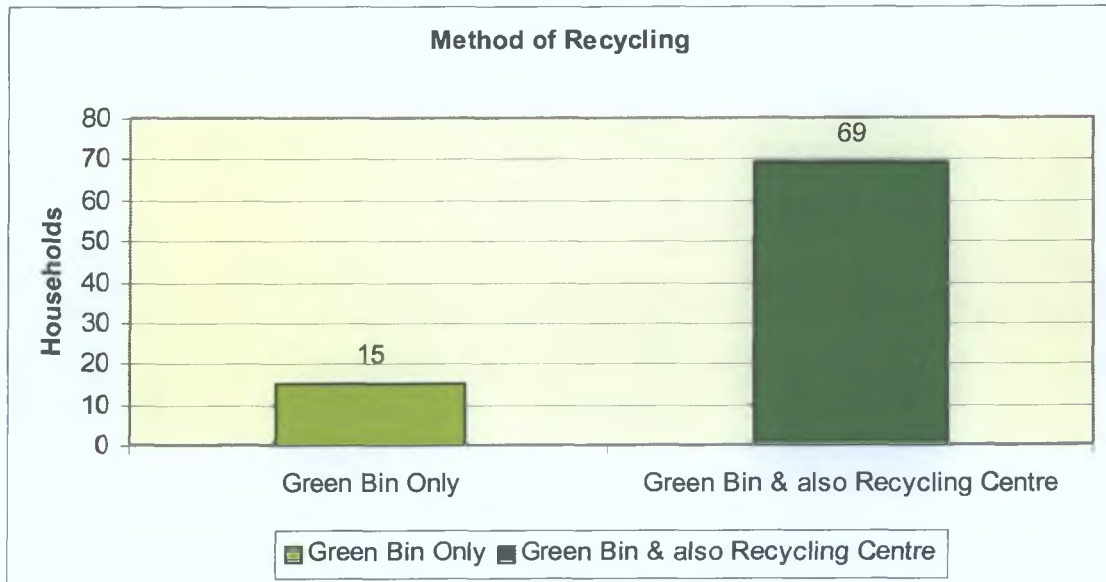


Figure 3.6 Recycling methods among actively recycling households

The location of the nearest recycling facility to each household is shown in figure 3.7. The term "Recycling Facility" in this questionnaire was used as a very general phrase, to include stand-alone glass bottle banks alongside municipal recycling centres where a greater variety of material can be recycled. Most households are situated in close proximity to some form of recycling facility, with the majority living within 3km of a recycling facility.

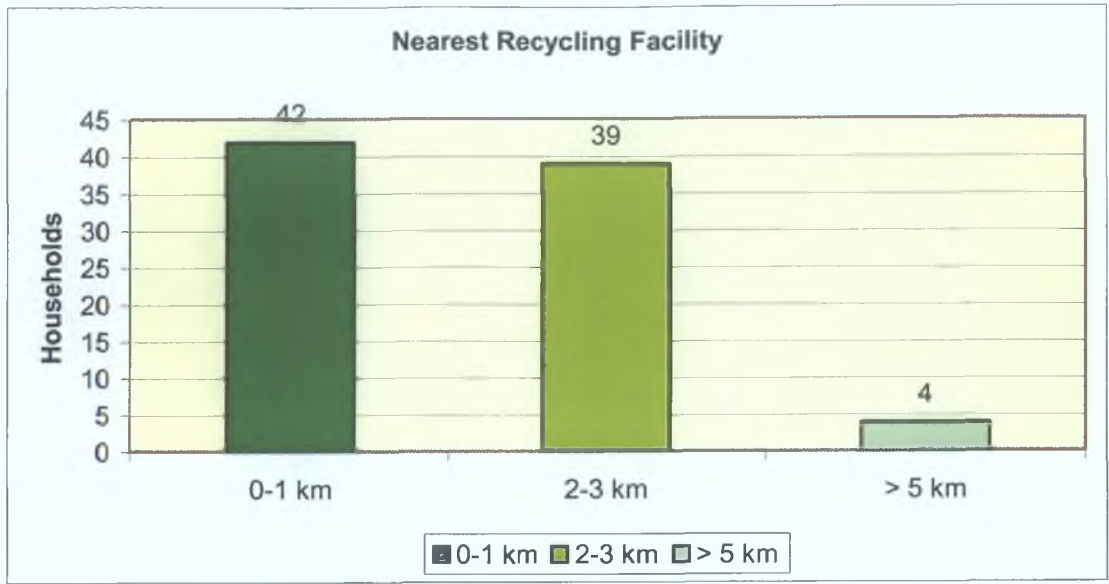


Figure 3.7 Location of recycling facilities to Dublin households

3.1.4 Municipal Waste Incineration in Dublin

Householders were questioned on the impact that incineration as a waste disposal option in Dublin would have on household recycling habits. Results are shown in figure 3.8.

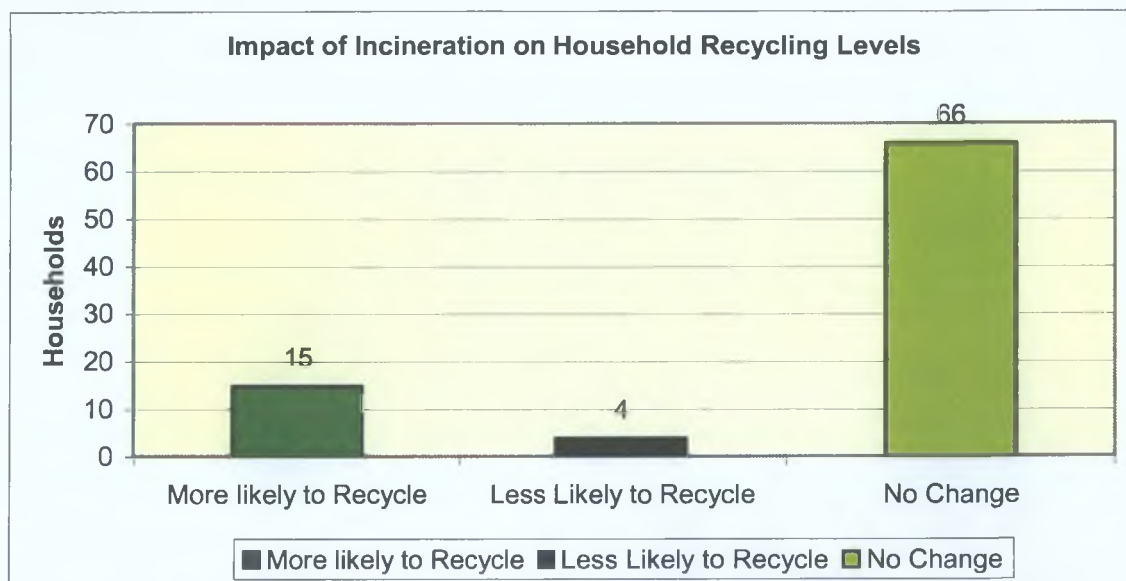


Figure 3.8 Impact of introduction of incineration on household recycling levels

The majority of households, 66 (77%), replied that the introduction of incineration would not impact their recycling habits and these households would carry on their recycling routine as normal. The introduction of incineration would make 15 (18%) households more likely to recycle and actively endeavour to increase their recycling levels. A minority of households, 4 (5%), stated that the introduction of incineration would make them less inclined to recycle.

Following on from this question, householders were finally asked for their personal opinions with regard to the proposed introduction of incineration into Dublin and whether

these households would welcome the introduction of incineration as a waste management option in Dublin. The results are shown in figure 3.9.

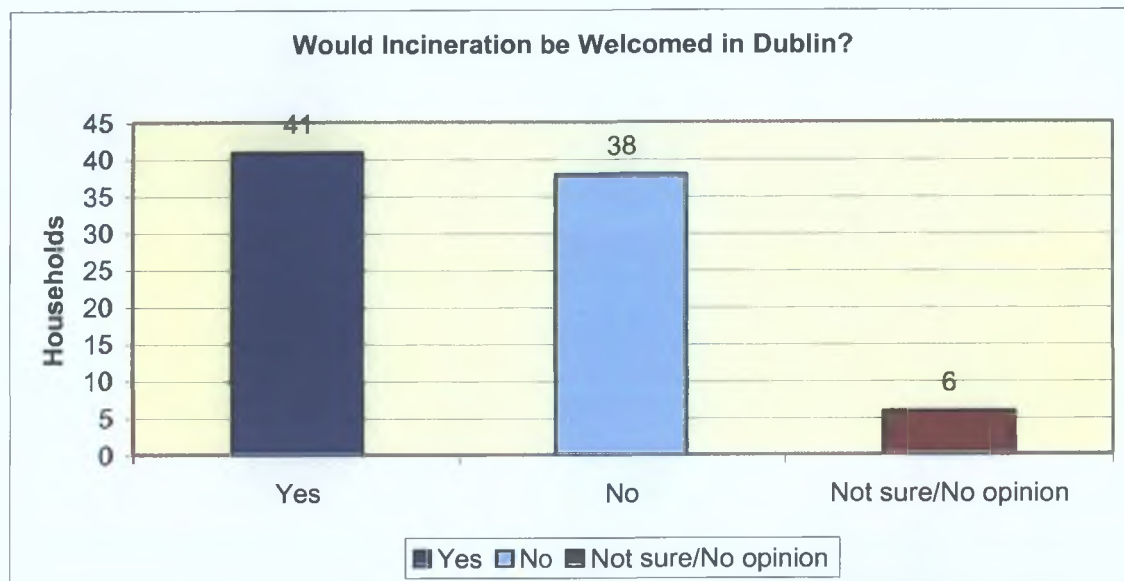


Figure 3.9 Would householders welcome the introduction of incineration in Dublin?

The results obtained were very close, with 41 (48%) households favouring the introduction of incineration, compared to 38 (45%) households opposed to the introduction of incineration in Dublin. A total of 6 (7%) households held no opinion or were not sure about the introduction of incineration.

3.1.5 Comments relating to the introduction of incineration in Dublin

All respondents were asked to comment on their views about the introduction of incineration as a municipal waste management option in Dublin. A total of 33 comments were collected and are shown below in table 3.2.

Table 3.2 Householder comments from questionnaire – thoughts on incineration

Householder comments from questionnaire – thoughts on incineration
“If that is deemed the best and most environmentally friendly way to get rid of waste”
“I would like to have more information available on incineration as I’m only familiar with the risks involved and not sure about the process and the benefits it can bring”
“Yes, provided that it is only material that cannot be recycled and that it is integrated with Mechanical and Biological Treatment processes. Another requirement of the incinerator would be that it would supply some benefit to the local community e.g. the waste heat used in a district heating type scheme”
“I would welcome incineration as a waste option if I was informed about the full process for incineration and was happy that there were no health implications for me and my family”
“I wouldn't like to live near one and someone has to. Pollutants generated would be a concern. I believe in continuing the campaign to recycling”

“In my opinion incineration is a terrible waste of resources and a cheap option for the government. With the proper facilities, most waste can either be recycled or converted to energy. When considering the impending energy crisis, it is shameful to waste as much as we do. At least with landfills there is still the potential to reclaim energy (even if it is only mobile methane plants). While incineration would be a sustainable waste management option, it only shows the country's inability to defy convention and revolutionise attitudes towards waste management”

“I think that it is inevitable that it will be introduced but I would adopt the NIMBY (not in my backyard) approach. There are clearly industrial type sites where it could be located so that it is well away from housing”

“I think that properly managed incineration is a better option than land fill site. The industry however must remain tightly regulated. Land fill sites have destroyed too many areas in Ireland and are not an acceptable choice for disposal in Modern Ireland”

“It can only add towards air pollution. Although I don't live near a dump which would perhaps make me change my mind”

“As a scientist I think we are more conscious of waste - but we are in the minority as an occupation - so it's important green ideas get through to large business etc”

“Once it was regulated, and any profit was put into community projects/parks etc”

“Incinerators seem too dirty. Recycling is apparently a clean and more environmentally friendly way of dealing with household waste”

“Strongly opposed to incineration”

“Provided it is in County Dublin and it’s new, state of the art with the ability of flue gas cleaning”

“Not at present, more measures could be taken before incineration is considered as an option”

“While incineration is not an ideal solution, if properly managed and implemented in conjunction with increased recycling, it will provide a sustainable alternative to landfill which cannot continue”

“Once it was not harmful to the environment”

“Glass collection would be beneficial and enable more people without own car to recycle more glass. Brown bin would reduce black bin use by 25-50%. Since green bin collection has moved to every 2 weeks (from 1 per month), we have reduced frequency we put out black bin” (South Dublin County Council Householder)

“Not sure about this, the environment would have to be protected and also wildlife not harmed in any way”

Yes to incineration...“If testing was done to prove the emissions were not bad for the environment and health. Also this would have to be on a Green TD’s doorstep”

“The present proposal for an incinerator in Dublin will not be cost effective- the city council will not have sufficient waste to run the incinerator cost effectively”

“Pollution concern”

“I would be concerned about pollution and it being an eye sore, I would also not like heavy trucks passing my door”

“What is the point in incineration waste when you can recycle it and use the materials to make other products!!!”

“Not sure about incineration, do not have enough information on possible alternatives or environmental impact of it.”

“It wouldn’t bother me either way”

“Would not like an incinerator near my home”

“Incineration, if properly managed, has to be a better option than burying it and hoping it goes away. That said – many incinerators need a certain amount of waste to operate successfully as a business – so they don’t really encourage us to cut down on waste in the first place”

“There should be no charge for taking bulky items (mattresses, fridges, ovens etc.) to the recycling centre. A charge only encourages people to dump items in alleyways or the countryside”

“No recycling facility as it is an apartment complex. Incineration I think is a better option for areas where recycling is well established so it was be seen for what it is- a last option for consumables that are difficult to recycle and even then products difficult to recycle should be taxed and companies made to explain their methods of production to the government and why more environmentally friendly options are not chosen. For areas with high recycling such as Galway incineration could be useful to get that last bit of benefit out of waste that cannot readily be recycled until a better option materialises”

“From my understanding the benefits outweigh the negatives. The negatives to me would be increased air pollution. The benefits would be fewer landfills around”

“I am extremely annoyed that our apartment block in the city centre has absolutely no recycling facilities. My two flatmates do not recycle at all, so I do it for everybody. There is a bottle bank quite close but in school grounds, so it is closed outside office hours. I carry all recyclable materials about one kilometre to Trinity College where everything can be recycled”

“I don't know much about incineration so cannot offer an opinion.”

The comments from the questionnaire show that some householders are very knowledgeable on the subject of incineration whereas a number of householders feel not enough information on the subject has been made available to the general Dublin public. These comments will be reviewed further in Section 4, Discussion.

3.2 Household Waste Survey

A survey of the waste management habits of a Dublin household was compiled over a one-month period, from 01March 2008 to 01April 2008. This household was serviced during this period by a black and a green bin. The household surveyed housed 2 people, both professionals' working day shifts, Monday to Friday. The household had no children. The black bin for landfill/disposal was only presented once for collection during this period - upon completion of the survey.

3.2.1 Household waste streams identified

The waste for disposal over a 1-month period was categorised into 7 groups. These groups and their quantities (kilogram, kg) are shown below in figure 3.10 and table 3.3. All household waste was logged prior to disposal in the appropriate bins. This methodology is similar to that used by the consultancy team from RPS-MCOS and CTC (Clean Technology Centre), where the entire waste generation in a given premises was surveyed over a week-long period, with separation and measurement of waste within the premises prior to waste collection, RPS Consulting Engineers, (2005). Results have been separated into recyclable waste and waste for landfill disposal. The calorific value of the total waste generated (recyclable and disposed) and also the calorific value of just the disposal fraction were calculated. These two values were calculated for comparison studies and will be examined further in Section 4, Discussion. The net calorific value of the household is the value of the waste purely for landfill/disposal.

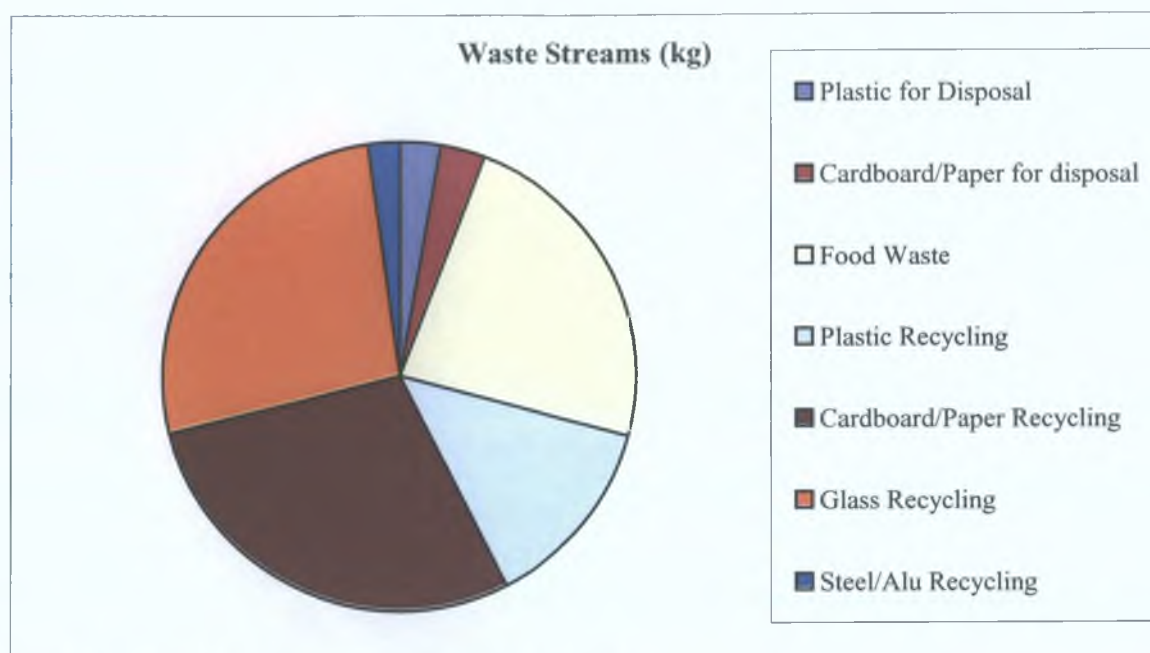


Figure 3.10 Household wastes categorised into streams

The waste streams with the highest volumes were for recycling collection, these being cardboard/paper and glass. Food waste was the largest stream for disposal/landfill, weighing in at 2124g or 2.124kg.

Table 3.3 Household waste streams identified (kg)

Cardboard/Paper Recycling	Glass Recycling	Food Waste	Plastic Recycling	Cardboard/Paper for disposal	Plastic for Disposal	Steel/Alu Recycling
2.573	2.400	2.124	1.200	0.280	0.240	0.213

3.2.2 Recycling of Household waste versus disposal

The level of recycling, as opposed to the disposal of plastics in this household is shown graphically in figure 3.11. The same scenario for paper/cardboard is shown in figure 3.12.



Figure 3.11 Plastic for recycling versus plastic for disposal

It may be seen that the ratio of plastic for disposal to plastic for recycling is 1:5 and for paper/cardboard it is approx 1:9.

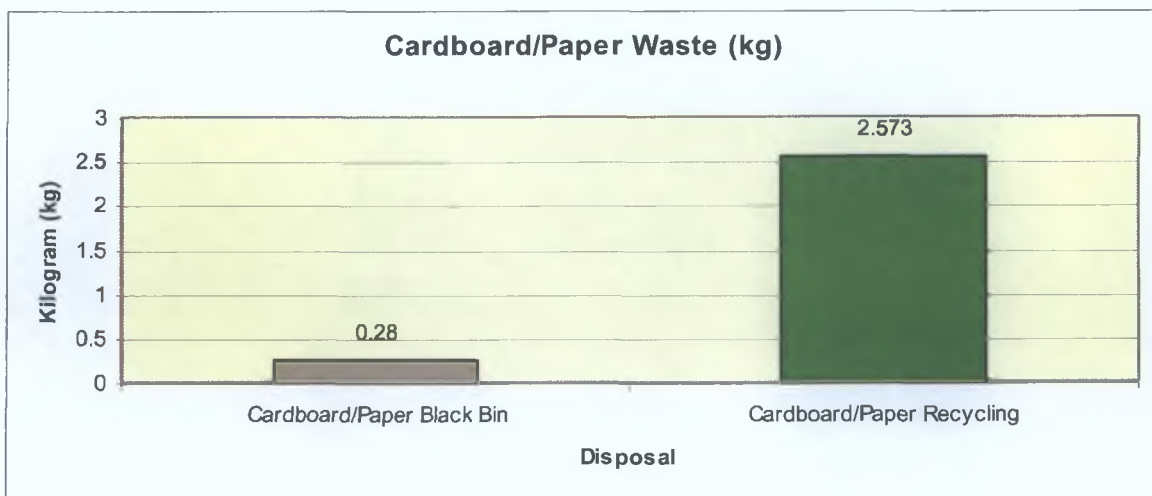


Figure 3.12 Paper/cardboard for recycling versus paper/cardboard for disposal

3.2.3 Calorific content of household waste

The calorific value of household waste was determined using the values shown in table 2.1, Cheshire Local Government Association, (2001).

It is clear from table 2.1 that some of the most recyclable elements of the waste stream (paper, card and plastics) have the best calorific values. Removing these from the domestic waste stream will lower the overall calorific value. Conversely removing metals and glass from the waste stream will marginally improve the calorific value of household waste as these have a negative calorific value.

The overall calorific value of the household waste, both for disposal and recycling is shown below in table 3.4.

Table 3.4 Calorific content of all household waste

WASTE STREAM	WEIGHT (kg)	ENERGY (MJ)
Plastic for Disposal	0.240	5.772
Cardboard/Paper for disposal	0.280	3.864
Food Waste	2.124	14.889
Plastic Recycling	1.200	28.86
Cardboard/Paper Recycling	2.573	35.507
Glass Recycling	2.400	-0.36
Steel/Alu Recycling	0.213	-0.062
TOTAL	9.03	88.47

TOTAL CALORIFIC VALUE: 88.47MJ / 9.03kg = 9.80 MJ/kg

The calorific content of waste for disposal, and potentially for incineration, is as per table 3.5 below.

Table 3.5 Calorific content of all household waste for disposal

WASTE STREAM	WEIGHT (kg)	ENERGY (MJ)
Plastic for Disposal	0.240	5.772
Cardboard/Paper for disposal	0.280	3.864
Food Waste	2.124	14.889
TOTAL	2.644	24.525

TOTAL CALORIFIC VALUE: 24.525MJ / 2.644kg = 9.28 MJ/kg

The total calorific value (MJ/kg) obtained in table 3.5 is the available energy from the waste generated by 1 household in Dublin housing 2 occupants, as calculated over a 1 calendar month period.

SECTION 4. DISCUSSION

4.1 Questionnaire

The questionnaire was devised in order to determine the waste management routine of Dublin householders with reference to their recycling habits and their overall opinion in relation to the proposed introduction of incineration as a waste management tool in Dublin.

Two methods of distribution were utilised, email and face-to-face contact. A high response rate was achieved; this may be attributed to the fact that the questionnaire was short and to the point, allowing for the questionnaire to be completed in a relatively short period of time. Initially the questionnaire was distributed through the face-to-face method however; email was then used to avoid a small and unvaried audience.

4.1.1 Household Information

The distribution of completed questionnaires was 33% Fingal, 33% Dublin City, 26% South Dublin and 8% Dun Laoghaire-Rathdown.

An average of 2.5 people was determined to reside in each household, which compares well to the figure obtained in the 2006 population census of 2.7.

Waste charges for household waste collections vary across the 4 Dublin boroughs, but all boroughs now charge for household waste collection.

Dublin City, Fingal and Dun Laoghaire-Rathdown County Councils all have a standing charge for householders to pay for their waste collection along with a per-lift charge.

Dun Laoghaire-Rathdown also charges per kilogram of household waste collected in the

black bins. This charge per kilogram could be seen as an incentive for householders to try to divert as much recyclable waste as possible from their black bin collection. No Dun Laoghaire-Rathdown respondents to the questionnaire had access to a brown bin facility in their household; this waste option had not yet been rolled out in this borough of Dublin as of May 2008, Dublin Local Authorities, (2008)⁴.

South Dublin County Council does not charge a fixed standing fee for black bin collection, it only charges using a pay-per-use system. Their bin charges are the lowest of all 4 Dublin boroughs and do not encourage a more conscientious approach towards household waste management. The results from the questionnaire reflect this as the majority of South Dublin respondents (46%) put out their bin for collection every week.

The majority of respondents manage their household bins themselves, compared to 18 out of 85 households who have their bins controlled by management companies. Therefore 79% of Dublin householders manage their bins themselves whilst the remaining 21% have their household waste controlled by a management company based on the survey performed during this study. According to 2006 census results, 85% of private Dublin householders live in houses (either detached, semi-detached or terraced) and 15% live in apartments or flats, CSO (2007).

From the results obtained, management companies do provide recycling facilities in their complexes but a small minority only provide a black bin collection with no recycling facilities available on-site. This means that recycling is the responsibility of the householder and if they are not prepared to travel to the local civic amenity facilities, their waste will not be segregated into recyclable streams. This will impact the calorific

value of their waste for disposal, as it will contain an elevated amount of plastics and paper wastes that are high calorific wastes.

Black bins are available to all households questioned and green bins for recyclable fractions are available to 94% of the households questioned. The missing 6% are households whose waste disposal is controlled by management companies. Brown bins are growing in distribution amongst the Dublin County Councils. At the time of the questionnaire distribution, households in Fingal and Dublin City Councils had brown bin collections and their catchment areas are growing.

This collection service will be brought in gradually and the introduction of a brown bin collection in the Dublin Region will decrease the reliance on landfill and help recycle biodegradable waste into a valuable resource. This diversion will help Dublin to comply with the Landfill Directive, 1999/31/EC. Response to the questionnaire indicated that 3 respondents in South Dublin County Council borough had access to a brown bin, however, it may be established that these brown bins are actually home composting bins that are the sole responsibility of the householder as this council does not provide a collection service currently for this bin.

The expansion of the brown bin service to all householders will be on a phased basis over the next two to three years as the necessary treatment facilities are made operational. Fingal Co Council was the first local authority to introduce the brown bin on a pilot scheme basis in November 2005. Currently Fingal County Council is transferring the brown bin material to an authorised recovery facility for treatment until the development of the Kilshane facility in North County Dublin is completed. Brown bins can accept food and garden wastes and are collected from households free of charge every 2 weeks.

4.1.2 Black bin collection and Recycling in Dublin

The majority of households were found to display their black bins for collection every week, however this was not by a large margin. It is clear that the availability of green and brown bins to householders is reducing the frequency that households put their black bins out for collection.

The majority of brown bin owners put out their black bins for collection every 3 or more weeks. This statistic indicates that brown bins are removing a considerable fraction of waste from disposal at landfills. As this collection service is increased, it can be envisaged that the amount of household waste for landfill disposal will reduce. It is this fraction of waste that is targeted for incineration in Dublin at the proposed Poolbeg facility.

As the majority of householders questioned have access to a green bin collection, the calorific value of their waste for disposal has been affected by the removal of some high calorific wastes from the waste stream. High calorific wastes will always remain a part of residual household waste for collection however due to contamination of papers/card and plastics used by households that cannot be recycled.

Recycling in Dublin has been embraced positively by its inhabitants, illustrated by 98% of respondents describing their households as actively recycling. Only a small fraction, 2%, of households do not actively recycle. Findings from an ERM/Forfás survey on public attitudes to waste issues found that some 71% of those surveyed agreed that they were willing to pay more to see more waste being recycled. In addition, respondents indicated a willingness to participate more in recycling activities. However, in return for

increased effort, they sought a greater commitment from local authorities in terms of providing improved recycling infrastructure and believed that public bodies should lead by example, Forfás, (2001).

Green bins accept the following items: TetraPak cartons, paper, newspapers, junk mail, magazines, aluminium beverage cans, light card, steel and tin cans, telephone directories, pizza boxes, and plastic bottles (clean with lids removed), Dublin Local Authorities, (2008)³. There are certain items that cannot be accepted by green bins that householders may not be aware of i.e. certain types of plastics and envelopes with plastic windows, so if these items are included in green bin waste it may result in this green waste being sent for landfill disposal. Plastics are widely accepted at civic amenity sites for recycling and as 69 of the 85 respondents revealed they recycle using amenity sites along with green bins, it may be assumed that a good percentage of plastics are removed from the black bin waste and diverted to recycling. Plastic is a high calorific waste, averaging at a calorific value of 24MJ/kg. Plastics are an ideal waste for incineration and despite high diversion rates, plastics will always be disposed of in a black bin due to contamination, certain plastics not accepted at amenity sites and also because some householders will not divert all of their plastic waste to recycling due to poor awareness.

The Dublin Waste Management Plan has set a recycling rate target of 60% for the Region and in response to this target; the Dublin Local Authorities are improving the recycling infrastructure available to householders. In the Dublin Region there are now 9 recycling centres in operation and 11 community bring centres which are similar to recycling centres but serve a smaller community and accept fewer waste types.


By the end of 2006 the Dublin local authorities had put in place 321 bring bank facilities for householders, representing an increase of 58 facilities since the end of 2003. This increase is indicative of the Dublin County Councils progressive approach to recycling and their determination to reduce Dublin's dependency on landfill as the sole method of disposal for its waste.

The majority of completed questionnaires illustrated that most of the respondents lived within a 3km radius of their nearest recycling facility and only 4 respondents lived further than 5km from a recycling facility. No distinction was made in the questionnaire between civic amenity centres, bring centres or bottle banks; the objective of the question was to determine whether general recycling facilities were available in their locality.

4.1.3 Opinion on the Introduction of Household Waste Incineration in Dublin

Householders were questioned on whether the introduction of incineration in Dublin would impact their recycling habits in the home. The majority of households, 77%, indicated that the introduction of incineration would not change their recycling routine and that they would continue to use their green bins and local recycling centres as before. The introduction of incineration would make 18% of householders more inclined to recycle and endeavour to divert more recyclable waste from their black bins for disposal/incineration whilst 5% admitted that they would be less likely to recycle if incineration came on-line in Dublin. This means that if incineration was available to treat Dublin's waste, this 5% of householders would lose interest in recycling and instead discontinue segregating their waste. Whilst this is a small minority of householders, (equating to 4 households), it shows that some Dubliners feel that it is easier and less of an effort to burn their waste than actively try to use their waste as a recyclable resource. As a relatively small number of households received this questionnaire, this figure may not be representative of the general consensus in Dublin; however it cannot be ignored. If households discontinued recycling at their high rates, the calorific value of waste available for incineration would rise.


Evidence from European countries has shown that high recycling levels can exist in conjunction with sustainable incineration, as there will always remain a residual fraction of waste available for disposal/incineration that cannot be recycled. Now that recycling has been established as a feasible method of diverting waste from black bin disposal in Dublin, it is unlikely that the level of waste presented for collection as black bin waste for disposal will change dramatically.



Householder opinion on the introduction of household waste incineration in Dublin did not result in a clear majority conclusion. Incineration would be welcomed by 48% of households compared to 45% of households that would not approve of incineration as a household waste management alternative. A small section of householders, 7%, are not sure or have no opinion on the matter. Findings from the ERM/Forfás survey on public attitudes to waste issues found that 57% of respondents said they would be opposed to the idea of having an incinerator located close to them. Yet when asked in general terms whether they would prefer their weekly household waste to be incinerated or landfilled, a small majority of respondents opted for incineration by a margin of 46% to 44%, 10% having no opinion Forfás, (2001).

The optional comments gathered from the questionnaire gave some insight on Dublin householder's attitudes towards incineration. It was felt that not enough information has been made available to the Dublin population with regard to the proposed development in Poolbeg, resulting in people not being aware of the benefits, and disadvantages of such an infrastructure in Dublin. Public hearings with regard the Poolbeg incinerator have often been held on a weekday when most people are in work so it has not been easily accessible. Concern was raised over the pollution impacts of incineration and that it would not be favourable to live in the vicinity of Dublin's incinerator. Incineration was seen by some as being a better alternative to landfill but would have to be tightly regulated in order to receive backing of the public.

The EPA, Food Safety Authority Ireland (FSAI) and the World Health Organisation (WHO) have all indicated that properly managed well run incinerators do not impact on




the environment or on human health and legislation controlling emissions from incinerators is among the strictest environmental legislation in the world. The aim of Waste Incineration Directive 2000/76/EC is to prevent or reduce, as far as possible, air, water and soil pollution caused by the incineration or co-incineration of waste, as well as the resulting risk to human health. The proposed Poolbeg incinerator will be licensed by the EPA and will be subject to rigorous monitoring of its emissions along with stringent anti-pollution devices installed. Whilst some comments suggested that the incinerator would only add to air pollution, once the waste is burnt at a monitored temperature greater than 850°C and flue gas cleaning measures are in place, the air pollution emitted from the incinerator should be minimal. Even if 1 million tonnes of municipal waste were incinerated in Ireland, this would contribute less than 2% of the dioxins emitted to air FSAI, (2003). Most dioxins will continue to come from uncontrolled burning of waste in back gardens, bonfires and accidental fires.

Another comment referred to incineration as a “dirty” method of treating waste and that recycling was perceived as a cleaner and more environmentally friendly method of dealing with Dublin’s waste. Incineration did have a very poor track record, as regulation of incineration up to recent years had been rather poor, resulting in poor practices developing in some incinerators. Unsurprisingly the upshot of this is that public opinion of incineration as a waste management technique is not very positive and operators will have to earn public support through competent management and an open approach to public fears.

Recycling may not be the clean and environmentally friendly management procedure that householders perceive it as. There are no facilities in Ireland to deal with plastics, glass or paper for recycling so these commodities must be exported for treatment. This does not comply with the European proximity principle and will only add to the carbon footprint of the materials for recycling.

Not all waste products can be recycled; there will always be a residual fraction remaining in household waste that will require disposal. Currently in Ireland this fraction is disposed of solely by landfill but this practice will have to change due to the introduction of the Landfill Directive 1999/31/EC. Incineration can alleviate the waste management problem in Dublin and it also has provisions to provide heat and energy for local householders in the future. In this way, incineration of Dublin's waste is a sustainable mechanism, extracting energy from an otherwise wasted resource. An incinerator in Poolbeg will require a constant supply of waste for it to be viable so it does not encourage householders to reduce the amount of waste they produce. However, encouragement is already in place in the form of increased waste collection charges by the Dublin local authorities, also green bin availability and brown bin roll out in the Dublin area. It is not likely that the waste supplies in Dublin will decrease substantially over the next couple of years; the population in Dublin is rising and commercial & industrial waste (that will also be accepted in the proposed Poolbeg incinerator) is either rising or staying at constant levels.

To allow a constant level of waste deliveries to the proposed Poolbeg facility, it is proposed that it will accept deliveries between 8:00 AM and 10:00 PM Monday through



Saturday, 312 days per year, and handle up to 50 trucks per hour Elsam (2006). Concern was raised from a respondent to the questionnaire over the number of heavy trucks that these deliveries will generate. The traffic impact analysis in the Environmental Impact Statement for the Poolbeg incinerator showed the proposed development will not generate significant traffic on either the local or strategic road network and adequate capacity was available on the road network to accommodate the development. Overall in transport terms, the site is well located and will not create any undue traffic impact on the local community or the road network provided proposed traffic management measures and the associated mitigation measures are implemented, Elsam (2006). This constant supply of waste is necessary to facilitate continuous operation of the facility and to allow it to perform at its optimum levels.

One respondent noted that a major benefit of introducing municipal waste incineration in Ireland would be the decrease in landfill usage. Instead of household waste disposed of with no further use, incineration will allow this waste to be reduced in size before it requires landfill or further treatment. The bottom ash remaining after the incineration process will have to be exported abroad until the framework for re-using bottom ash is established in Ireland. Flue gas residues and fly ash will also be exported for treatment abroad as a hazardous waste as there is currently no facility in Ireland capable of treating this waste. So whilst Dublin's municipal waste will be diverted from landfill and reduced in volume following the incineration process, it will still require treatment that does not comply with the proximity principle that waste should be dealt with as close as possible to its source. The incineration of waste in the proposed facility in Poolbeg may be

sustainable due to the constant supply of municipal waste and its anticipated use as an energy supply but the export of its final residue is not and needs to be addressed.

One respondent to the questionnaire was not keen on the introduction of municipal waste incineration in Dublin as they felt more measures could be taken before incineration can be considered an option. These measures could include treatment of residual waste in Ireland to reduce costs and dependencies on other countries for treatment facilities.

From the comments received it is clear that many householders questioned during this survey were knowledgeable on the subjects of recycling and incineration. The overriding sentiment from these comments is that the public requires more information and clarity on the proposed incinerator and its effects on Dublin householders. Whilst some can see the benefits in that municipal waste will be diverted from landfill and potentially used to provide heat and energy to the locality, others are wary about the introduction of incineration and are concerned over its pollution impacts. There is a lot of conflicting evidence and information circulating in the media about the pollution and health impacts of incineration but the focus of this dissertation is on the sustainability of an incinerator in Dublin. It is clear from the results obtained in the questionnaire that recycling in Dublin is gaining in momentum; this has been achieved through active advertising campaigns by the councils and increased household waste collection charges. However, a constant supply of waste is still available for disposal that needs to be diverted from landfill in order for Dublin, and Ireland, to comply with the Landfill Directive 1999/31/EC and local authority waste management plans.

Now that the supply of waste has been established, the calorific values of this household waste for disposal shall be discussed.

4.2 Household Waste Survey

A survey of household waste generated by a Dublin household was performed over a period of 1 calendar month in March 2008. This household is located in North County Dublin, in the borough of Fingal County Council. During this period, the household was serviced by a black bin collection and a green bin collection. Black bins in this area of Fingal are collected by the council themselves and disposed of in Balleally landfill in Lusk, County Dublin. Oxigen Waste provides green bin collection service under contract by Fingal Co.Co. During the period of March 2008, black bins could be presented for collection on a weekly basis once they were tagged. Green bins were collected monthly, on a day predetermined by Oxigen.

The dynamics of the household correlated well to the average household figures as determined by the census of 2006, with 2 people residing in the house compared to an average of 2.5, CSO (2006). As this household is privately owned, the householder as opposed to a management company presents the green and black bins for collection.

No children resided in this house so the outcome of the waste survey can be seen as a worst-case scenario for its resulting calorific value of its household waste. A household with children and babies would produce a higher volume of waste due to disposal of nappies, increased contaminated packaging waste and other sundries. Therefore it may be assumed that the determined calorific value of the waste from this particular household would be within the lower range of estimated energy values of household waste.

The purpose of this survey was to determine a best estimate of the calorific value of household waste for disposal. Most studies are in agreement that the average calorific

value of household waste is in the range of 9-10GJ/t (MJ/kg). However this calorific value depends on the assumption made on the composition of household waste, Cheshire Local Government Association, (2001). The calorific values of waste diverted for recycling in this study were also calculated for information purposes.

The majority of paper/cardboard can be diverted for recycling but a residual fraction of paper/cardboard will always remain in a household waste stream for disposal by landfill, or other methods, due to its contamination by food products and/or other sources.

In the case of this household, a high fraction was diverted to the green bin for collection or to the nearest recycling centre. As per figures 3.11 and 3.12 in Section 3, the ratio of plastic for disposal to plastic for recycling is 1:5 and for paper/cardboard it is approx 1:9. This indicates a high proportion of household waste generated in this household was diverted from landfill to recycling. In 2006, the national recovery rate for plastics was 14.5% and for paper/cardboard this figure was 41.3%, EPA, (2008). A study by the Cheshire Local Government in the UK found that approx 65% of the average waste stream is considered recyclable, this figure included a 65% average for paper/cardboard and a 33% average for plastics, Cheshire Local Government Association, (2001).

The figures obtained in this study for paper/cardboard and plastics may not always be recreated in every household in Dublin. As these results are not typical, these figures can be taken as a worst-case scenario figure and higher volumes of paper/cardboard and plastics waste may be generated by other households. Thus the household under scrutiny may have resulted in a lower than average calorific value for total household waste for disposal.

Referring to table 3.4 in Section 3, the removal of the most recyclable elements of household waste such as plastics and paper/cardboard will result in a reduced calorific value for the household waste presented for disposal by incineration. Glass and metals are shown to have a negative calorific value meaning the energy generated from incinerating these items is less than the energy that was required to fully incinerate these items. Therefore their removal from this waste stream is advantageous and recycling of these items must be promoted in order to ensure the incinerator is functioning in a sustainable manner.

The total calorific value of all the waste generated by this household was calculated to be 9.80MJ/kg. The calorific value of the waste for disposal, and potentially for incineration was calculated to be 9.28MJ/kg.

Despite the diversion of 6.4kg of waste to recycling, this only reduced the calorific value of the waste remaining for disposal/incineration by 0.5MJ/kg.

Kjaer, in his information day presentation for the Dublin Waste to Energy project in 2004, stated that the Poolbeg plant has a design heat value of the waste of 11.5 MJ/kg but requires the plant to be able to handle waste in the range of 8-15MJ/kg.

The calorific value of the waste generated by this household comfortably fits into this bracket and also complies with the calorific value specifications of the feasibility study compiled for the Limerick/Clare/Kerry region of 7-15MJ/kg. The value obtained in the household waste survey of 9.28MJ/kg is slightly below the lower calorific value of 10.5 GJ/tonne (equal to 10.5MJ/kg) stated in the Poolbeg incinerator Environmental Impact Statement. However, as this household waste survey may be interpreted as a calorific

value worst-case scenario, it can be assumed that the waste from many other Dublin households will be above this 10.5MJ/kg lower limit of specification, as stated in the Poolbeg incinerator EIS.

SECTION 5. CONCLUSIONS

- Recycling is gaining momentum in Dublin with householders recycling using both green wheelie bin and recycling centres. The introduction of incineration would not dissuade householders from recycling; in fact it may encourage householders to recycle more.
- From the survey performed, the majority of households present their black bins for disposal every week in Dublin.
- Majority of Dublin householders welcome the introduction of incineration for municipal waste treatment in Dublin, but the margin is very tight.
- Feedback from the questionnaire indicates not enough information has been made available to Dublin householders about the proposed Poolbeg incinerator site resulting in public concerns over pollution and possible negative impacts that remain unanswered.
- The calorific value of household waste generated in Dublin is high enough to sustain the operation of the proposed Poolbeg incinerator.
- Whilst the incineration process is sustainable, the treatment of residual ash from the incinerator will require further development and national investment. The export of this waste goes against the proximity principle, which advocates that waste should be disposed or managed close to the point at which it is generated, thus aiming to achieve responsible self-sufficiency at a regional level.
- The incineration process itself is sustainable as a municipal waste management tool for Dublin but the management of the waste resulting from the process is not sustainable, as it will be shipped abroad for treatment and disposal.

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