An Bord Pleanála

STTATEMENT OF EVIDENCE

Proposed Ringaskiddy Waste-to-Energy Facility

by

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ON BEHALF OF

Cork Harbour Alliance for a Safe Environment - 'CHASE'

JUNE 2009

Introduction

1. My name is Alan David Watson. Since 1996 I have been the Director of 'Public Interest Consultants' an environmental consultancy specialising in chemicals, energy and waste planning and permitting issues. I have been a Chartered Engineer since 1986 and have an Honours degree in mechanical engineering. I have previously worked for the Department of the Environment for seven year; as a senior design and installation engineer working on waste and combined heat and power plants and, until 1996, as the senior specialist for Friends of the Earth Ltd. on Industry and Pollution issues.
2. I have a wide range of experience in the field of waste disposal planning and related aspects of law, medicine and toxicology. I have undertaken research on these issues for many years and been the author of a large number of reports for a range of local authorities, environmental groups, citizens groups, lawyers, MPs and commercial interests and inter-governmental organisations such as UNEP. I also have wide experience of appearing as an expert at many public inquiries and in several judicial review proceedings on behalf of local authority and private clients.
3. I have also given evidence to parliamentary select committees and to other hearings into waste related issues. I have presented many papers at conferences on planning and pollution related issues and have been a visiting lecturer at several universities. I have also been accepted as an expert on combustion processes by a Florida court and acted as an expert on waste treatment and disposal in UK courts. I have been a member of the statutory Environmental Protection Advisory Committee for Environment Agency Wales and the Stockholm Convention Expert Group on Best Available Techniques/Best Available Practices for dioxin and PCB reduction.
4. This Statement of evidence is presented on behalf of Cork Harbour Alliance for a Safe Environment ('CHASE').
5. The main issues addressed in this evidence are:

   Obligations arising from the Stockholm Convention

   External Costs associated with Emissions

   Disposal vs Recovery

   Generating Efficiency and CHP

   Ash Generation and Disposal
6. The conclusions that I reach are:

Obligations arising from the Stockholm Convention

7. The European Regulations implementing the Stockholm Convention require that 'priority consideration' must be given to alternatives to the proposed incinerators. Indaver has provided no information in the EIS to inform such any review based on emissions of POPs.

8. The priority consideration should include a proper review of whether the current recycling targets are sufficiently ambitious; the use of MBT with stabilized waste to landfill and/or cement kilns in addition to composting and anaerobic digestion of organic waste. For the hazardous wastes non-combustion alternatives should be included. As incineration is the technology that has the highest production of POPs, when properly assessed and taking into account the high levels in the air pollution control residues, it seems unlikely that the review would support this proposal.

External Costs associated with Emissions

9. The health impact assessment in the EIS has not properly assessed the direct and indirect health effects of the proposed incinerators. The simplistic and incorrect assumption has been made that as long as the air quality standards are achieved at the point of maximum ground level concentrations then emissions from the incinerators would be acceptable and would have no adverse impact on health or the environment.
10. In an effort to establish whether the emissions that have been omitted from consideration in the EIS have any 'significant' impacts I have applied the Ireland specific CAFE external costs to the projected emissions from the incinerators.
11. I have used the total emission levels derived from the EIS, as above, and the maximum and minimum country specific external costs. I have then multiplied these costs over a nominal 25-year operating period.
12. Using this approach the minimum external costs associated with emissions of particulates, VOCs, SOx, NOx and ammonia alone is in the range €53 million to €154 million.
13. I conclude that the claim in the EIS that there would be "*no deleterious effect on human health either in the immediate vicinity or in the wider context*" due to the operation of the facility is incorrect.

Disposal vs Recovery

14. The current legal position, following the decisions of the ECJ is that the proposed incinerators are both disposal technologies. However the December 2008 revisions to the Waste Framework Directive '2008/98' [1] offer the possibility for municipal waste incinerators to demonstrate that they may be classed as recovery options rather than disposal subject to meeting the requirements of an efficiency assessment in Annex II 'Recovery Operations'.
15. The efficiency equation does not apply to Hazardous waste incineration which should always be classified as disposal and classed under D10 'Incineration on Land' of Annex I 'Disposal Operations'.
16. I have reviewed the presentation that was made to the hearing by Claire Downey suggesting that the incinerators would exceed the 0.65 threshold.
17. Using the data provided in the EIS results in an efficiency factor of 0.59.
18. Correcting the presentation for arithmetic errors and parasitic loads the new information presented by Claire Downey indicates that the efficiency would be 0.63.

19. In practice the operational efficiency is likely to be lower than this theoretical optimal because fluctuations in the calorific value of the waste, lower load efficiency reductions and start-up/ shut-down losses will reduce the useful output.

20. In the event that the application is approved it would be sensible to include a condition similar to that at Poolbeg to any licence with a requirement for independent verification. This should be tied to an obligation that in the event that the incinerator in operation, contrary to the claims of the applicant, does not satisfy the criteria for recovery then the restrictions relating to disposal operations should apply to the facility. The consequences should include a strict application of the proximity principle which would limit the area from which waste could be delivered to the facility for disposal.

Generating Efficiency and CHP

21. The proposed incinerators would be particularly inefficient generators of electricity managing less than 22% when assessed in a more traditional way compared to more than 60% for modern CCGTs.

22. The European Commission’s thematic strategy on waste prevention and recycling notes "*at low energy efficiencies incineration might not be more favourable than landfill*".

23. The poor efficiency and environmental performance of incinerators is one reason the Waste Incineration Directive requires heat to be recovered as far as possible and this has major benefits for reduction of emissions and climate change impacts.

24. I strongly disagree with the assessment that this site is ‘ideally suited’ for CHP. The lack of any supporting information in relation to the potential heat loads; existing heat sources; plans for or cost of heat mains and associated distribution infrastructure reinforce my conclusions.

Ash Generation and Disposal

25. It is unclear from the EIS what treatment or disposal is proposed for the bottom ash and it appears that Indaver has not established appropriate treatment facilities for the ash. Even in the best circumstances for Indaver of the ash being non-hazardous the EIS accepts that if the ash it to be utilised for road construction rather than landfilled then some treatment is required but this has not been assessed in the EIS.

26. It would be anticipated that as the production of ash is a direct impact of the proposed incinerator the EIS should include comprehensive details relating to the treatment and disposal proposed in Ireland.

27. This is particularly important as there is increasingly strong evidence that at least a significant proportion of the bottom ash is hazardous waste.

28. The English Environment Agency has admitted it does not "*have 100% confidence*" in its classification of incinerator bottom ash (IBA) as non-hazardous waste and Veolia wrote to the Agency saying "*around 40%"* of its IBA would become ecotoxic under the recent guidance which includes zinc compounds

29. The National Hazardous Waste Management Plan says:

> *Is there a case to suggest that all incinerator ash could be classed as hazardous?*

30. On the basis of the evidence available it is reasonable to conclude that bottom ash should be regulated as hazardous waste.

Obligations arising from the Stockholm Convention:

31. Ireland has signed but not yet ratified the Stockholm Convention. The European Union has, however, both signed and ratified the Convention. Furthermore in 2004 a European Regulation (No 850/2004 on persistent organic pollutants and amending Directive 79/117/EEC as amended) ('Reg 850/2004') [2] was enacted to ensure that the obligations arising from the Stockholm Convention (and the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants together with the associated UNECE protocols) are implemented within Europe.

32. The Regulation is "binding in its entirety and directly applicable in all Member States". The Regulation is given effect in Ireland by the S.I. No. 821/2007 — Waste Management (Facility Permit and Registration) Regulations 2007. The domestic regulations require that the provisions of the European Regulation should be given effect "in relevant waste permits granted by a local authority".

33. Article 6 of Regulation Reg 850/2004 requires that Member States shall, when considering proposals to construct new facilities using processes that release chemicals listed in Annex III (dioxins, polychlorinated biphenyls, hexachlorobenzene and polycyclic aromatic hydrocarbons) without prejudice to Council Directive 1996/61/EC give:

    "priority consideration to alternative processes, techniques or practices that have similar usefulness but which avoid the formation and release of substances listed in Annex III".

34. The EIS purports to address the obligations of the Stockholm Convention at s 4.22.2 of Chapter 4. This section acknowledges that the Convention requires that:

    "priority consideration should be given to alternative processes, techniques or practices that have similar usefulness but which avoid the formation and release of such chemicals"

35. Nowhere in the application, however, is there evidence of any assessment having undertaken to assist the hearing in this "*priority consideration*". The Stockholm Convention BAT/BEP guidance (which was not in draft form at the time the EIS was written as is claimed – the guidelines were adopted at COP3 of the Stockholm Convention in Dakar in 2007 [3]) contains a lengthy introductory section on assessment of alternatives and the approach that could be used to give priority consideration to these alternatives but this appears to have been completely overlooked by the EIS – as does the EU implementing Regulation 850/2004.

36. A 2007 paper by Vandecasteele [4] reviewing aspects of the Indaver operations in Belgium claims that:

    "On a yearly basis … ca. 16 g TEQ leaves the installation, which is comparable to the input amount of ca. 20 g TEQ: no more PCDD/PCDFs leave the installation than enter it. Moreover, the output PCDD/PCDFs are concentrated in a much smaller volume than the input

PCDD/PCDFs."

37. If this was correct then the necessity for consideration of alternatives would be reduced. It is clear, however, that the assessment is largely predicated to the assumption relating to the levels of dioxin in the incoming waste.

38. These assumptions are that:

    "The average PCDD/PCDF concentration in residual municipal solid waste is estimated at 20–70 μg TEQ/ton (Vehlow et al., 2003). Wilken et al. (1992) obtained an average TEQ-value of 50 μg/ton of wet total waste for municipal solid waste from Germany. If an average of 50 μg TEQ/ton is assumed, this corresponds to ca. 20 g TEQ for the total input quantity of waste of 400,000 ton in 2004 in the considered installation."

39. The levels claimed are out of date (the Vehlow figures are a secondary reference in a conference presentation and refer to German data from the early 1990s) and are not representative of current waste streams.

40. Burnley [5] reported that according to his best estimate, a modern incinerator produces about 15 times as much dioxin as that in the incoming wastes. Using pessimistic assumptions, the overall dioxin loading could be increased 170-fold. Even on the most optimistic assumptions, incinerators remained a net dioxin source.

41. Burnley used contamination levels for the input waste of from UK sampling[1] which showed *"showed fairly consistent dioxin concentrations of 3-13ngTEQ/kg".* These levels are typical of those reported in the literature since 1995. They can be compared with the levels reported in the EIS for soil samples around Cobh of 1-1.2 ng TEQ/kg (s. 7.5.3). There is no reason for MSW to be very much higher than these background levels unless there are particular source of contamination – in the case of the data from Wilken [6] it appears that this was contaminated ash in the waste. The levels of ash in modern MSW are now very low and the UK levels are more representative of modern arisings.

42. If the UK levels are applied to the waste input data then the dioxin input would be between 3.8 and 16.7 times smaller than assumed by Vandecasteele. Properly corrected the paper would show that the annual dioxin input should be between 1.2 g and 5.2 g with an output of c.16 g. The incinerator is therefore more likely to be a significant net producer of dioxins.

43. The obligation remains to give "*priority consideration*" to those alternatives which do not produce POPs and this should emphasise not only MBT combined with landfill (after full stabilisation) and/or incineration but also increased recycling levels together with anaerobic digestion and composting of organics.

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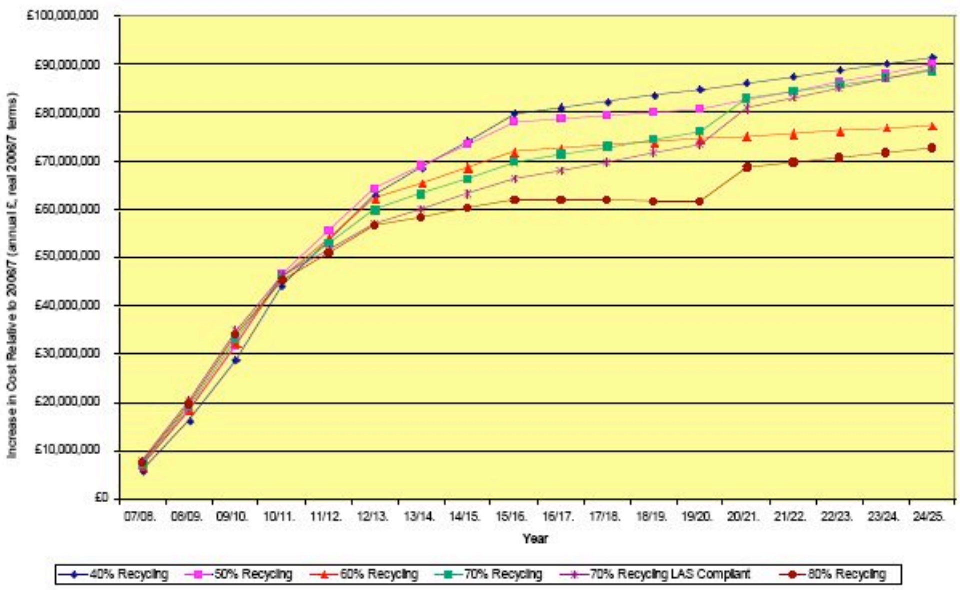
[1] From A preliminary assessment of trace organic compounds in household waste, CWM 133/95, from Waste Management Information Bureau, AEA Technology, F6 Culham, Abingdon, Oxfordshire OX14 3DB

44. Whilst this evidence is not the place for such a review I note that the recycling rate assumed in the need assessment for the proposal is just 50%.

45. A recent consultation paper by the National Assembly for Wales [7], however, estimated that up to 93.3% of municipal waste could either be recycled or composted/ anaerobically digested. Perhaps more significantly it showed that the most cost effective recycling level over the period to 2024/25 would be 80% of the waste:

Figure 3: Evolution in Annual Increases in Cost Relative to 2006/7 (annual increase in real £ 2006/7)



46. The current ‘Zero Waste’ consultation in Wales is promoting a 70% recycling level [8] as being more readily and rapidly achievable. Scotland has already included an ‘aspirational’ 70% target in the recently announced revised waste strategy[2] [9]. These levels of recycling, whilst high compared with current practice in Ireland, are already exceeded in parts of Europe such as in Flanders and this is acknowledged in the EIS (s 1.1 Ch 1.). There is no reason to doubt, therefore, that they can be achieved in Scotland, Wales – or in Ireland.

47. In these circumstances it is difficult to understand why the EIS caps the recycling potential at just 50%. It is almost inevitable that higher levels will be set and achieved in the future – increasing pressures on resources the special circumstances of global climate change will drive these changes. Yet the EIS says that “*the municipal part of the facility has been designed in line with an ambitious 50% recycling target*”. This is clearly <u>not</u> “*an ambitious*” recycling target.

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[2] *The Scottish Government is also proposing in the strategy that by 2025 no more than a quarter of municipal waste should be treated using energy-from-waste technology. This cap includes the use of anaerobic digestion.*

48. There is also a range of non-combustion alternatives available for hazardous wastes which do not produce POPs – or which produce much lower levels of POPs than incineration. Some of these technologies are included in the BAT/BEP guidelines produced by the Stockholm Convention [3] and a more comprehensive review of options is available from UNIDO [10].

49. **The priority consideration should include a proper review of whether the current recycling targets are sufficiently ambitious; the use of MBT with stabilized waste to landfill and/or cement kilns in addition to composting and anaerobic digestion of organic waste. For the hazardous wastes non-combustion alternatives should be included. As incineration is the technology that has the highest production of POPs, when properly assessed and taking into account the high levels in the air pollution control residues, it seems unlikely that the review would support this proposal**.

External Costs of Emissions:

50. I have read the evidence presented by Professors Howard and Staines and have seen the comments made in response by Drs Porter and Hogan.

51. I agree with Professors Howard and Staines in their criticisms of the health risk assessment in the EIS. The approach adopted by the Indaver is summarised at s 7.2.2 (Ch 7 p 7-11) as:

    All information available on the Ringaskiddy facility indicates that all emissions will be well within the statutory Air Quality Standards. These provide strong evidence that there will be no deleterious effect on human health either in the immediate vicinity or in the wider context, due to its operation

52. The comments of Dr Hogan further indicates that the health assessment of the emissions to air from the proposal has been essentially limited to an expected area of deposition, described as a an area around the plant with a radius of c.1km.

53. It is far too simplistic, in my opinion, to assume that as long as the air quality standards are achieved at the point of maximum ground level concentrations then emissions from the incinerators would be acceptable and would have no adverse impact on health or the environment,

54. Professor Howard detailed the inadequacy of this approach particularly in relation to pollutants which have no threshold such as particulates. Even by 2001 Staessen [11] had concluded that "*current environmental standards are insufficient to avoid measurable biological effects*". More recently Kraft et al [12] found that no safe level could be established for oxides of nitrogen and concluded that "*on basis of epidemiological long-term studies a threshold below which no effect on human health is expected could not be specified*". Thus the NOx emissions should be considered in a similar way to other no-threshold emissions such as particulates. It is self-evidently wrong to ignore the impacts from such emissions because the majority of the effects are not in the very tightly defined immediate vicinity of the incinerator.

55. Furthermore the failure to consider the secondary impacts described by Professor Howard represents a major flaw in the application and is inconsistent with the obligations from the Environmental Assessment Regulations.

4. I note that at s.1.5.2 (also at s.18.2) of the EIS a description is given of the statutory requirements for the contents of an EIS which includes a description being required of:

    'the likely significant effects (including direct, <u>indirect</u>, <u>secondary</u>, cumulative, short, medium and long-term, permanent and temporary, positive and negative) of the proposed development on the environment resulting from:

    "The existence of the proposed development
    The use of natural resources

The emission of pollutants, the creation of nuisances and the elimination of waste" and a description is required of the forecasting methods used to assess the effects on the environment.'   (my emphasis)

5. The EU definition of 'Indirect Impacts' is included in Ch.18 s 8.4 of the EIS as:

   Indirect Impacts: Impacts on the environment, which are not a direct result of the project, often produced away from or as a result of a complex pathway (sometimes referred to as second or third level impacts or secondary impacts).

6. I have seen no evidence that the secondary particulate emissions described by Professor Howard have been considered at all in the EIS. Nor, I should add, as I return to this point in a following section, have I seen any consideration of the effects associated with the treatment or disposal of residues from the proposed incinerators although they clearly fall within this obligation being significant effects arising from the existence of the development and the emission of pollutants from the proposal.

7. The EU "Clean Air For Europe" ('CAFE') programme has assessed the secondary impacts of pollutants in detail for each country in the EU25 together with assessments for emissions on the four major seas around Europe. The overview of the methodology [13] says, in relation to the assessment of the impacts of air pollution on human health:

   The pollutants of most concern here are fine particles and ground level ozone both of which occur naturally in the atmosphere. Fine particle concentration is increased close to ground level by emissions from human activity. This may be through direct emissions of so-called 'primary' particles, or indirectly through the release of gaseous pollutants (especially SO_2, NO_x and NH_3) that react in the atmosphere to form so-called 'secondary' particles. Ozone concentrations close to ground level are increased by anthropogenic emissions, particularly of VOCs and NO_x. (my emphasis)

8. Ozone is clearly a secondary impact associated with the release of VOCs (volatile organic compounds) and NOx, both of which are significant emissions from the facility as demonstrated below. As with the effects of secondary particulates, however, the impacts of secondary ozone appear to have been completely omitted from consideration in the EIS.

9. These are serious omissions from any assessment of a major combustion facility and I support the criticisms of the EIS made by Professor Staines when he concludes:

   Overall, this report is wholly inadequate, and does not contribute to answering the question posed. Leaving aside the disgraceful plagiarism, the writer has not done what he suggested was required, a baseline environmental analysis, followed by an estimation of the impacts of changes in this on human health. It is not possible for any reasonable person to draw any conclusions as to the health impacts of the proposed development from the EIS

10. It is true that if the impacts of these emissions were found to be negligible in a scoping exercise then they could reasonably be omitted from further detailed investigation. There is, however, no evidence that EHA (or any other consultant involved in the preparation of the EIS) has undertaken such a scoping exercise.

11. In an effort to establish whether the emissions that have been omitted from consideration in the EIS have any 'significant' impacts I have applied the Ireland specific CAFE external costs to the projected emissions from the incinerators.

12. Oxides of nitrogen are, as described in the evidence of Professor Howard, responsible for the generation of secondary particulates.

13. No bag filter system can be effective at reducing those particulate levels because they are formed after the filters. The appropriate approach would be to use primary NOx reduction techniques such as selective catalytic reduction (SCR) which is in increasingly common use on incinerators around the world but is not proposed for these facilities.

14. The emissions data in the EIS shows that the incinerators would produce about 361 tonnes per year of oxides of nitrogen[4] if operated at the Waste Incineration Directive Standards:

Emissions	***Average Daily Emission Conc. mg/m3***	***Combined (both stacks) Emission Rate (g/s)***	***Annual Emissions tonnes***
Total Dust	10	0.67	17.96
Volatile organic compounds (VOCs)	10	0.67	17.96
Sulphur Dioxide (SO_2)	50	3.37	90.33
Nitrogen Oxides (as NO_2)	200	13.47	361.07
Ammonia	10	0.67	17.96

15. To help put this into perspective the NOx emissions can be compared with those from cars – accepted as being a major source and contributing approximately 45 per cent of the total emissions in 2007[5].

16. Ireland's national emission ceiling for NO_X under the National Emissions Ceiling Directive '2001/81/EC' is 65 kilotonnes (kt), to be achieved by 2010 whilst emissions in 2007 were 120.9 kt so any avoidable increase is to be welcomed – at least as a contribution to avoiding missing the target by a wider margin than is absolutely necessary.

17. A modern car exhaust produces about 1 kg of NO_x per 10,000 km[6]. The emissions from the incinerator would therefore be approximately equivalent to the emissions from a modern car driving 3.61 billion[7] km. The total

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[4] See the table of emissions abovebelow

[5] http://www.epa.ie/environment/air/emissions/nitrogenoxides/

[6] Euro V emission limit Class M =100 mg/km

[7] US Billion i.e = $1x10^9$

population of the town of Cobh was c 6,517 in 2006[8]. Therefore the emissions from the incinerators would be the equivalent of every member of the population of the town of Cobh driving an annual average of more than 554,000 km. The incinerator emissions would, of course, be emitted at higher level but this is a major contribution to the total air pollution burden in any terms.

18. The CAFE Programme assessment of the impacts and associated external costs is detailed extensively [13-16] and has been subject to a publically available peer review [17].

19. I have used the total emission levels derived from the EIS, as above, and the maximum and minimum country specific external costs. I have then multiplied these costs over a nominal 25 year operating period.

20. Using this approach the minimum external costs associated with emissions of particulates, VOCs, SOx, NOx and ammonia alone is in the range €53 million to €154 million.

21. I have assessed the sensitivity of these externalities to the claimed operating regime whereby it is suggested by Indaver that the actual emissions are likely to be lower than the permitted emission levels (though I understand that Indaver is not prepared to offer to guarantee those lower emission levels by their being incorporated into any license).

22. To do this I have taken emission levels of PM, VOCs, SOx as 40% of the WID standards. For NOx, which is a more demanding target for a plant with SNCR I have taken average emissions at 90% and for ammonia slip, largely linked to the achievement of NOx levels, I have taken 80% of the EIS emissions levels.

23. The outcome is that the total external costs range from € 39 million to € 112.5 million. These are, in any terms, enormous external costs and by failing to include them in the EIS Indaver has not, in my opinion, satisfied the requirements of the EIA Directive nor of the implementing Planning and Development Regulations 2001.

24. The applicant has also clearly failed to properly assess the health and environmental impacts of the emissions from their proposal. The consequence of ignoring these secondary and far field impacts of the emissions means that the public, by accepting damage to their health, would be subsidising Indaver by approximately €9 - €25.5 per tonne of waste burned.

25. I note that these external damage costs are very similar to those calculated for direct non-greenhouse gas related emissions by Eunomia [18] and others:

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[8] http://en.wikipedia.org/wiki/Cobh

Table E - 1: Externalities from Landfill, Incineration and MBT

	Landfill	Incineration	MBT
Direct emissions non-GHG related	€ 2.64	€ 23.51	€ 0.49
Direct emissions GHG related	€ 59.13	€ 28.71	€ 15.62
Total Direct Emissions	**€ 61.78**	**€ 52.22**	**€ 16.11**
Offsets GHG related	-€ 1.60	-€ 6.79	-€ 4.72
Offsets non-GHG	-€ 2.95	-€ 9.61	-€ 6.18
Total Offsets	**-€ 4.55**	**-€ 16.40**	**-€ 10.90**
Net Environmental damages	**€ 57.23**	**€ 35.82**	**€ 5.22**
Disamenity	€ 4.25	€ 14.30	€ 9.28[a]
Total External Costs	**€ 61.48**	**€ 50.12**	**€ 14.49**

a) This is an average of the two figures for landfill and incineration (see discussion in main text below).

Note: GHG = greenhouse gases

26. I conclude that the claim in the EIS that there would be "*no deleterious effect on human health either in the immediate vicinity or in the wider context*" due to the operation of the facility is incorrect.

External Costs Calculations:

Emissions	*Average Daily Emission Conc. mg/m3*	*Combined (both stacks) Emission Rate (g/s)*	*Annual Emissions tonnes*	*External Costs Min €*	*Max €*	*Annual Costs Min*	*Annual Costs Max*	*25 year Costs Min*	*25 year Costs Max*
Total Dust	10	0.67	17.96	15,000	42,000	€ 269,396	€ 754,310	€ 6,734,907	€ 18,857,740
Volatile organic compounds (VOCs)	10	0.67	17.96	680	2,000	€ 12,213	€ 35,920	€ 305,316	€ 897,988
Sulphur Dioxide (SO_2)	50	3.37	90.33	4,800	14,000	€ 433,607	€ 1,264,688	€ 10,840,185	€ 31,617,205
Nitrogen Oxides (as NO_2)	200	13.47	361.07	3,800	11,000	€ 1,372,071	€ 3,971,786	€ 34,301,786	€ 99,294,644
Ammonia	10	0.67	17.96	2,600	7,400	€ 46,695	€ 132,902	€ 1,167,384	€ 3,322,554
						€ 2,133,983	**€ 6,159,605**	**€ 53,349,577**	**€ 153,990,130**

Emissions	*Annual Average Daily Emission Concentration mg/m3*	*Sensitivity - average emissions as % of WID*	*25 year Costs at < WID emissions Min*	*25 year Costs at < WID emissions Max*
Total Dust	10	40%	€ 2,693,962.80	€ 7,543,095.84
Volatile organic compounds (VOCs)	10	40%	€ 122,126.31	€ 359,195.04
Sulphur Dioxide (SO_2)	50	40%	€ 4,336,073.86	€ 12,646,882.08
Nitrogen Oxides (as NO_2)	200	90%	€ 30,871,607.44	€ 89,365,179.42
Ammonia	10	80%	€ 933,907.10	€ 2,658,043.30
			€ 38,957,678	**€ 112,572,396**

Based on:

Availability *85%* *Operating period* *7446 hrs*

Disposal or Recovery?

27. Advocate General Jacobs concluded that the primary purpose of incinerators is waste disposal and not the generation of electricity in the 2002 judgment by the European Court of Justice on the case C-458/00, the Commission of the European Communities versus the Grand Duchy of Luxemburg [19]. The Court added that even if, as a secondary effect of the process, energy is generated and used, this classification as a disposal operation remains the same. The generation of electricity, whether purported to be renewable or otherwise, is therefore a secondary function.

28. The position today remains as it did in 2002. However the December 2008 revisions to the Waste Framework Directive '2008/98' [1] offer the possibility for municipal waste incinerators to demonstrate that they may be classed as recovery options rather than disposal subject to meeting the requirements of an efficiency assessment in Annex II 'Recovery Operations'.

29. The efficiency equation does not apply to Hazardous waste incineration which should always be classified as disposal and classed under D10 'Incineration on Land' of Annex I 'Disposal Operations'.

30. The relevant equation is included in the December 2008 Poolbeg incinerator licence. This licence includes, as Condition 7.2, a requirement to demonstrate operation at a minimum efficiency factor of 0.65:

> 7.2 The licensee shall build and operate the facility to achieve an energy efficiency of, as a minimum, 0.65 using the formula below to calculate Energy Efficiency:
>
> **Energy Efficiency = [Ep-(Ef +Ei)] / [0.97 x (Ew + Ef)]** where:
>
> **Ep** = annual energy produced as heat or electricity (GJ/year) (heat produced for commercial use is multiplied by 1.1 and electricity is multiplied by 2.6)
> **Ef** = annual energy input to the system from fuels contributing to the production of steam (GJ/year)
> **Ew** = annual energy contained in the waste input using the lower net calorific value of the waste (GJ/year)
> **Ei** = annual energy imported excluding Ew and Ef and **0.97** is a factor accounting for energy losses.
>
> The Energy Efficiency shall be reported annually in the AER.

31. Whilst the EIS provided no indication of how the Indaver proposal would perform in relation to this assessment a presentation that was made to the hearing by Claire Downey suggesting that the incinerators would exceed the 0.65 threshold.

32. The presentation is not referenced and was not entirely straightforward to understand – as the assumptions that are included in the calculation are clearly essential to the outcome it is considered more appropriate, at least as a starting point, to consider the data provided in the EIS rather than the post-hoc revisions.

33. The simplest assessment of thermodynamic efficiency would be to take the useful output as a proportion of the energy input. The EIS says total heat

input (which is limited by the thermal capacity of the primary chambers) is 2 x 50 MW = 100 MW. The total electrical output is 25MW (given as a range from 24.9 to 25.2 MW at Fig 4.18) and the parasitic load is 3 MW (s.4.15.6).

34. The crude electrical generating efficiency is therefore just 22%. This would be reduced by deduction of any support fuel oil and imported electricity. Applying this to the formula would give a 'best case' scenario for Indaver.

35. This can be done simply by dividing by 0.97 to allow for heat losses and multiplying the electrical output by 2.6 as in the equation above.

36. The EU efficiency ratings are potentially misleading because they are not a statement of power generation efficiency. Rather they offer a comparison with alternative power generation plant fired by fuels such as coal. The factor of 2.6 is included on the basis of comparing emissions with a conventional power station with an efficiency of 38% (100/38 = 2.6) this is the equivalent of an inefficient coal fired power station and is still low compared with best practice at > 60% for new combined cycle gas turbines, CCGTs) [20].

37. This would give a factor of 22x2.6/0.97 = 0.59.

38. This is clearly below the 0.65 threshold for recovery. As allowance for other factors such as the four tonnes of supplementary fuel oil that is projected to be used each year can only reduce the factor lower then it can be concluded that on the basis of the data provided in the EIS the proposals would not qualify as recovery operations.

39. There has been no indication of why any of these factors should have changed since the EIS was submitted. Indeed the only obvious change is that the Directive has been agreed with a higher factor than the 0.5 threshold that was unsuccessfully campaigned for by CEWEP.

40. In the presentation introduced by Claire Downey it is claimed that the energy efficiency in electricity mode is 0.69.

41. A key assumption that underpins this higher claimed efficiency is that heat and electricity used 'parasitically' within the incinerator is counted as useful output. Ms Downey has also applied factors for which no source or explanation has been given – such as multiplying the fuel oil usage by 0.75.

42. If the parasitic heat load is omitted from the calculations then Ep becomes simply 12.4 x 2.6 = 32.24 MW.

43. There is no basis given for applying the 0.75 factor to fuel oil so this should become Ef =0.24/0.75 = 0.32 MW.

44. There is an error in the calculation for Ew as (12 x 15.5)/3.6 = 51.7 (and not 49.9).

45. Putting these together we get:

$$\text{Efficiency} = 32.24 - (0.32 + 0.15) / [0.97 \times (51.7 + 0.32)]$$
$$= 31.77/50.46 = 0.63$$

46. This is again below the threshold for classifying the plant as recovery. The reason that this remains higher than that based on the data in the EIS is

unclear and more data on the performance of the plant would have been useful to clarify the reasoning behind the changes.

47. If a plant such as this were to be built it would be prudent to include a condition similar to that at Poolbeg to any licence with a requirement for independent verification. This should be tied to an obligation that in the event that the incinerator in operation, contrary to the claims of the applicant, does not satisfy the criteria for recovery then the restrictions relating to disposal operations should apply to the facility. The consequences should include a strict application of the proximity principle which would limit the area from which waste could be delivered to the facility for disposal.

Generating Efficiency, CHP and Climate Implications:

48. It can be seen from that the incinerators would be particularly inefficient generators of electricity managing less than 22% when assessed in a more traditional way compared to more than 60% for modern CCGTs.

49. The European Commission's thematic strategy on waste prevention and recycling notes that "*at low energy efficiencies incineration might not be more favourable than landfill*" [21].

50. This conclusion is supported by a large body of literature showing that the external costs of thermal treatment are actually very similar to those for landfill. Studies finding similar results include, but are not limited to:

    - Eunomia, A Changing Climate for Energy from Waste?, Final report for Friends of the Earth, 03/05/2006. [22].
    - Rabl, A., J. V. Spadaro, et al. (2008). "Environmental Impacts and Costs of Solid Waste: A Comparison of Landfill and Incineration." Waste Management & Research. [23].
    - Holmgren, K. and S. Amiri (2007). "Internalising external costs of electricity and heat production in a municipal energy system." Energy Policy **35**(10): 5242-5253. [24]
    - Eshet, T., O. Ayalon, et al. (2006). "Valuation of externalities of selected waste management alternatives: A comparative review and analysis." Resources, Conservation and Recycling **46**(4): 335-364. [25]
    - HM Customs & Excise (2004). "Combining the Government's Two Health and Environment Studies to Calculate Estimates for the External Costs of Landfill and Incineration, December 2004." [26]
    - Turner, G., (Enviros Consulting), D. Handley, (Enviros Consulting), et al. (2004). Valuation of the external costs and benefits to health and environment of waste management options Final report for DEFRA by Enviros Consulting Limited in association with EFTEC, DEFRA. [27]

51. An independent study by Dijkgraaf [28] concluded:

    "The net private cost of WTE (waste-to-energy) plants is so much higher than for landfilling that it is hard to understand the rational behind the current hierarchical approach towards final waste disposal methods in the EU (European Union). Landfilling with energy recovery is much cheaper, even though its energy efficiency is considerable lower than that of a WTE plant."

52. This conclusion is similar to that reached by the OECD [29] following their review of waste Management in the UK and the Netherlands:

    "In both countries, there is currently a strong preference given to incineration compared to landfilling of waste – as reflected e.g. in the landfill taxes they apply. A similar preference underlies the Landfill Directive of the European Union, which fixes upper limits for the amounts of biodegradable waste member states are allowed to landfill.

However, estimates in both countries indicate that the environmental harm caused by a modern landfill and a modern incineration plant are of a similar magnitude, while the costs of building and operating an incinerator are much higher than the similar costs for a landfill. Hence, the total costs to society as a whole of a modern incinerator seem significantly higher than for landfilling - which indicates that some reconsideration of the current preference being given to incineration could be useful."

53. And:

"Analyses of the negative environmental impacts of landfilling and incineration in both countries suggest, however, that the foundation for the present preference for incineration is questionable from the point of view of total social costs".

54. It should be noted that the "social costs" of waste management include the respective private costs i.e. the costs to society of building and operating the various management options together with the external environmental costs.

55. The poor efficiency and environmental performance of incinerators is one reason the Waste Incineration Directive [30] requires that:

The heat generated during the incineration and co-incineration process is recovered as far as practicable e.g. through combined heat and power, the generating of process steam or district heating; ***Article 4 (2)(b)****:*

Any heat generated by the incineration or the co-incineration process shall be recovered as far as practicable. ***Article 6 (6):***

56. The benefits of CHP are also emphasised in the 1995 Waste Management Strategy for the Cork Region.

57. The energy (and emission) savings that can be by using heat as well as electricity are large.

58. The Environment Agency in England says:

In an incinerator the steam temperature is lower (about 400^{o}C) to avoid corrosion of the boiler that can be caused by the mixture of impurities in mixed waste. This limits the electrical efficiency of an incinerator to about 27 per cent.

59. They continue:

Better use of the energy is possible if the heat is used in a district heating system. This can bring the overall efficiency up to 50 to 70 per cent, depending on the overall design.

60. A 2005 report for DEFRA in the UK on extending the Renewable Obligation to include energy from waste with CHP ILEX consulting wrote:

We estimate that EfW with CHP will produce a net environmental gain, producing additional carbon savings beyond that from electricity-only EfW plant – of between 120 kgCO_2 and 380kgCO_2 for each MWh_{th} of heat *produced*[9].

61. They estimated that:

> *" a 400kt/yr EfW with CHP facility would create additional carbon savings of between 0.7 and 1.0 million tonnes of carbon dioxide (CO_2) in total over a 20-year lifetime, over and above those achieved by a conventional EfW facility without CHP."*

62. The EIS, whilst otherwise almost completely silent on CHP claims that

> *"The location of the waste-to-energy facility on the Ringaskiddy Peninsula provides an ideal opportunity to distribute this steam/hot water to satisfy local industrial heat demand, via a district heating network. A number of large-scale industrial facilities, such as pharmaceutical and chemical plants, are located within 1 – 2 km of the site, which have large and constant process heat requirements. Indaver has received funding from Sustainable Energy Ireland to investigate the potential for combined heat and power".*

63. Having viewed the site I strongly disagree with this assessment. The lack of any supporting information in relation to the potential heat loads; existing heat sources; plans for or cost of heat mains and associated distribution infrastructure reinforce my conclusions.

64. There have often been grand claims made about intentions to deliver CHP at the planning stage which have not subsequently been delivered in practice. The incorrectly named SELCHP ('South East London Combined Heat and Power') which is not a CHP plant, and looks increasingly unlikely to ever become one, is a case in point having now operated for 17 years without any heat being exported at all. The reality is that unless a site is chosen with CHP heat load as an initial criteria and that this is incorporated into the original design then it is unlikely that the incinerator would ever operate in CHP mode.

65. If Indaver disagree, and are confident in their assessment that the location genuinely offers "*an ideal opportunity*" for CHP then they would presumably have no reservations about a condition attached to any permission which reflects those now required in Scotland.

66. Scotland's position on the thermal treatment of residual municipal waste (MW) is set out in the SEPA "Thermal Treatment of Waste Guidelines 2009". The practical implications of these Guidelines will be that thermal treatment plants handling waste should:

    - Take only residual waste after segregation (residual waste is the waste that remains after recycling separation has taken place and could be either mixed waste or segregated waste biomass);
    - Be part of an integrated network of recycling and composting and other waste management facilities; and

[9] Additional net carbon savings assumed for the upper bound a plant operating at 20MWth capacity producing 125GWhth per annum, at a net saving of 380kgCO2/MWhth. For the lower bound ILEX assumed a plant operating at 45MWth capacity producing 280GWhth per annum at a net carbon saving of 120kgCO2/MWhth.

- Recover and use the energy derived from waste efficiently.

67. SEPA will require thermal treatment facilities to be capable of recovering heat or heat and power as far as practicable in line with the requirements of the Waste Incineration Directive (WID) which means that operators are set indicative efficiencies which cannot be met without some heat use:

	Thermal treatment plant not including ACT plants		ACT plant
	Capacity ≤70,000 tonnes /year	Capacity >70,000 tonnes/year	Any capacity
QI value	85	93	100
Indicative efficiency	30-35%	35-40%	45%

68. The QI value is to be estimated and calculated in accordance with the relevant CHPQA method[10] for that type of thermal treatment plant and fuel type.

69. Even with good quality CHP the current configuration would be unlikely to be the best solution to residual waste treatment in climate change terms [22, 31]:

CARBON COST OF RESIDUAL WASTE TREATMENT

	£ per tonne of waste
MBT with anaerobic digestion generating heat and electricity	6.01
Autoclaving, followed by gasification	8.38
MBT producing stabilised output for landfill	9.55
Incineration with CHP	10.21
MBT producing RDF for gasification	10.71
MBT producing RDF for incineration	10.97
Incineration generating electricity only	11.45
Landfill	31.90

70. This shows the higher carbon costs associated with thermal treatment when compared with the options described above of MBT with stabilised output to landfill.

71. Eunomia [22] demonstrated how electricity only incinerators produce about twice as much carbon dioxide per kWh as coal fired power stations.

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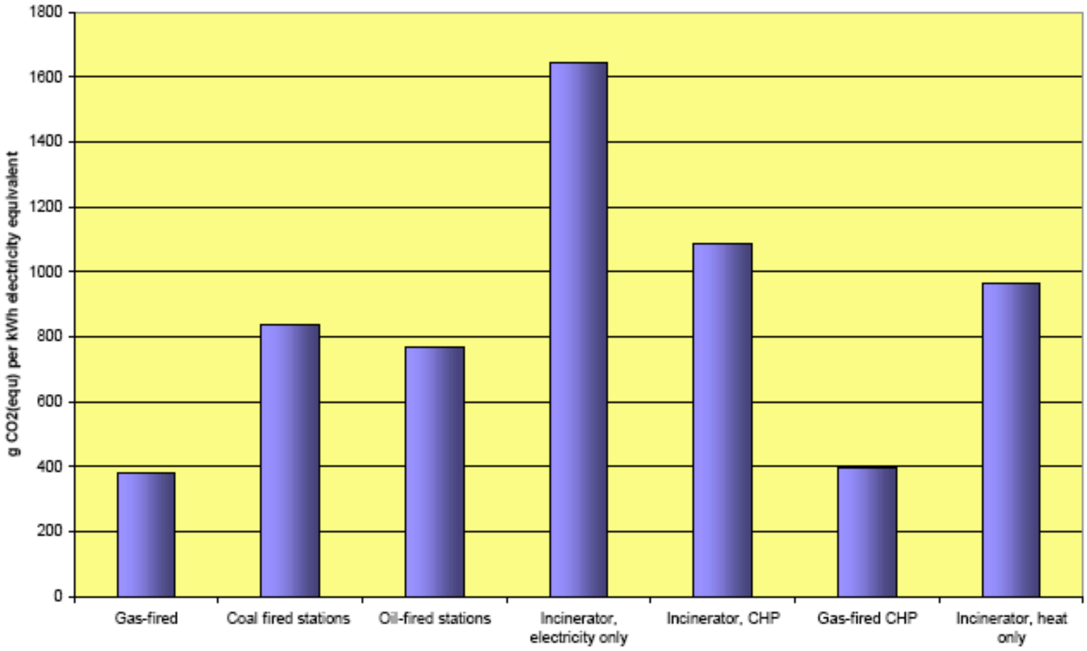
[10] Use of CHPQA Methodology for permitting energy from waste plants in Scotland: AEA, 9 October 2008: www.sepa.org.uk/waste/waste_regulation/energy_from_waste.aspx

Figure 3: Includes CO_2 from Biogenic Carbon, Heat=0.4 x Electricity



72. For completeness it should be noted that this graph includes biogenic carbon. This is the appropriate approach to adopt when accounting for incinerator emissions. The EIS says (s 10.2.3 p10-2) in relation to the "IPCC Guidelines for National GHG Inventories":

> *"the focus of the UNFCCC and the IPCC is on anthropogenic emissions because it is these emissions that have the potential to alter the climate by disrupting the natural balances in carbon's biogeochemical cycle, and altering the atmosphere's heat-trapping ability. The carbon from biogenic sources such as paper and food waste was originally removed from the atmosphere by photosynthesis, and under natural conditions, it would eventually cycle back to the atmosphere as CO2 due to degradation processes. Thus, these sources of carbon are not considered anthropogenic sources and do not contribute to emission totals considered in the Kyoto Protocol"*

73. This is not a correct interpretation of the IPCC inventory requirements.

74. Biogenic emissions are not attributed to incineration but they are not ignored - these emissions are counted elsewhere in the national inventories [32].

75. IPCC says[32]:

> *If incineration of waste is used for energy purposes, both fossil and biogenic CO_2 emissions should be estimated*[12].

[12] Fossil CO2 should be included in national emissions under Energy Sector while biogenic CO2 should be reported as an information item also in the Energy Sector.

76. That this is the appropriate approach has recently been confirmed in a strongly worded editorial by Ari Rabl in the International Journal of Life Cycle Assessment [33]:

> *In a part of the LCA community, a special convention has been established according to which CO_2 emissions need not be counted if emitted by biomass. For example, many studies on waste incineration do not take into account CO_2 from biomass within the incinerated waste, arguing that the creation of biomass has removed as much CO_2 as is emitted during its combustion.*

77. "The logic of such a practice" he continues:

> *would imply absurd conclusions, e.g. that the CO2 emitted by burning a tropical forest, if not counted, would equalize the climate impact of burning a forest and preserving it, which is obviously wrong. Likewise, the benefit of adding carbon capture and sequestration (CCS) to a biomass fuelled power plant would not be evaluated because that CO_2 is totally omitted from the analysis.*

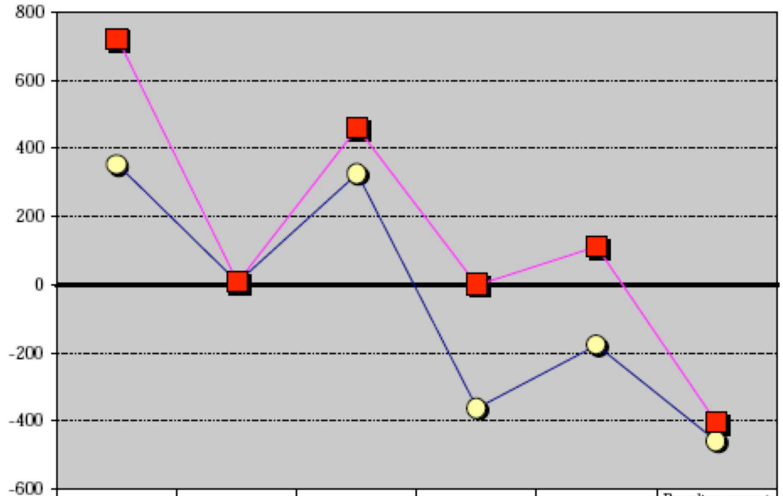
78. Amongst the advantages of including biogenic carbon emissions, Rabl says, are those:

> *By explicitly counting CO_2 at each stage, the analysis is consistent with the 'polluter pays' principle and the Kyoto rules which imply that each greenhouse gas contribution (positive or negative) should be allocated to the causing agent.*

79. Lifecycle calculations for real efficiencies of biostabilisation and following the IPCC prescription are included in the Eunomia ATROPOS model, which found [34] that "*scenarios using incineration were amongst the poorest performing*"[13] while those using MBT were much better. A detailed review by AEAT for the European Commission [35] similarly finds that MBT when sequestration is taken into account performs much better than energy from waste. The graph when the displaced fuel is assumed to be low carbon, as will be increasing the case over the next 40 years and is true when there is competition with renewables shows:

[13] This report was peer reviewed by EMRC Consulting, who concluded that the report is free from major flaws in terms of the methods and data used. The findings and recommendations of the peer review were incorporated into the final report.

Figure 21: Overall net greenhouse gas fluxes from waste management options – EU-average landfill gas collection and wind electricity replaced kg CO2 eq/tonne MSW.



	Landfill raw waste	Mass burn	RDF-FBC	MBT landfill	MBT incin	Recycling, compost & AD
Net flux	350	8	324	-363	-178	-458
Net flux excluding sequestration	720	8	458	1	111	-403

80. Mass burn, uniquely amongst the scenarios, is unaffected by considerations of sequestration because the carbon is nearly all released immediately [36]. It is therefore favoured by models which do not take any account of sequestration. I note that the EIS has taken no account of sequestration in the assessment of climate change.

81. It is also noted that the assessment of the waste composition in terms of carbon content in Tables 10.3 and 10.4 is based on the average waste composition. In fact after recycling the levels of biogenic carbon fall and fossil carbon increases.

82. This has been illustrated in policy terms by the 2007 English consultation [37] on the review of the Renewables obligation. The UK Government response to the submissions to the consultation was published in January 2008 [38] and said :

> ***Deeming the biomass fraction of waste:*** *we will proceed with the introduction of deeming, but will begin with a lower deemed level of 50% fossil fuel energy content that will increase over time to 65% following a trajectory in line with the Government's waste policy*[14]*.*

83. This consultation and response considers the carbon levels in the waste that would be burned <u>after</u> the removal of the recyclables that the Government clearly considers should be taken out as illustrated in the table below.

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[14] *The Government proposes setting the deemed levels of fossil energy content at: 50% from 2009 to 2013; 60% from 2013 to 2018; 65% from 2018. There is the possibility of producing evidence of different waste analysis but this must be well founded and evidence based:* We will allow operators the opportunity to present Ofgem with evidence that the fossil fuel content is lower than the deemed level and look to make the fuel measurement system more flexible.

84. Thus a more accurate approach to the carbon assessment is to reduce the level of biogenic carbon and increase the fossil carbon contribution as more recycling is undertaken.

85. Furthermore it is not correct to add carbon from displaced power in the Table 10.7. As these incinerators are being promoted as renewable energy they are contributing to renewables targets and are effectively in competition with other renewables. In those circumstances the reference relied upon in the EIS [35] indicates, as above, that the displaced carbon emission level is that of the other renewables – i.e. near zero for other non-incineration options.

Annex E: Analysis on Biomass Fraction of Waste for Use in Deeming the Fossil Fuel Fraction of Waste

			Unsorted waste			Scenario A[32]			Scenario B[33]		
	Biomass %	GCV (MJ/kg)	% waste	Total GCV	Biomass GCV	% waste	Total GCV	Biomass GCV	% waste	Total GCV	Biomass GCV
Paper and card	100	12.6	18.0	2268.0	2268.0	2.7	340.2	340.2	9.0	1134.0	1134.0
Plastic film	0	23.6	2.7	637.2	0.0	9.5	2249.3	0.0	8.6	2039.0	0.0
Dense plastic	0	26.7	3.5	934.5	0.0	1.4	373.8	0.0	2.1	560.7	0.0
Textiles	50	15.9	2.4	381.6	190.8	1.2	190.8	95.4	1.4	229.0	114.5
Absorbent hygiene products	50	8.0	2.2	176.0	88.0	7.8	621.3	310.6	7.0	563.2	281.6
Wood	100	18.3	3.2	585.6	585.6	1.6	292.8	292.8	2.4	439.2	439.2
Other combustibles	50	15.6	1.5	234.0	117.0	5.3	826.0	413.0	4.8	748.8	374.4
Non-combustibles	0	2.8	12.3	344.4	0.0	43.4	1215.7	0.0	39.4	1102.1	0.0
Glass	0	1.5	6.6	99.0	0.0	3.3	49.5	0.0	3.3	49.5	0.0
Ferrous metal	0	0.0	1.6	0.0	0.0	0.8	0.0	0.0	0.8	0.0	0.0
Non-ferrous metal	0	0.0	0.4	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0
Kitchen waste	100	5.3	17.2	911.6	911.6	4.3	227.9	227.9	4.3	227.9	227.9
Green waste	100	6.5	19.2	1248.0	1248.0	1.9	124.8	124.8	1.9	124.8	124.8
Fines	50	4.8	4.0	192.0	96.0	14.1	677.8	338.9	12.8	614.4	307.2
WEEE	0	7.6	4.5	342.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hazardous household waste	0	0.0	0.6	0.0	0.0	2.1	0.0	0.0	1.9	0.0	0.0
TOTAL			**99.9**	**8353.9**	**5505.0**	**99.7**	**7189.9**	**2143.6**	**100.0**	**7832.6**	**3003.6**
Biomass GCV					**66%**			**30%**			**38%**

Base data from:
Carbon Balances and Energy Impacts of the Management of UK Wastes: Table 3.2 (GCV); Table 1.24 (municipal waste composition England), Table B1.2 (recycling and recovery upper limits – for Scenario A), Impact of EfW and recycling policy on UK GHG emissions: Table 3.1 (% biodegradability)

32 Scenario A: Removed 85% paper/card, 75% food, 90% green, 50% wood, textiles, glass & metals, 60% dense plastic, WEEE
33 Scenario B: Removed 50% paper/card, 75% food, 90% green, 25% wood, 40% textiles & dense plastic, 50% glass & metals, WEEE

Ash Generation and Disposal

86. The proposed incinerator would both produce ‘bottom ash’ and ‘air pollution control residues’ (including both boiler ash and bag filter dust).

87. The application says:

> *“Waste-to-Energy plants (or thermal treatment plants) are higher up on the waste hierarchy than landfilling and produce mainly inert residue with only 10% of the volume of the original waste”(s 3.8 Ch 3)*
>
> *“The incineration process will produce a mainly inert bottom ash, much of which will be suitable for use as fill for road construction or for daily cover of landfill sites” (s.4.7.2 Ch 4)*

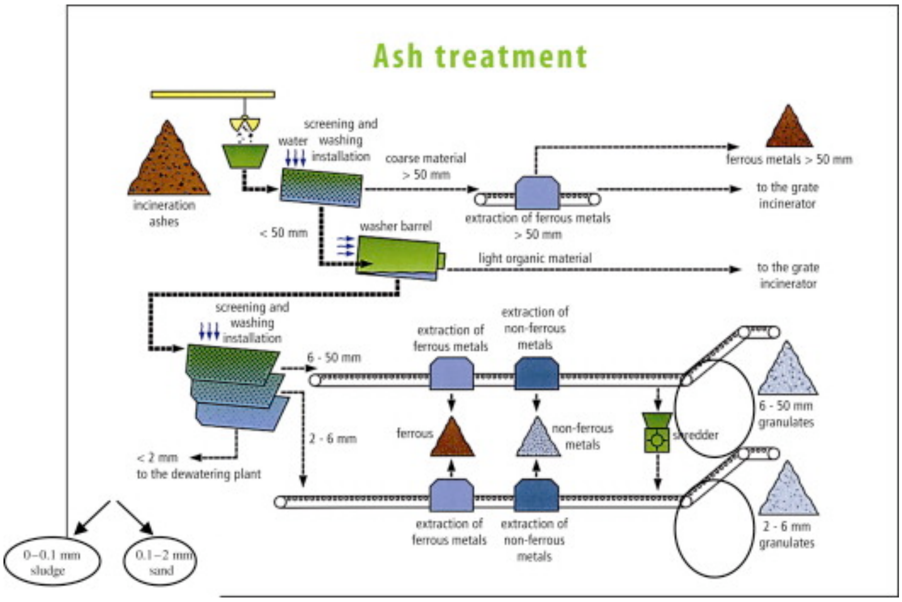
88. It is not clear what is meant by ‘mainly inert’ as the waste classifications for landfill are inert, non-hazardous and hazardous.

89. What is actually proposed for the bottom ash is unclear from the EIS and it appears that Indaver has not established appropriate treatment facilities for the ash. Even in the best circumstances for Indaver of the ash being non-hazardous the EIS accepts that if the ash it to be utilised for road construction rather than landfilled then “it must generally be of better quality than if it were to be disposed of in landfill. This improvement in quality can be achieved by treating the ash in an ash recovery plant”.

> *No suitable treatment facility is currently available and the EIS continues:*
>
> *If an ash recovery plant is constructed in Ireland it would be the intention of Indaver Ireland to proactively identify potential uses for the bottom ash. If no market can be found for the bottom ash, it will be disposed of to a suitably licensed landfill site for non-hazardous waste.*

90. There are neither appropriate facilities necessary to treat the ash nor any evidence indicating that such facilities might be forthcoming. It must therefore be assumed for the purpose of determining this application that all the ash would be disposed to landfill and no credit can reasonably be given for the use of any bottom ash.

91. It appears, by contrast, that the treatment of ash by Indaver in Belgium, including carbonation, is incorporated into the plants and the operations are illustrated below:



Schematic presentation of the wet bottom ash treatment at Indaver.

92. It would be anticipated that as the production of ash is a direct impact of the proposed incinerator the EIS should include comprehensive details relating to the treatment and disposal proposed in Ireland.

93. This is particularly important as there is increasingly strong evidence that at least a significant proportion of the bottom ash is hazardous waste. At the end of 2006 the Environment Agency in the UK indicated that they had tested bottom ash samples and reported:

    "Levels of lead and zinc in a number of isolated compliance monitoring samples have exceeded the hazardous waste threshold for H14."

94. This reflected growing concern about the environmental impact of combustion residues in disposal and utilisation, especially for the release of toxic substances such as heavy metals (such as arsenic, cadmium, chromium, copper, mercury, molybdenum, nickel and, particularly in relation to ecotoxicity, lead and zinc) together with soluble salts from the residues [39-42].

95. The content of toxic metals present in the bottom ash from municipal waste incinerators is usually 10-100 times larger than in natural soils [43].

96. As a result of the toxicity associated with the heavy metals and other contaminants several researchers have concluded that bottom ash should be classified as a hazardous waste because of the ecotoxic properties it exhibits.

97. Ferrari et al [44] subjected municipal waste incineration bottom ash to a range of ecotoxicity tests in both the leachate and solid phase.

98. Their results clearly demonstrated "a significant increase in all antioxidant stress enzyme activity levels across all plant tests even at the lowest test concentrations (solid phase and leachate)". This was demonstrated to be a good indicator of solid or leachate phase toxicity.

99. As with many other test regimes it is clear from this work that the bottom ash may not prove hazardous in all tests. This indicates that care must be

taken with the test regimes and that selective testing could deliver apparently reassuring, and hence misleading, results. For ash to be demonstrated to be hazardous, however, a single failure of an appropriate test is sufficient.

100. Ibáñez et al. [45] found that all four samples of MSW bottom ash from two incinerators (one in an industrial and the other in a rural area) contained chemicals at or above the hazardous waste range. This study was published before zinc oxide and chloride had to be considered when assessing the hazardous classification of ash.

101. More recently the work by Lapa et al [46] on the EC Valomat project concluded:

> *"all bottom ashes [including sample B1] should be classified as ecotoxic materials."*

102. Radetski et al [47] then investigated the genotoxic, mutagenic and oxidant stress potentials of municipal solid waste incinerator bottom ash leachates and reported:

> *"The MSWIBA leachates were found to be genotoxic with the Vicia root tip micronucleus assay.*

103. These findings were confirmed by Feng et al. [48]:

> *In this study, our results clearly demonstrated that MSWIBA leachates had genotoxicity on Vicia faba root cells as other researches did [47]. Bekaert et al. (1999[15]) demonstrated that the aqueous leachates from a landfill of MSWI ash had a significant genotoxicity on the amphibian erythrocytes.*

104. UNEP [49] warned in 2005 that whilst ash from incinerators has been reused in civil engineering works:

> *"in industrialised countries, the most prevalent method of management is disposal of the ash in lined landfills to control the risk of underground pollution by soluble toxic chemicals leached out of the ash.*

105. UNEP continued:

> *"Both fly ash and bottom ash contain chemical constituents that pose potential serious risks to operating personnel and the public. The chemical constituents of concern include heavy metals, dioxins, and furans".*

106. Feng expressed surprise about countries that do not include bottom ash on their hazardous waste lists:

> *However, in many countries and territories (such as USA, some OECD countries, China), Bottom ash is not included in the List of Hazardous Wastes, being dumped into landfills directly or after maturation (Gau and Jeng, 1998; [45];[50]). Therefore, we suggested that the comprehensive evaluation of the environmental impacts of BA is necessary before*

---

15 Bekaert, C., Rast, C., Ferrier, V., et al., 1999. Use of in vitro (Ames and Mutatox tests)and in vivo (Amphibian Micronucleus test) assay to assess the genotoxicity of leachates from a contaminated soil. Org. Geochem. 30, 953–962.

decisions can be made on the utilization, treatment or disposal of bottom ash.

107. Ore et al [51] examined the leachate from bottom ash that had been stored outside for six months and then used for road construction.

108. They carried out several ecotoxicity tests and found a high initial release of salts and Cu in line with relatively high concentrations in laboratory generated MSWI bottom ash leachates presented in the literature [50, 52]

109. A mung bean assay using *Phaseolus aureus* revealed the toxicity of bottom ash leachate - which continued to the final tests three years later, albeit due to different compounds leaching.

110. Leachates with significantly higher concentrations of Al, Cl, Cr, Cu, K, Na, NO_2–N, NH_4–N, total N, TOC and SO_4 were generated in the road-section built on bottom ash when compared to the road-section built with conventional gravel. Compared to the leachate from gravel, the concentrations of Cl, Cu and NH_4–N were three orders of magnitude higher, while those of K, Na and TOC were one order of magnitude higher. After 3 years of observations, while the concentrations of most components had decreased to the level in gravel leachate, the concentrations of Al, Cr and NO_2–N in bottom ash leachates were still two orders of magnitude higher.

111. The authors concluded that high concentrations of chloride emitted from the road can lead to increased toxicity to the recipient, e.g. for plants, and the bottom ash reused in a road construction could thus have a toxicological impact on the surroundings.

112. If the ash had not been weathered (and carbonated) for six months before use then the leaching would have been significantly more damaging.

113. A series of ring tests for ecotoxicity methods have been carried out in Europe [53, 54]. These included sampling and testing of incinerator bottom ash from a Dutch incinerator (Cu 6,800 mg/kg; Zn 2,639 mg/kg; Pb 1,623 mg/kg) a high pH (about 10.5). The bottom ash was found to be ecotoxic in these tests even after it had been aged for several months [55].

114. The English Environment Agency has admitted it does not "*have 100% confidence*" in its classification of incinerator bottom ash (IBA) as non-hazardous waste and Veolia wrote to the Agency saying "*around 40%"* of its IBA would become ecotoxic under the recent guidance which includes zinc compounds

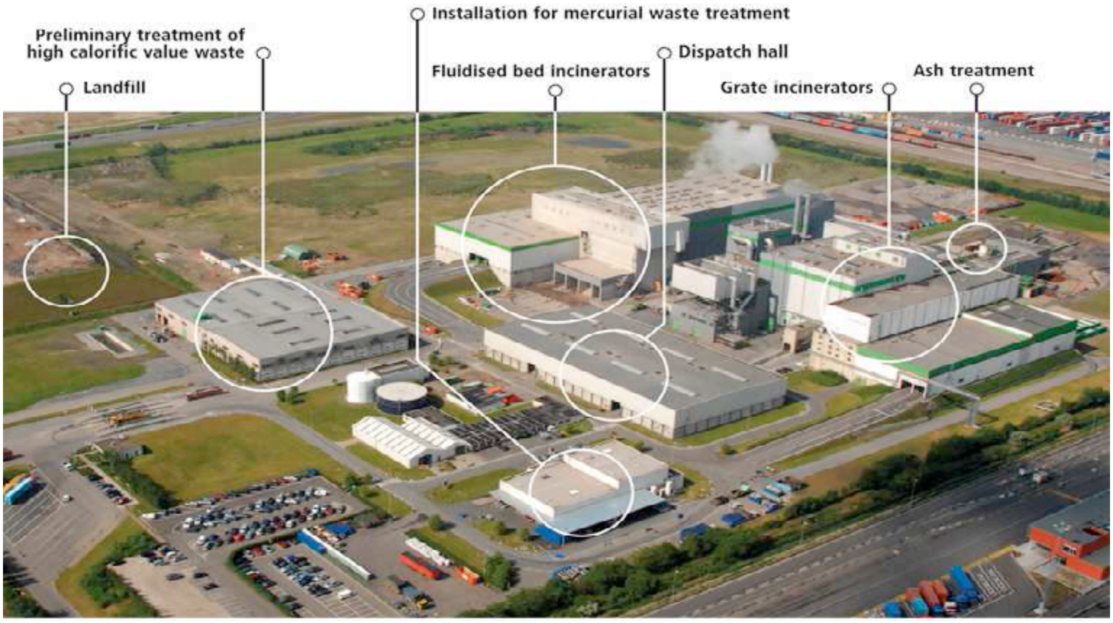
115. The National Hazardous Waste Management Plan says:

Is there a case to suggest that all incinerator ash could be classed as hazardous?

116. On the basis of the evidence available it is reasonable to conclude that bottom ash should be regulated as hazardous waste.

Doel Incinerator:

The Indaver waste management facility at Doel is illustrated below:



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