Sheffield Green Party

Waste Management Strategy

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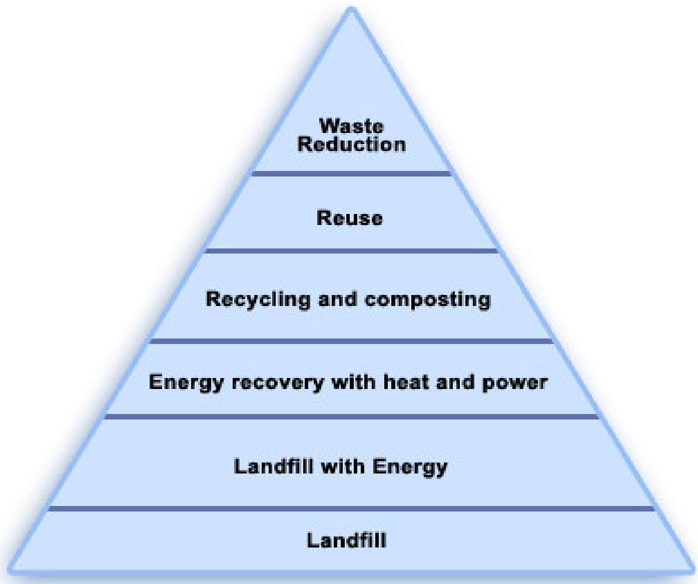

"The hierarchy of waste is used to guide the way we deal with waste in the City" – Key recommendation from the Sheffield City Council Waste Management Strategy

A SUSTAINABLE WASTE MANAGEMENT STRATEGY FOR SHEFFIELD

Much of this document on waste strategy concentrates on the Sheffield Incinerator. This is because around half of Sheffield's waste ends up in the incinerator. The incinerator forms a central part of waste management for Sheffield and will do so for some time to come. The research presented in this report makes clear how other solutions for waste can be more beneficial.

In Appendix 1 a report from a tour of the incinerator from members of the Green Party highlights how the new incinerator is an improvement over the old, but also that there are still many concerns. In Appendix 2 we present a study on the greenhouse gas emissions of the incinerator. Whilst sometimes promoted as a "green" option, the incinerator produces 8 tonnes of greenhouse gases every hour.

In looking at alternatives, Appendix 2 compares recycling and incineration. However, what is clear from the research is that the greatest reductions in greenhouse gas emissions come from reducing or reusing the waste. Recycling itself is not carbon neutral, or without effect on the environment.

The most valued option for waste management is minimising the amount of waste we produce, followed by reusing, recycling, reclaiming energy, and finally, disposal. Whilst the council's current waste strategy acknowledges this[1], the focus of Sheffield's strategy so far has been on reclaiming energy from waste to reduce landfill. However, a progressive waste strategy needs to concentrate on factors higher up the waste hierarchy. With restricted finances the council's options for increasing recycling are limited. What Sheffield Green Party proposes is that the main focus needs to be waste minimisation and reusing where possible.

Reducing the amount of waste we produce is now accepted to be a necessary step for our long-term sustainability. Reusing what could be wasted is another effective and low-cost way of minimising waste. What the council can do is:

- Continue to promote home and community composting;
- Step up the promotion of reusable nappies;
- Publicise in a friendly and accessible way how people can minimise waste, e.g. re-using drinks bottles, planning shopping to minimise food waste, increase awareness of the need to conserve;
- Explore through links with Schools, PCT, faith and community groups development of projects that have waste minimisation as a focus;
- Relate waste minimisation to health and the local environment;
- Use the invest to save scheme to explore how council processes, source materials, and training can be changed/improved to minimise waste and save money;
- Promote to local business the benefits of waste minimisation and lobby all businesses to use less packaging, publicising initiatives such as 'bags for life'.

[1] http://www.sheffield.gov.uk/environment/how-we-work/waste-management/strategy/waste-strategy

There are numerous case studies and example of good practice from other councils that Sheffield could use to guide policy and ensure maximum effectiveness for the lowest cost[2].

Reducing and reusing can help, but it can never be a complete solution. Veolia could recycle far more of what goes into the incinerator, but that would cost the council a substantial amount of money.

In the short-term we would propose the council should:

- Promote re-use and repair by advertising projects such as the “Freecycle” website, negotiating with Veolia to futher increase recycling rates at “Dumpit Sites” through establishing better contacts with groups offering re-use and repair, such as “Cot-Age”;
- Explore profitable recycling options such as the recycling of aluminium cans, and assess whether the blue bin scheme could incorporate these cans;
- Assess the possibility to include uncooked fruit and veg waste in kerb side garden waste collections (as currently happens in Derbyshire) for areas where composting is not an option;
- Promote waste as a resource and support low scale cheap recycling projects – such as art from waste, small manufacturing projects, and through work with community groups, charities, and schools;
- Work with bodies such as Recycling Action Yorkshire towards an integrated regional recycling structure. This would both stimulate business and provide a complete recycling solution. The incinerator could play a part in this process as an end point for non-recyclable waste.

In the medium to longer term we propose the council should:

- Expand recycling to offer complete kerb-side collections;
- Explore how to convert district heating network to an environmentally sustainable solution;
- Implement a full mechanical and biological treatment of waste through the use of biogas reactors, regional recycling, and so on.

Reducing, reusing, and recycling can save the local environment as well as the global. It saves money and resources. The council has the opportunity to take the lead on this issue and make Sheffield a truly green city.

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[2] http://www.wrap.org.uk/local_authorities/toolkits_good_practice/lacf_case.html
http://www.bathnes.gov.uk/BathNES/environmentandplanning/recyclingandwaste/wastestrategy/mainstratstats.htm

Appendix 1
REPORT FROM A VISIT TO THE SHEFFIELD INCINERATOR

On 25th August 2006 Nigel Garrod of Veolia showed members of Sheffield Green Party, Graham Wroe and Jeff Rice, round the Sheffield Incinerator. He was helpful, very keen to talk to us about the plant and answer all our questions. Nigel explained that we were not permitted to take photographs. First impressions of the plant were that is a considerable improvement on the old incinerator, much more high tech, and much cleaner.

1.0 Collection of waste

No attempt is made at to remove articles that would cause pollution when burnt. Veolia operate according to the contract specified by the Council. This is why there is no 'front end separation of' waste. The Council could modify the contract to include this.

The waste arrives in refuse lorries and skips that dump it into a massive silo. This area is now all enclosed- in the old incinerator it was in the open air, so dust and smell could affect the local area. The crane driver picks up large amounts of waste, takes it up the ceiling (several stories high) and drops it, thus mixing the waste well and drying it. As the incinerator operates 24/7 some waste is put to one side for the weekend!

We saw the magnets pulling out the steel from the bottom ash. It is not 100% efficient as some steel still ends up in the ash, but most of it is removed and recycled. Aluminium is a valuable material that could be separated first if the Council wanted this.

2.0 Emissions

Most of the gases are continuously monitored. We saw the computers in the control centre that keep constant moving averages of all the emissions, as well as the precise temperatures in various parts of the furnace etc. They have very strict limits as to what they are allowed to emit and if there is any chance of going over these limits the men operating the plant must shut it down. Graphs of the emissions are on the Veolia website (see http://www.onyxsheffield.co.uk/emissions.asp).

Dioxin monitoring happens internally twice a year and by the Environment Agency once a year. We saw where this is carried out. There has been a dramatic improvement in the dioxin emissions from incinerators. 5 years ago incinerators produced 40% of the dioxins in our atmosphere - this has now been reduced to 2%. Nigel Garrod said it was not necessary to continuously monitor dioxins as they are strongly correlated with the other emissions, which are continuously monitored. The technology does not yet exist to continuously monitor dioxins.

Dioxins cause major health problems at very low levels and could be caused by a number of circumstances which may or may not be correlated with other emissions. Chlorine is necessary (e.g. burning PVC), so dioxins may be correlated with HCl. Also dioxin emissions may be caused by low temperatures - e.g. on unplanned shutdown or on start-up following shutdown if there is un-burnt waste on the grate. Dioxins are also likely to be correlated with particle emissions (which is more likely if something has gone wrong), and maybe Carbon Monoxide, which indicates incomplete combustion.

Nigel Garrod said that the carbon used to extract heavy metals from the gases also removed dioxins. Dioxins destroyed at high temperature can reform at lower temperatures after the gases have passed the filters. We are still not clear how these are controlled. It does seem that the incinerator is probably now a much smaller source of dioxins than other nearby steel plants for example.

The graphs on the Veolia website for emissions look very similar each month - we asked if there are variations on shorter timescales and if so what are the causes. Indeed there are some variations during the day - for instance they were cleaning filters when we were there – and so emissions do vary to this extent.

Lime is used to neutralise emissions. This is quarried from Buxton. If better quality lime was used, emissions could be further improved - this may be necessary if legislation on emissions changes. One barrier at the moment is that better quality lime would be expensive.

The Environment Agency inspects the incinerator annually. When Veolia took over the incinerator it was a "D" (very poor). By the time they stopped using the old incinerator they had got it up to a "B". They expect the new incinerator to be an "A". The report can be seen in Appendix 3.

3.0 Ash

We saw the bottom ash. It was pretty homogeneous, although it did still have odd bits of metal in. 24% by weight of the waste ends up as bottom ash, and 3 % top ash. Half of the 3% is made up of lime and carbon that is mixed with the ash to neutralise it. Any improvements in recycling will therefore reduce the amount of ash and reduce the need for landfill.

We wondered that as the emissions to air have improved dramatically whether the fly ash is now more toxic. Nigel responded that the fly ash is mixed with lime - it is then called APC residue. It is not more toxic than ash from the old incinerator because the whole process is controlled much more carefully ensuring minimum pollution. The fly ash is a closed system so we could not see this. APC residue goes to a specialist treatment plant in the midlands where it is blended with liquid wastes to form a solid "non-hazardous" waste, which goes to landfill. We were told the material is at all times contained within silos or mixing vessels so there is no possibility of fugitive emissions affecting the environment. We are still concerned that dioxins could leach out of this waste in the landfill site.

The only material that is removed from the ash is the metal that is picked up with the magnets. Veolia are considering investing in more plant that would further separate waste (including Aluminium) from the ash using eddy currents. The ash goes to the Landfill site at Carcroft Doncaster. We are of the opinion that it would be more sensible to have separate doorstep collections for the aluminium.

4.0 Heat and Power

We talked about the possibility that waste could gradually be substituted with some sort of bio fuel to make the incinerator into a truly green heat and power plant. Normally the incinerator maintains adequate temperature without additional gas. This is injected if it's temperature falls below a satisfactory operating temperature, and to start it up after being switched off. Because of the contract to supply heat to buildings, Veolia have to operate a separate water heating plant to supply hot water when the incinerator is switched off. Veolia are exploring the possibility of using biomass to fuel this separate heating plant, which would have to be a new installation on the site of the old incinerator.

The output of the heat and power station is 21MW max output (3.6 MW hot water for the district heating scheme and 15.9MW for the electric power). Whilst biomass generators can produce this amount of energy wood chip cannot be used in the incinerator itself because its calorific value is too high. The incinerator cannot be converted to any other kind of fuel.

Veolia is, of course, a private company whose main purpose is to make a profit for its shareholders. They are part of the French multinational Vivendi. This need to make a profit contributes to the expense of the district heating system for tenants at Park Hill and Hyde Park Terrace/Walk.

When Hyde Park flats were refurbished Castle Court and Harold Lambert Court were removed from the District Heating System. This was because of the administration difficulties. The Housing Association was not keen on buying the heat and then having to charge each tenant. Veolia tend to deal with big customers, not individual tenants. Hyde Park Walk / Terrace is different - they just have one account each with Veolia.

There are lots of plans to add buildings to the district heating system, including the massive new St Paul's Tower currently being built on the registry office site, and the New Retail Quarter. However, developers should not be able to use the district heating system as an excuse for not doing more to improve insulation or to add alternative energy production to plans. Not using energy in the first place would be better than using energy from burning waste.

Appendix 2
GREENHOUSE GAS EMISSIONS FROM THE SHEFFIELD INCINERATOR

Executive Summary

This report concentrates on the greenhouse gas emissions from the Sheffield combined heat and power (CHP) incinerator at Bernard Road and makes comparisons with the recycling and landfilling of municipal waste. The report does not compare other environmental impacts of incineration, recycling or landfill. In considering waste streams the report used a full life cycle model where the life of products from production to disposal was considered.

The Sheffield Incinerator produces around 8 tonnes of greenhouse gas every hour directly from the incineration of municipal waste. The energy efficiency of the Incinerator is heavily dependant on the use of the district heating network.

Priority waste streams to recycle are plastics, textiles, and aluminium. Reducing or recycling the plastic waste stream could save up to 2 tonnes of greenhouse gas emissions per hour. Recycling of textiles could save a further 2 tonnes of emissions per hour.

Free capacity in the CHP incinerator could be used for suitable waste otherwise headed for landfill. In the long term the more renewable energy is used for heat and power production and the more recycling options become available, the less viable CHP Incineration will be.

An expansion of recycling facilities is desirable, for example an Anaerobic Digestion facility. The incinerator would be best used as an end point of a Mechanical and Biological Treatment process that separates as much waste as possible to be recycled or composted. However, this plan would incur large costs and may be best approached as a solution for South Yorkshire rather than just the Sheffield region.

A significant contribution to the greenhouse gas emissions of the CHP Incinerator is due to Nitrous Oxide (N_2O). Changing to ammonia-based selective non-catalytic reduction and reducing the input of nitrogen containing waste into the incinerator would be beneficial and low cost.

The most effective option for reducing greenhouse gas emissions would be to reduce the amount of waste being produced.

1.0 Introduction

This is a short report on the Greenhouse Gas emissions from the Sheffield Incinerator. The study is based on figures from numerous governmental sources, research carried out on behalf of the waste industry, and figures from Sheffield City Council. The production of greenhouse gases is acknowledged to be a key environmental challenge with the advent of climate change.

We will first build the picture by looking at actual CO2 emissions from the incinerator (section 2). Alternatives to incineration will then be considered for each waste stream (section 3). We will introduce the concept of short cycle CO2 (section 4) and the energy reclaimed from Combined Heat and Power incineration (section 5). Finally the overall GHG savings for waste streams will be considered, using analysis of greenhouse gas emissions from the full life cycle of materials including all aspects of production, transportation, and disposal (section 6).

Sheffield is currently deciding on adding another waste stream into the recycling effort. Sheffield recycles 52,000 tonnes of household waste annually, a recycling rate of 21%. The main waste streams by weight that are recycled are paper (37% of total recycled) and green waste (32% of total recycled).

148,000 tonnes of municipal waste is sent to a Combined Heat and Power (CHP) Incinerator along with 65,000 tonnes of commercial waste every year. The Incinerator can process up to around 215,000 tonnes of waste annually. 42,000 tonnes of municipal waste is sent to landfill each year [b,h].

In comparing the options of CHP incineration, landfill, and recycling, other factors such as pollution from the production and disposal of materials has not been considered. It should be noted that the recycling of materials has a reduced environmental impact regarding release of environmentally harmful chemicals compared with the combination of disposal of materials by either landfill or incineration and the production of fresh materials [3].

This report will consider only the municipal waste that is currently being processed by the CHP incinerator.

The figures used in this report are often based on estimates. When considering the full-life cycle of materials from production to disposal, there is considerable uncertainty involved. The range of error on many of the variables used for calculating the figures quoted in this report are large and percentages are quoted to one decimal place as a matter of convention only.

2.0 Carbon Dioxide Equivalent Output of the Sheffield CHP Incinerator

Veolia feeds, on average, 25 tonnes of waste into the Energy Recovery Facility (a CHP incinerator) every hour, 17 tonnes of which is municipal waste. The incineration process generates many different gases, some of which may have significant effect as greenhouse gases [h].

As the waste is burnt the carbon it contains combines with oxygen to form Carbon Dioxide (CO_2). Around a quarter of municipal waste is composed of carbon, this means about 17 tonnes of Carbon Dioxide (CO_2) is emitted every hour. This is the primary source of greenhouse gases [1].

There are traces of other emissions including methane and sulphur dioxide. For example, around 2kg of Nitrous Oxide (N_2O) is emitted per hour. The N_2O is produced when waste containing nitrogen is burnt. Another product of incineration are oxides of nitrogen that are then controlled through use of urea – however this method of control results in the production of more N_2O [3,4].

Where CO_2 emissions are quoted in sections 2 to 5, that is just the gas emitted on incineration.

In section 6 we talk about the Full Life Cycle CO_2 emissions, where all the greenhouse gas emitted in the production and disposal of the waste is taken into account.

Different gasses have varying effects on the atmosphere. N_2O has a greenhouse effect up to three hundred times that of CO_2. The effects of these current emissions on the atmosphere 20 years from now would be incinerator emissions equivalent to 17.5 tonnes CO_2, per hour. For comparison, if a similar amount of waste were dumped at landfill it would emit methane equivalent to 12 tonnes of CO_2, per hour [f,1].

One hundred years from now incinerator emissions would still be equivalent to 17.5 tonnes of CO_2 being emitted per hour. However, because methane is broken down in the atmosphere faster than CO2 or N_2O, corresponding landfill emissions would be equivalent to 4.5 tonnes of CO_2 being emitted per hour [c,e].

The long lifespans of CO_2 and N_2O in the atmosphere mean that incineration has long term effects greater than that of landfill. However, if the energy of incineration is reclaimed then carbon equivalent gases produced in this way could offset energy production. This will be explored in more detail in section 4.0.

To put the emissions of the incinerator into context, around 560 tonnes of CO_2 is emitted for the whole of Sheffield every hour; the incinerator is therefore responsible for 3% of city's CO_2 emissions. The incinerator is the second largest single producer of CO_2 in the city, after Georgia-Pacific Ltd, a firm manufacturing paper, packaging and building materials [f,h].

3.0 Recycling/Composting versus Incineration

Household waste collected is composed of a wide variety of materials, many of which are recycled in Sheffield (see Table 1),

Table 1: Municipal waste composition and recycling in Sheffield [b,g].

Waste stream	*% of total*	*% of total recycled*	*Waste stream*	*% of total*	*% of total recycled*
Food waste	20	-	Wood inc furniture	4	2.8
Paper and board	18	8.9	Plastic film	3	0.0
Garden waste	17	7.6	Disposable nappies	3	0.0
Glass	10	1.5	Textiles	3	0.3
Sweepings / construction	7	0.0	Scrap metal/white goods	2	0.4
Dense plastic	5	0.3	Other	5	0.6
Metal packaging	3	0.1	Total	100	24.0

The benefits of recycling are different for different waste streams, these will be summarised for each below.

3.1 Food and garden waste

This waste stream accounts for around a third of all household waste. There has been a large increase in the proportion of food waste due to an increase in packaged foods and bulk buying over the past decade. Alternatives to incineration for this waste stream include Anaerobic Digestion and composting.

The use of compost has additional benefits in reducing the need for peat-based compost, reducing the need for fertilisers and associated CO_2 production costs, and reducing N_2O release associated with non-organic fertilizer, the source of a third of human-made nitrous oxide emissions.

Anaerobic Digestion produces biogas that can then be burnt off for heat and power. When used for organic materials such as food, paper and garden waste Anaerobic Digestion also produces compost and fertiliser. In practice Anaerobic Digestion is often used as part of a waste treatment facility so that all organic waste is diverted to the digester – in this case the quality of compost produced may mean it is only suitable for incineration or landfill.

Home composting is a viable disposal mechanism for much waste and relatively inexpensive. However, this requires a garden, investment in time, and will on the part of the householder. An alternative may be expanding local composting centres. Animal by-products legislation has meant there are more constraints on the composting of kitchen waste, yet there is no bar on including non-cooked fruit and vegetables with garden waste kerb-side collections [4,5].

3.2 Paper/Cardboard

This waste stream accounts for under a fifth of all household waste. There is a substantial carbon cost to putting paper in landfill. Although Sheffield recycles a significant proportion of paper and card, a large proportion still enters the incinerator. What is not suitable for recycling could be composted [b,g].

3.3 Glass
There are clear benefits for recycling in terms of avoiding waste being put in landfill. Compared to incineration the clearest savings come when glass is recycled into glass products, rather than products like glass fibre [5].

3.4 Plastics
Different types of plastics offer different opportunities regarding the proportion that can be recycled into new products. For example the recycling of PET (e.g. bottles, textile fibers, film food packaging) offers the highest gains in terms of energy efficiency. There are problems in the economic viability of plastics recycling, especially for some plastic types, and recycling would need to be subsidised [4].

Currently Sheffield has a mechanical plastics materials recovery facility that has the capacity to sort most hard plastics. It is estimated that the plastics waste produced by South Yorkshire as a whole would be sufficient to supply a feedstock recycling plant capable of recycling nearly all plastics streams; however, this would require a large investment [b].

Plastics used in incineration are essentially a fossil fuel, albeit one with high manufacture costs. In addition up to 5% of plastics may be composed of nitrogen, thereby increasing N_2O production [3,4].

3.5 Wood
In general, incineration of wood should be a carbon neutral option, however there are wide options for the recycling of wood that might provide a more carbon efficient option e.g. manufacture of fibreboard. The recycling of wood may save forest resources that could be utilised as long term carbon stores [4].

3.6 Aluminium
Recycling is better than incineration and can be done both at household and using separators at a recycling facility. Around 50% of Aluminium can be recovered from the incinerator slag using eddy current separators; this is not enough to make the process more carbon efficient than recycling. An eddy current separator would be better utilised in sorting waste prior to incineration. Furthermore, aluminium cans could be sorted by the household; in Sweden this has lead to 80% of aluminium household waste being recycled. Aluminium is one of the few materials where recycling is economically profitable [3,5].

3.7 Steel
Although up to 90% of steel can be recovered from incinerator waste, recycling is still a more carbon efficient option due to higher proportion of reclamation. The expenditure in energy of heating the steel during incineration is offset by a saving in the processing needed on recycled materials; however, steel recycled prior to incineration is of a higher quality than that which has passed through an incinerator [5].

3.8 Textiles

There are a number of recycling options that can offer benefits over CHP incineration. Textiles can be separated out at the household and the carbon cost of recycling is low compared to that of producing new materials [3,5].

4.0 Short-cycle CO_2, Fossil CO_2, and Renewable Energy

In comparing emissions and possibilities for feeding the incinerator we need to compare short-cycle CO_2 such as found in garden waste and fossil fuel CO_2 such as found in plastics. Short-cycle CO_2 contains carbon that has been recently taken from the atmosphere and thus will not increase the overall level of CO_2 over a period of time. The amount of short-cycle CO_2 released by the incinerator is around 7 tonnes per hour. Additionally, the N_2O produced is also a greenhouse gas, bringing the total greenhouse gas production to **8 tonnes per hour**[3].

In this report "greenhouse gas" is measured in tonnes of CO_2 equivalent. That is how many tonnes of CO_2 would produce an equivalent greenhouse effect to all the greenhouse gases (like CO_2 and N_2O and methane) that are released.

Sometimes the carbon equivalent is used, which is the weight of carbon in the CO_2 equivalent.

The comparison in section 6 uses the full life cycle of materials from their production to disposal. The energy costs of producing materials through recycling are generally less than the cost of producing them from raw materials. The energy for these processes is assumed to come from mainly fossil fuel sources. If a process utilises non-fossil CO_2 energy crops, or other renewable energy sources, it will be far more efficient in relation to greenhouse gas emissions.

It has been assumed that paper/card and wood that enters the incinerator is short cycle; however, not all this waste will arise from sustainable forests.

5.0 Energy and Heat Generation of the Sheffield Incinerator

So far we have not taken into account that the energy generated by the CHP Incinerator is used for power and heat. In this report the greenhouse gas saved through the production of energy by the incinerator will be compared with an average energy production involving fossil fuels. If this energy were to come from short-cycle sources such as biomass, or non-combustion based renewables such as wind power, then the greenhouse gas savings for CHP Incineration are considerably reduced. It is assumed in this report that all the heat produced by the incinerator will be fully utilised – that is currently not the case.

5.1 Alternatives: Natural Gas

To generate an equivalent amount of energy would produce 1.7 tonnes of CO_2 equivalent per hour. However, this would be purely fossil fuel, not short-cycle carbon. Also, such a solution is not sustainable as natural gas is a limited resource.

5.2 Alternatives: Biomass

Energy crops, such as wood chip from Short Rotation Coppice (SRC), have a low greenhouse gas impact as it is not a fossil fuel. The main problem with SRC and other fuel crops is the cost to establish the crop with no yield for several years. Also, any scheme should acknowledge carbon and environmental costs from farming and the production of herbicides and fertilizers that would be required.

Wood chip cannot be used alone in the incinerator as its calorific value is too high. It may be possible a woodchip/waste mix would be acceptable for use – possibly using low grade woodchip with a high moisture content and lower calorific output [i]. Sewage sludge pellets, produced through Anaerobic Digestion of waste water, could also be considered as they have a lower calorific value than energy crops[3].

5.3 Alternatives: Waste diverted from landfill

As the incinerator can reclaim energy from burnable waste it is a far better option than landfill. If there is not sufficient composting and recycling facilities to handle burnable waste streams then CHP incineration is the next best option. Given the amount of waste currently going into landfill this is likely to be a viable option for some time [b].

5.4 Alternatives: Renewable energy sources

Renewable energy sources could supply power and heat equivalent to the output of the incinerator with very little carbon emission. Although the incinerator is most efficient running at a constant temperature it could be gradually discontinued with the falling waste input. The incinerator could be run on alternate weeks with renewable sources providing energy for the district heating network the rest of the time.

6.0 Waste Streams and Full-Life Cycle Greenhouse Gas Savings

This section uses greenhouse gas comparisons for the full-life cycle of the waste stream. Where energy is generated by the waste disposal process it is assumed to replace energy generated from a typical mix of fossil-fuel and other sources. Recycling or incineration can save the emissions of greenhouse gas that would have otherwise arisen from the production of materials or energy.

Full Life Cycle analysis in this section means taking into account how much greenhouse gas was produced at all stages, not just when the item is incinerated or recycled. For a tin can this would include the machines mining the metal, the transporting and processing, the production of a tin can, through its use and disposal.

Using a simple comparison of recycling and CHP incineration the best waste stream to recycle with regards to greenhouse gas emissions are plastics and textiles. A 100% recycling of these waste streams would save around four tonnes of greenhouse gas emissions per hour – equivalent to half the greenhouse gas production of the incinerator (Table 3).

6.1 Options - Landfill

One option considered in section 5 was diverting waste away from the incinerator and replacing it with waste destined for landfill. Under this scenario plastics still offer the highest saving in greenhouse gas emissions, followed by food waste and textiles. If these three waste streams were recycled there would be a total greenhouse gas saving of around 7.5 tonnes per hour – nearly equivalent to the 8 tonnes emitted by the incinerator (Table 4 and section 4).

6.2 Options – Reduction and Replacement with Renewables

Reductions in the waste stream will result in the greatest reduction in greenhouse gas emissions. A reduction strategy would have to focus on raising awareness and participation across the community. Combined with a use of renewable energy sources to replace energy and heat generation this would be the most effective mechanism to reduce emissions.

Table 3: Estimated Greenhouse Gas (GHG) life-cycle emissions comparing CHP Incineration, landfill, and recycling, kg per hour, by waste stream and overall, for 100% recycling of each waste stream*.

Waste stream	*% of waste*[4]	*CHP Incinerator*	*Landfill*	*Recycling*	*Recycling - CHP Incinerator*	*Landfill - CHP Incinerator*
Paper/card[1]	12.1	-1409	455	-1224	186	1864
Food waste	22.4	-849	2765	-394	455	3614
Garden waste	16.3	-617	2012	-287	331	2630
Plastic[2]	8.9	465	12	-1691	-2156	-453
Glass	7.2	28	10	-308	-336	-18
Metal[3]	8.3	-1892	11	-2118	-226	1903
Textiles	3.6	-98	9	-1925	-1827	108
Total	**79**	**-4372**	**5274**	**-7946**	**-3574**	**9646**

*The energy contribution of the incinerator is compared to the average energy profile of the EU. All waste streams are assumed to have an equal contribution to the production of NOX in the CHP Incinerator.
[1]Waste stream for paper/card likely to be an overestimate due to recycling in Sheffield [2]Assuming an equal split of HDPE and PET plastics [3]Assuming aluminium/other non-ferrous/ferrous split of 1/3/8 [4]Estimate of waste stream being incinerated, derived from average municipal waste stream for UK and Sheffield City Council recycling figures. Non-recyclable waste streams comprise around 20%. (refs: g,2)

Table 4: Estimated Greenhouse Gas (GHG) life-cycle emissions where extra capacity is used to divert waste stream from landfill, kg per hour, by waste stream and overall, for 100% recycling of each waste stream*.

Waste stream	*% by weight*	*Tonnes per hour*	*CO2 savings from diversion**	*CO2 savings from recycling/composting**	*Total GHG savings*[1]*
Paper/Board	12.1	2.0	-1438	186	-1252
Food waste	22.4	3.8	-2671	455	-2216
Garden waste	16.3	2.8	-1943	331	-1612
Plastic	8.9	1.5	-1059	-2156	-3215
Glass	7.2	1.2	-859	-336	-1196
Metal	8.3	1.4	-991	-226	-1217
Textiles	3.6	0.6	-428	-1827	-2255

*kg/tonne municipal waste/hour [1]There would be an additional carbon emission for transportation of waste of around 1kg CO_2 per tonne by road, around 0.75kg CO_2 per tonne by rail, from sites in South Yorkshire. (refs: g,2)

7.0 Summary and suggestions

The Sheffield Incinerator is an efficient energy recovery system. However, it still produces around 8 tonnes of greenhouse gas every hour from incineration alone.

A significant contribution of the greenhouse gas emissions of the CHP Incinerator is due to N_2O. Use of an ammonia based, rather than urea based, selective non-catalytic reduction would halve N_2O emissions produced through this route. There are other processes that could further reduce N2O emissions, although these would be costly. Recycling of plastics and textiles and composting of waste food would also reduce the N_2O output [4].

Most municipal waste streams could be recycled. Where capacity in the incinerator is released by recycling then that, in the short term, could be used by suitable material currently going towards landfill. In the event insufficient waste was available for the incinerator to function, alternatives such as biofuels could be explored; however, it is unlikely the incinerator will offer good energy efficiency as it was not constructed for this purpose. As renewable energy plays an increasing role in domestic energy use and industrial processes, the incinerator will not be a viable option compared to recycling and composting. An alternative energy source, such as a biogas reactor, will need to be found for the district heating network.

The primary waste stream in terms of reducing greenhouse gas emissions is plastics. Recycling plastics, both solid and films, would probably give a saving of 1 tonne of greenhouse gas every hour (where plastics recycling has been carried out by UK local authorities a 50% recycling rate has been achieved[3]). Whilst all plastic waste streams can be recycled there are different challenges regarding different forms of plastic. Some plastics recycling would need to be subsidised, for example by carbon offset schemes. Sheffield already has a large materials separation facility for plastics and a small plastics recycling facility at Outokumpu.

[3] http://www.wasteonline.org.uk/resources/InformationSheets/Plastics.htm

It would also be advantageous to recycle Textiles, producing savings of up to 2 tonnes of greenhouse gas each hour. The council could work with charitable organisations to separate items at recycling centres for re-use through charity shops or reprocessing.

If waste was recycled the spare capacity in the incinerator could be used as a short-term solution for waste currently being dumped in landfill. Taking into account the diversion from landfill, recycling of food waste could save over 2 tonnes of greenhouse gas emissions per hour. Any further improvements in the recycling of paper and card, and the composting of garden waste, would further free up capacity for burnable short-cycle CO_2 waste heading for landfill.

There is no legislation barring household separated uncooked fruit and veg waste from kerbside garden waste collections. Clear information to householders, monitoring of collections, and high standards on composting sites should sufficiently reduce risks from unwanted animal by-products. Eventually a separate collection would be preferable as the separate collection of biological waste minimises processing costs and improves efficiency.

In constructing new facilities such as an Anerobic Digestion facility and a plastic feedstocks plant, to complement existing facilities, Sheffield would be able to have an integrated Mechanical Biological Treatment process that would make a sustainable reduction on the waste entering the incinerator. However, the budget constraints on the council make this an unlikely prospect. Given the amount of waste required to make such facilities viable such an investment may make more sense as part of an integrated recycling strategy for South Yorkshire rather than just the city of Sheffield.

The most efficient for the reduction of greenhouse gases would be a reduction on the amount of waste being produced. Approaching waste reduction in a positive way to engage businesses and householders could make a large impact on greenhouse gas emissions for a relatively low cost.

8.0 Sources

Miscellaneous sources:

[a] Biosciences Federation and the Royal Society of Chemistry
[b] DEFRA
[c] Environment Agency
[d] Environmental Protection Agency
[e] Intergovernmental Panel on Climate Change
[f] National Atmospheric Emissions Inventory
[g] Sheffield City Council
[h] Sheffield First
[i] Veolia environmental services

Greenhouse gas emissions and waste management comparisons:

[1] Enviros Consulting Ltd and University of Birmingham with Risk and Policy Analysts Ltd, Open University and Maggie Thurgood (2004) *Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes* Department for Environment, Food and Rural Affairs

[2] Johnke, B. (2003) *Emissions from waste incineration (Background paper - Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*) IPCC

[3] Smith, A. Brown, K. Ogilvie, S. Rushton, K. Bates, J. (2001) *Waste management options and climate change – Final report to the European Commission* AEA Technology

[4] Svoboda, K. Baxter, D. and Martinec, J. (2006) *Nitrous Oxide Emissions from Waste Incineration* Institute of Chemistry, Slovak Academy of Sciences

[5] Ray Georgeson Et al (2006) *Environmental Benefits Of Recycling* Waste & Resources Action Programme (WRAP)

Appendix 3
ENVIRONMENT AGENCY INSPECTION REPORT

<u>Attendees</u>

Pat Pagdin – Plant Manager
Eric Crookes – Electrical/Systems Control Engineer
Martin Barrett - EA

<u>Report</u>

1 The NEL check monitoring letter has been received and responded to by Veolia. The date has been delayed until October. Routine monitoring by Alcontrol is planned for w/c 16 October – MB to make sure the dates do not coincide. The monitoring location has been checked by Bureau Veritas and found to comply with EA Guidance M1.

2 Waste descriptions were reviewed. There is no intention of Veoila taking separately collected fractions of municipal waste where segregation has taken place for the purpose of recycling – these categories can be removed from the list if it proves appropriate.

No specific trade or industrial wastes are currently incinerated so provision in the waste list does not appear necessary at this time.

Contraband seized by the Police of HM Customs and Excise could be identified as a component of mixed municipal in Schedule 5 of the permit because of the small quantities involved.

3 A Plant thermal efficiency of 82.2% is included in the commissioning report which seems rather high for an energy from waste incinerator. The UREA consumption does not meet the Veolia Plant acceptance criteria and is the subject of on-going dialogue with CNIM. The NH3 slip is currently around 6mg/m3 as a daily average.

Plant availability has been variable over recent months, but achieved 98.7% in June – this corresponds to a reduction in gas support fuel (676MWTh used) for the same period.

4 Bottom ash was despatched to Croft Farm (294 tonnes) and Parkwood 312 tonnes) during w/c 28 August. APC residues (113 tonnes) were sent to a Veoila site in Birmingham.

5 The operation of the furnace control system could not be demonstrated at the time of the visit in relation to the permit waste feed conditions – either from the Plant manuals or via the engineers control screen.

The waste inhibit switch interrupts the CEMs recording. This could be used to prevent the recording of ELV breaches rather than for the purposed of initiating a planned controlled shutdown. The records do not appear support this supposition but the matter will be kept under review.

It was not possible to examine the interfacing of instruments with PLCs and PCs to understand how the processing of raw monitoring data is undertaken. On a Plant of this type and complexity there must be staff trained to interrogate the control system for the fault diagnosis. The entry of calibration factors for the PCME dust monitor is entered by CBIS, the software developer for the site.

The furnace temperature is calculated as the average of three pendant thermocouples installed in the furnace roof. The average temperature at the time of the visit was 822 deg C and the "adjusted figure" for control purposes was 993 deg C. It was not possible to examine the calculation of the "adjusted figure" or whether it is based of a suction pyrometry test. On the information available, it appeared that the temperature offset was 171 deg, which is even greater than that for the old Plant! The acceptance of the control system on behalf of Veolia was signed off by Fitchner Consultants.

6 A copy of the daily emissions log for the day was provided by the Operator voluntarily.

7 The emissions were within the permitted levels at the time of the visit. The contemporaneous half hourly readings were:

NOx	mg/m3	144
SO2	mg/m3	20
HCl	mg/m3	6.0
CO	mg/m3	1.0
TOC	mg/m3	0.3
NH3	mg/m3	5.8
Dust	mg/m3	4.9

Furnace O2	6.1%
Furnace temp deg C	995 deg C (adjusted figure)
Steaming rate kg/hr	69,000
Lime injection (manual)kg/hr	252kg/hr (auto)
Carbon injection (manual)	8.1 kg/hr (auto)
Urea injection	182ltr/hr (auto)
Electric export to Grid	13 MWe
Heat to District Heating Scheme	7.0 MWTh

HCL upstream of abatement	mg/m3	147

Conclusions

8 The emissions into air at the time of the visit appeared in compliance with the limit values in the authorisation.

9 There must be sufficient training for process technicians so the control system logic can be examined. This training may not need to extend to specialist PLC programming. It was suggested that a GE Fanuc approved system builder may by based in the Sheffield area. There may have been some language difficulty in obtaining suitable training from CNIM?

Recommendations and actions

10 Copy this report to the Operator by email with a request to investigate process technical training on the control system.