"THE CONTRIBUTION OF AD TO LOCAL AUTHORITY WASTE MANAGEMENT PLANNING: THE LEICESTER CITY COUNCIL APPROACH"

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Abstract
This paper summarises the history and operational aspects of an Integrated Waste Management contract for a City of around 0.3 million in habitants generating in the region of 150,000 tonnes of mixed municipal refuse. It is offered as the UK's first operational contract which will achieve major diversion from landfill by carefully balancing technical, economic and public acceptability considerations within a political framework which demands high levels of transparency with regard to overall impacts in terms of process emissions and any net benefits derived from improved material resource efficiency when balanced against the generation of warranted renewable energy generation.

1. The UK Framework

This technology is dedicated to processing waste arisings from households – although it has the capability to deal with commercial wastes which are similar in composition that is not its primary function. In the UK household waste arisings amount to 30 million tonnes – around 20% of total waste flows which are reportable to the regulator. Of total household waste arisings, around 24 million tonnes is currently landfilled – 30% of all material currently landfilled nationally. Of the 30 million tonnes generated, it is calculated that around 14 million tonnes is bio-organic and thus contributes to methane generation when deposited in landfill (figure 1).

At local level:

- 35 bodies are responsible solely for decisions on the disposal of domestic refuse (each managing, on average, 0.5 million tonnes),
- 238 bodies are responsible solely for waste collection (each managing, on average, 50,000 tonnes), and
- 46 unitary authorities (managing a range from 70,000 to one million tonnes) undertake collection and disposal (figure 2).

Leicester City is a Unitary Authority that exercises total control over collection and disposal on an integrated basis.

At national level the UK has signed up to a variety of EU Directives[1], which permit all the above bodies to achieving minimum 50% diversion from landfill (currently 16% overall) within the next decade. To achieve these objectives government has 2 major instruments:

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[1] Biffa Waste Services Ltd (1997) *Great Britain plc: The Environmental Balance Sheet*, ISBN 09523922-16, http://www.biffa.co.uk/publications

(i) Progressive increases in the landfill tax from £0 in 1997 to £35 by – latest – 2011[2].

(ii) The commencement of a Waste Emissions Trading scheme sometime in 2005 between unitary and disposal authorities with Tradeable Permits issued on the basis of defined diversion performance criteria[3].

In addition, government provides around £300m per annum for public sector initiatives to cover the capital and start up costs of recycling and recovery programmes – some of them based on competing bid infrastructures.

2. Public Attitudes

Leicester comprises a rich mix of ethnic minorities – principally from the Indian subcontinent – integrated into a prosperous city with a background in textiles and light engineering. This mix is important because it is represented in the political representation on the Council which in turn is influenced by relatively high awareness of sustainability issues and longer term considerations. These approaches were reflected in the original invitations to tender and influenced the technological mix. There are 117,000 households.

3. The Economics and Contractual Framework

The total capital investment amounted to around £25m (around £170 invested per annual processed tonne) and is for a term of 30 years for a contract worth £300m over that period. Of the total

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EU Landfill Directive 1999/31/EC ()JL182 16.7.1999 p1) plus annexes. *Article 18 of EU Directive* 75/442/EEC
The British Library (Annual) *Environmental Information – A Guide to Sources*, ISBN 0-7123-0825-3
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Ecotec Research and Consulting (2002) *Financing of Municipal Waste in Europe*, Eunomia Report
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DETR (March 2001) *Guidance on Municipal Waste Management Strategies*, Product code 00EP1391, http://www.environment.detr.gov.uk/waste/index

[2] DEFRA (2002) *Priorities for the Second Term*, http://www.defra.gov.uk
OECD (June 2002) *Environmental Fiscal Reform*, OECD Conference, http://www.oecd.org/pdf/M00030000/M00030285.pdf
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PIU, Report, http://www.cabinet-office.gov.uk
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SDC, DTI & DEFRA *Pioneering – the Strategic Route to Sector Sustainability*, http://www.sd-commission.gov.uk
CBI *Report on Environmental Taxes*

[3] Ecotec Research and Consulting *Report on Environmental Taxes and Charges in the EU*, in conjunction with Cesam, CLM, University of Gothamburg, UCD & IEEP (CR), http://www.ecotec.co.uk
(2002) *The UK Emissions Trading Scheme*, http://www.ukace.org
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House of Commons, Environment Committee, various references in connection with Green Tax Commission
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DEFRA (2001) *Traded permits for biodegradable domestic waste*, discussion document

investment, 75% is represented by process technology, 25% by logistics/vehicles and associated infrastructure. As a unitary authority Leicester – in common with a number of other examples in the UK – is in a stronger position to guarantee the waste tonnage available to be delivered to the plant (because it also controls collection). These 2 important pre-requisites were in place as a condition of bidding the contract. In exchange Biffa has committed to operate within defined cost levels subject to clear escalation factors and to achieving specified landfill diversion ratios which – if not achieved – commits it to funding, at its own risk, the cost of any penalties which subsequently accrue to the unitary authority for non compliance on central government targets.

"Biffa Leicester" operates as a Separate Legal Entity (SLE) with equal representation on its Board from Biffa and Leicester City Council. As such it has its own P&L and balance sheet and decisions on any changes to operations and performance reviews are conducted on an arms length basis to the main business. This is designed to provide for flexibility for future capital investment requirements in the event of changing volumes and composition in the waste in decades to come. Deposit wastes at Biffa Leicester pays a gate fee that is retained within the SLE. Similarly any yield from Tradeable Permits from renewable energy (ROCs) or organic diversion (WETs) is retained within the SLE and distributed 50/50 between Biffa Limited and Leicester City Council. This mechanism could be important for the City in the first 10 years of the contract on the basis that WETs are currently predicted to trade at around €200-€250 per tonne. If Leicester achieves a diversion rate of 50% in the early stages of the contract their net costs of waste management could be lower than when they sent 85% of their material to landfill pre contract start up.

4. Technology and Market Drivers

The UK waste contracting sector faces an immediate period of great uncertainty. The absence of a cohesive national framework for tracking resource flows in the economy do not provide the best framework for accurate assessment of risk. Public sector contracts like Leicester City can remove much of that uncertainty. In essence, the nation as a whole has to divert around 60 million tonnes from landfill (75% of current inputs) from geological methods of storage to processes which neutralise that material within a matter of weeks and make it available for productive applications. Since the economy is founded on energy as a key driver of economic cost and carbon is the most significant component in energy costs, the waste industry, in effect, will have to optimise choices between different carbon substitution exit routes (Figure 3). These may be by producing material to place on the landfill (rather than within it) as compost or mulch, to generate material for reuse and recycling to obviate the need for virgin energy inputs or to convert those materials direct into energy (steam/electricity/methane) as a substitute for alternative non renewable inputs (Figure 4). The Leicester contract offers a combination of all of these within its framework. When considering the adoption of particular technical solutions there is a broad choice but the company prefers biologically based approaches because they operate at lower scales (and thus offer a more flexible approach when spreading risk across different options) and they tend to be cheaper to operate in terms of maintenance, invested capital per tonne processed and other factors. This is because they are lower temperature and lower pressure systems compared to thermal combustion alternatives. Localised transport impacts servicing smaller scale systems are also lower. Over 25 year contract lives thermal systems may also be liable to CO_2 Traded Permits.

The contractual charge to Leicester City Council of just under £80 per household per year comprises 50% for logistics/recycling and 50% operation of the process technologies. From our perspective, thermal process technologies have a further significant potential drawback insofar as they process 2 tonnes of air inputs for every tonne of waste burnt[4] (figure 5 below).

[4] NSCA (2002) *Comparisons of Emission from Waste management Options*, ISBN 09034-7459.0, http://www.nsca.org.uk

The EA Technology report into comparative pass through rates and the mass balances of different technology processes suggests that incineration plants with energy recovery create one tonne of CO_2 for every one tonne of waste processed. This could represent a significant future financial handicap in a world where Tradeable Permit systems for CO_2 certificates is becoming the norm. Enclosed biological plants still emit CO_2 (in the power generation phase when burning the methane) but the ratios are far lower. We have yet to have sufficient period of operation on the new plant to construct a full mass balance on the whole operation but this might be possible by the time of the conference. At the moment these CO_2 emissions per tonne of waste produced at the household in Leicester (150,000 tonnes) is estimated to be around 200kgs of CO_2 (emitted by the combustion engines at Wanlip) or 40% of the ratio for mass burn plants per contract tonne (300kgs per process tonne).

5. Process Description

5.1 Logistics Collection

Householders are offered 4 distinct collection systems:

- kerbside recycling for paper/glass/plastic bottles for 90% of households and communal bring sites for the balance.
- commingled collection for normal domestic waste which remains (including meat products).
- collection or civic amenity site deposit service for bulky and exceptional domestic material.
- improvements to 2 Community Recycling Centres.

Organics from the ball mill are delivered to enclosed aerobic digesters which produce a similar product as the in-vessel composters on the Isle of Wight. It is anticipated that flows through this technology will be seasonal and range between 15,000 and 25,000 tonnes per annum.

Kerbside recyclables are collected by segregated compartment trucks and the material is decanted out into the baling and concentration yard at Bursom. Material is then dispatched to appropriate mills, etc for recovery.

5.2 Processing

Two CA sites are equipped for segregated reclamation and commingled collection. The material is returned to Bursom for direct recycling or processing through the ball mill.

The remaining material is dumped on the reception floor and conveyed up into the ball mill for fragmentisation. The ball mill technology was adopted from experience and observations of the cement and stone crushing industries. This technology is well established, robust and operates in extremely rugged terrains around all parts of the world. The ball mill comprises a rotating drum which is 6.4 metres in diameter and 2 metres wide. Within the ball mill are loaded 42 tonnes of ball bearings, each weighing 5.5kgs. These progressively wear out in use and are replaced by top ups added to the input streams. Any metals derived from their destruction are retrieved and recycled downstream as products of abrasion. The mill will process 100,000 tonnes per annum but its design capacity is 140,000 tonnes per annum (equivalent to 25-30 tonnes per hour) (figure 6).

From the ball mill, material passes through a variety of conventional rotating magnets as a floc of 80mm or less which recover ferrous and non-ferrous through conventional means. Grit and screenings are removed in rotating classifiers whilst plastics are pummelled to a fine thickness and shredded into pieces. Metals, plastics and fines are all deposited in an arrangement of separate containment drums for removal to recyclers. Polymers are recovered for use in the cement industry although other applications are not ruled out dependent on future trends in gate fees via re-polymerisation routes or commercial thermal energy generators. Figure 7 gives a broad synopsis of these material flows. The remaining material is removed from the Bursom site and then sent to

Wanlip sewage treatment works where each day's batch of material is introduced into an individual tank (figure 8). When it leaves the ball mill, in the region of 10% of mass is removed due to the heat and friction of the process. At Wanlip, the material is mixed with high BOD water streams returning from within the process further down stream or from the adjacent sewage works.

The ground material is split into fractions by size, below 40mm and 40mm-80mm, with both sizes passing under magnets to remove metals for recycling before passing through further separation technologies.

The smaller sized fraction is split, taking off the articles that are less than 5mm. This material that is less than 5mm constitutes the organic fraction and is taken to the anaerobic digester in Wanlip for further processing.

The ball mill sorts the larger particles with air separation, with paper and plastics from the 5mm-40mm pieces stream turned into floc – a high energy substitute fuel used by cement kilns to replace coal. Additional paper and plastics are then taken from the 40mm-80mm stream with ballistic separation – which sorts materials based on weight.

The heavier part of the 40mm-80mm stream is passed through an eddy current separator to remove non ferrous metals for recycling and the remaining material is sent to landfill. 25% of the material processed by the ball mill will be sent to landfill, mainly comprising stones and silicates.

The entire operation is carried out inside a warehouse and operates under a negative air pressure with biofilters to minimise odour and noise nuisance for the nearby housing estate, crisp factory and retail park

At any one time, just 5 workers are required to operate the complex mechanism because from start to finish the entire process is automated, including loading the end materials into trailers and compressing the floc into bales ready for transport.

6. The Digester

Away from Bursom ball mill, work then continues on the 0mm-5mm organic fraction, which is placed in the anaerobic digester located on a site in Wanlip, where Severn Trent Water – Biffa's sister company – operates.

The digester is able to process up to 50,000 tonnes of organic waste a year. The plant uses an aerobic process (where the micro-organisms digest the waste in the presence of oxygen to produce by-products of carbon dioxide and water) and an anaerobic process (where the micro-organisms digest the material in the absence of oxygen to produce methane).

On arriving at the Wanlip site, the organic material goes through a washing process to filter out plastics and glass which represent a 5% residue. The slurrified organic material is then pumped to the first tank where the process is aerobic and the material is treated in compliance with the Animal By-Product Regulations. The building is fully enclosed with in-built air filters.

First is hydrolysis. Air is pumped through from the bottom to the top. It has been found that it is more efficient to have an aerobic process first. The waste spends 24 hours in the hydrolysis chamber before it is drip fed into the 3 digesters where the organic material is broken down anaerobically over the course of 18 days. In the first stage the slurry heats to around 50ºC and Ph drops to 3.8-4.0 thereafter temperature in the anaerobic phase rises to 70ºC with Ph rising to 11+.

The composting process will all be carried out within sealed, cylindrical digestion tanks, where the organic waste is liquefied, heated and broken down by bacteria, similar to processes already carried out at the sewage treatment works. The methane gas produced by the digestion process in the tanks will be harnessed and used to generate electricity. The compost product will be marketed for agricultural use by Severn Trent Water Ltd.

The process includes:

- All waste handling being carried out in an enclosed building with in-built air filter units to control odour and dust.

- All composting being carried out in 5 sealed digester tanks with total capacity of 8,000 tonnes digestate (28 days).
- Energy recovery through the capture of methane gas produced by the composting process and its conversion into electricity (approximately 1.5 megawatts – enough to power up to 1,500 homes).

- Recycling of the organic household waste into reusable agricultural compost, leading to achievement of recycling targets.

- Integration with an existing sewage treatment complex.

- A live link, via CCTV, to an education centre at the new recycling facility at Bursom, in Leicester.

7. Conclusion

Leicester City Council has taken a proposed pro-active and positive approach to the problems presented by waste.

It has developed a partnership approach which, with the combined service, is contracted to achieve 60% recycling and recovery by 2006.

The relationship has been built on the basis that should this figure be exceeded, then both parties benefit, and aspirational targets are for the achievement of 70% landfill diversion.

This is a nationally significant plant insofar as municipal authorities are running out of time to deliver against targets for organic waste diversion from landfill. Many – for political reasons – are reluctant to commit to direct thermal options and thus need to see tangible evidence of more acceptable technologies which retain operational flexibility over long term contracts, are not seen to prejudice direct recycling and represent realistic value. The new Leicester City package is designed with these constraints in mind and is offered as a template for other UK Waste Disposal Authorities and Unitaries.

For more information go to www.biffaleicester.co.uk or www.biffa.co.uk.

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