

LANDFILL FINANCING AND CONTRACTS

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SUMMARY: Cost is the expenditure incurred by the seller whilst price is what the buyer is prepared to pay. This paper assesses how non-hazardous waste landfill costs in the UK have increased over the last 20 years; it looks at current landfill costs; and it assesses how landfill costs may increase over the next 20 years. Costs are compared with the RPI (retail price index). It is shown that non-hazardous waste landfill costs in the UK have increased four fold against RPI over the last 20 years, and it is predicted that they will increase at the same rate over the next 20 years. The paper concludes by assessing how landfill contracts are moving away from price for disposal towards the waste hierarchy, and comments on the viability of landfill.

1. INTRODUCTION

This paper addresses costs for non-hazardous landfill sites in the UK. Costs are indicative and vary with the characteristics of the facility. The costs quoted relate to disposal of residual waste and do not include waste treatment costs prior to landfill. Costs quoted are exclusive of landfill tax, but the influence of landfill tax is reviewed. All costs quoted are particular to specific examples.

A distinction first needs to be made between cost and price (gate fee):

'cost the expenditure incurred in gaining something''

'price the amount of money demanded by the seller of something or paid by the buyer'

Cost is controlled by the seller and price is influenced by the buyer. Price is the buyer's cost. The price (gate fee) may or may not cover the full cost for the landfill. It is market led. Prices vary:

- due to economy of scale and the speed at which the void is filled. Filling the void quickly can become a priority to reduce costs and generate income
- during the lifetime of the facility, depending on the stage in its investment cycle and the corporate strategy of the company or body owning the facility
- due to regulatory and economic instruments, and landfill tax
- due to the market for waste treatment facilities i.e. spot prices and long term contracts

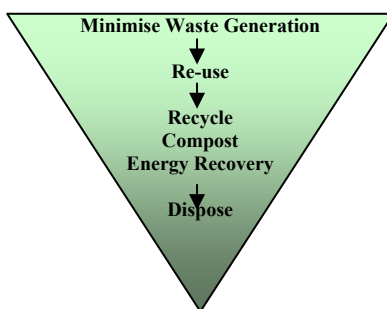
If gate fees are less than costs at any stage in the site's life this and the finance charges must be balanced by greater charges at other times.

2. SCENE SETTING

Current waste arisings in England are summarised in ‘Waste Not, Want Not’, the Prime Minister’s Strategy Unit report compiled in November 2002 (Strategy Unit, UK Government). This concludes:

- household waste growth is 3% per annum, greater than the growth of the economy as a whole
- we are a wasteful society; 20% of food goes straight into the bin
- 28 million tonnes per annum of Municipal Waste is generated, of which 89% is household waste
- nearly 80% of all household waste is landfilled
- landfills contribute 25% of emissions of methane (CH₄), the greenhouse gas which has 24 times more impact than carbon dioxide (CO₂)
- at the current rate of waste growth, waste management costs are set to double by 2020 from £1.6bn (€2.2bn) to £3.2bn (€4.3bn)

Waste management and landfill costs in the UK are being driven by sustainability and European Directives. The main legislative driver is the EU Framework Directive on Waste (75/442/EEC as amended by 91/156/EEC) and its daughter Directives, notably the Landfill Directive (1999/31/EC). The Directive on Waste introduces the waste management hierarchy:



The UK has implemented legislation that seeks to reduce the amount of waste disposed to landfill, by increasing landfill prices and making alternative waste solutions more competitive. Additionally, all new planning applications are subject to evaluation of the BPEO (Best Practicable Environmental Option) and implementation of the Proximity Principle. There are also many other drivers in the UK for the waste hierarchy such as Best Value, and LPSA (Local Public Sector Agreements).

Waste management and landfill costs in the future are likely to be driven, in part, by climate change policies and regulations for the reduction of greenhouse gases. The Kyoto Protocol has provided a stimulus for national governments to address greenhouse gas emissions from waste management. The Prototype Carbon Fund (PCF) has been established by the World Bank to reduce CO₂ and CH₄ emissions by providing payment to project sponsors in developing countries for certified emissions reductions.

In the UK, similar mechanisms have been considered for integrating domestic emissions reductions projects i.e. UK Emissions Trading Scheme, which has been operating since 2002. The UK has also seen the recent introduction of a Renewables Obligation that provides a

substantial financial benefit for LFG utilisation, biomass combustion, and advanced thermal waste treatment projects. Finally, the IPPC (Integrated Pollution Prevention and Control) Directive (96/61/EC) lays down measures to prevent, or if not reduce emissions to air, water and land from various activities. This is expected to have significant price impacts in UK waste markets.

These government measures are expected to reduce the quantity of waste disposed to landfill over time. However landfill will remain a significant disposal route for wastes in the UK for some time because:

- there will always be a need for disposal of residues
- there is significant suitable landfill void available (e.g. quarries requiring restoration)
- landfill is flexible as it can treat (dispose) all wastes
- it does not require a consistent quantity or quality of waste

Landfills store and degrade the wastes. The biodegradable elements from the waste, landfill gas and leachate, are polluting to the environment and must be contained and managed. A considerable proportion of the cost of landfill is in the containment of the waste and the management of landfill gas and leachate.

3. LANDFILL COSTS

3.1 The Last 20 Years

Enviros Consulting Limited (Enviros) (formerly Aspinwall & Company) has been closely involved in assessing landfill costs for the public and private sectors over the last 20 years. We contributed to Waste Management Paper 26 (WMP26) on Landfilling Wastes (Department of the Environment) in 1986 and subsequently prepared Waste Management Paper 26B (WMP26B) concerning Landfill Design, Construction and Operational Practice in 1995 (Department of the Environment). Enviros, over the last 20 years, has carried out a number of projects for waste management companies to appraise landfill costs. Details from published and unpublished information are drawn together in this section.

The cost of landfill has increased over the last 20 years due to the improved standards of waste management, although savings have been made due to economy of scale, efficiencies, and other sources of income. In the mid 1980's landfills in the UK were frequently not lined, and could be designed as dilute and disperse sites. By the early to mid 1990's landfill design had to include risk assessment, notably for leachate and groundwater, with containment of landfill gas and leachate. Sites also needed to be constructed with Construction Quality Assurance (CQA), WMP26B quoted typical CQA costs of 2.5% to 5% of the construction cost of the liner system.

Landfill costs were divided in WMP26 into site acquisition; assessment; development; operation; restoration and aftercare costs. Costs in WMP26B are based upon the same parameters. These parameters are still appropriate and are used to compare costs in this paper.

Table 1 gives examples of landfill costs from 1980 to 2003 whilst Table 2 summarises the percentage increase in costs against the retail price index (RPI) (Office for National Statistics).

Table 1. Landfill Costs, 1980 to 2003.

Parameter	1980 (1)		1984 (2)		1990 (1)		1995 (3)		2003 (4)	
	2 Mm ³ , 200,000 tpa £/t	%(5)	2 Mm ³ , 100,000 tpa £/t	%(5)	2 Mm ³ , 200,000 tpa £/t	%(5)	4 Mm ³ , 200,000 tpa £/t	%(5)	4.125 Mm ³ , 250,000 tpa £/t	%(5)
1. Site acquisition	0.400	—	—	—	2	—	—	—	—	—
2. Site assessment	0.040	1	0.028	1	0.108	0.080	0.148	1	0.162	0.120
3. Site development	0.310	11	0.351	8	2.093	1.550	4.468	35	8.451	6.260
4. Site operation	2.092	73	3.969	86	4.887	3.620	5.265	41	5.400	4.000
5. Restoration	0.297	10	0.107	2	0.878	0.650	1.674	13	1.971	1.460
6. Aftercare	0.121	4	0.140	3	1.202	0.890	1.282	10	1.350	1.000
Total (6)	2.862	0	4.595	60	9.167	6.790	12.838	334.39	17.334	12.840

Notes: 1. 1980 and 1990 costs taken from a comparison in 1991 of landfill costs for the private sector

2. 1984 costs taken from Waste Management Paper 26 (published 1986)

3. 1995 costs worked up from Waste Management Paper 26B (published 1995)

4. 2003 costs taken from a cost evaluation for the private sector

5. Percentage increase above 1980

6. Excludes site acquisition costs

Table 2. Landfill Costs, 1980 to 2003, Percentage Differences and RPI

Parameter	1980		1984		1990		1995		2003	
	£/t	%	£/t	%	£/t	%	£/t	%	£/t	% increase
Total Landfill Cost	2.862	—	4.590	60	9.1665	220	12.8385	9.510	17.334	12.84
RPI (2)	—	263.70	—	351.80	33	126.1(3)	72	—	149.1	170.9(4)

Notes: 1. Percentage cost increase against 1980 estimate

2. RPI, All Items Index (PR02) issued by the Office for National Statistics, March 2003

3. January 1987, base index reset to 100. Percentage increase from, 1980 to 1986=46.3%

The landfill costs are only indicative and are dependent upon the size and scale of the landfill. In general, the higher the rate of input the lower the landfill unit costs. Landfill costs can also be calculated using discounted cash flow (DCF) analysis to calculate the net present cost of the full life costs of the landfill. This represents the sum of money which would have to be set aside now to finance the landfill throughout its life. This type of analysis has not been carried out for the data shown in Table 1.

Land acquisition costs (or royalty payments) are difficult to price because they are very dependent upon land availability, land costs, and the need for the landfill. WMP26 and WMP26B do not quote acquisition prices in their worked examples, but our review for a private sector company in 1991 calculated a price increase from £0.4/tonne to £2/tonne (€0.54/tonne to €2.7/tonne) between 1980 and 1990, and prices between £2/tonne and £5/tonne are now quoted (€2.7/tonne to €6.75/tonne) (Biffa Waste Services). However where the landfill is to be developed in a quarry that would otherwise be a liability, acquisition costs may be much lower. Acquisition cost is not summated in Table 1 as it is difficult to specify in any formalised manner.

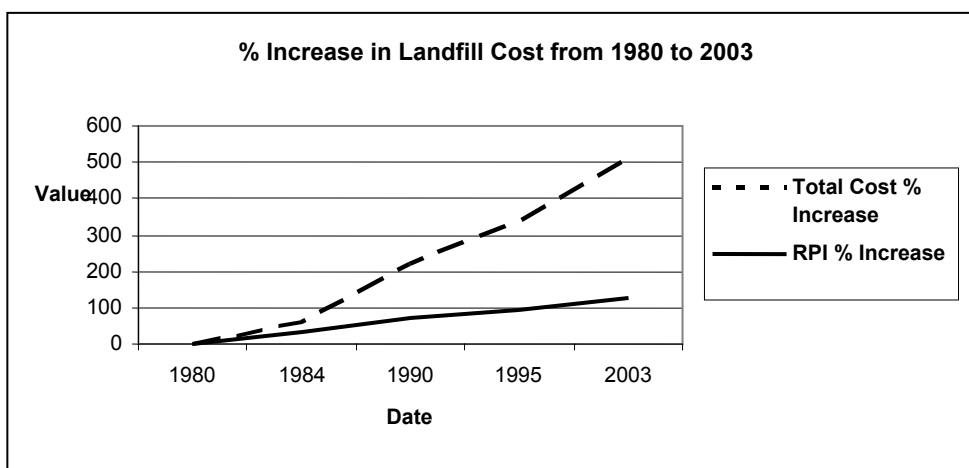
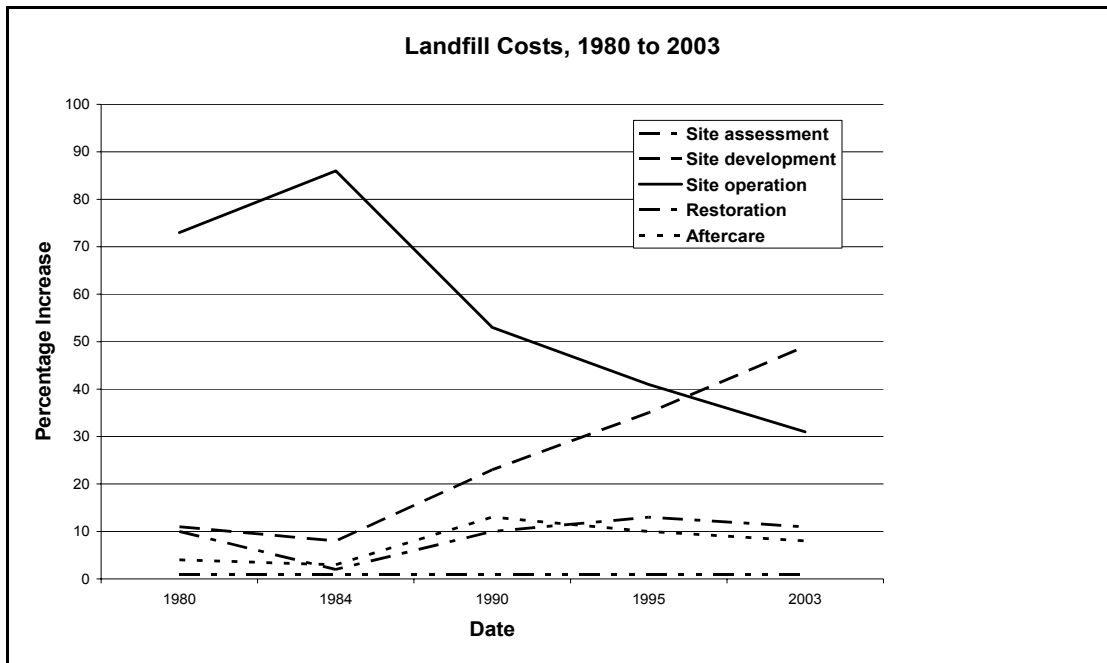
Site assessment costs have remained approximately 1% of the full landfill cost over the last 20 years, and have increased proportionally to the full landfill cost.

Site development costs i.e. the costs for preparing and lining the site, and providing leachate and landfill gas management facilities, have increased notably over the last 20 years, from around 10% of the total cost to up to 50% of the total cost today in the examples taken. The reasons for this are containment requirements for landfills, risk assessment, and that sites for landfill frequently lack suitable available materials for site engineering.

Site operation costs have shown a reduction as a percentage of the overall cost over the past 20 years, reducing from around 75% to just over 30% in the examples taken. This is due to the economy of scale as landfill sites have become larger. In the UK in 2003, the bulk of waste is handled by 360 very large landfills, accepting an average of 300,000 tpa (Biffa Waste Services). A few landfill sites in the UK take over 1 million tonnes of waste per year.

Restoration costs have not increased significantly as a percentage of the total cost, whereas Aftercare costs have doubled.

It is interesting to compare these costs against the RPI (Office for National Statistics). The RPI has shown a 126% increase from 1980 to 2003, whereas the landfill costs have shown a 506% increase. The increase in the landfill cost have had a fairly linear gradient over the years. They have increased around 4 times the RPI. These landfill costs do not include landfill tax. Landfill tax in the UK was £13/tonne (€17.5/tonne) (2002-2003).



3.2 Current Costs, 2003

Landfill costs in the UK are currently being controlled and influenced by the requirements of the Landfill Directive and the IPPC Directive. The Landfill Directive currently applies fully to new sites. The requirements of the Landfill Directive are being applied to existing sites between now and 2007 through the implementation of IPPC. The number of permitted landfills for residue disposal is reducing in the UK:

March 1997 1,881 sites registered for landfill tax;

December 2001 1,536 sites registered for landfill tax.

IPPC controls releases from landfill. PPC permits require:

- A conceptual model of the site
- A hydrogeological risk assessment to ensure the site complies with the Groundwater Directive (80/68/EC)
- Site stability risk assessment to ensure liners, waste and capping are stable
- Landfill gas risk assessment to determine gas production and risks

- Nuisance and health risk assessment, to demonstrate any impact on local amenity or harm to human health

The Landfill Directive specifically references municipal ‘waste which is waste from households, as well as other wastes which, because of its nature or composition, is similar to waste from households’. However, the design and financial requirements of the Directive apply to all controlled wastes that are landfilled.

The Landfill Directive requires:

- *Article 5*: Biodegradable municipal waste going to landfill nationally to be reduced to 75% of the biodegradable municipal waste produced in 1995 by 2010 (with the 4 year derogation) to 50% by 2013, and 35% by 2020 (subject to review in 2013).
- *Article 6*: That only waste that has been subject to treatment is landfilled.
- *Article 8*: Adequate financial provision, or equivalent, shall be made prior to the commencement of disposal, and until the aftercare operation is complete.
- *Annex 1; 3.1*: The landfill must be sited and designed to meet necessary conditions of preventing pollution of soil, groundwater and surface water by a combination of liners and geological barriers:

3.2 The geological barrier for non-hazardous waste shall be at least equivalent to 1m of mineral material of permeability of 1×10^{-9} m/s and should not be less than 0.5m thick.

3.3 Leachate collection should be a 0.5m drainage layer over an artificial sealing layer (liner). Surface sealing is recommended to include 1m soil, 0.5m drainage blanket, impermeable mineral liner, artificial sealing layer, gas drainage layer.

3.4 The requirements of 3.2 and 3.3 may be reduced accordingly based on an assessment of no unacceptable risk.

4.2 Landfill gas should be collected from all landfills receiving biodegradable waste and the landfill gas must be treated and used. If the gas collected cannot be used it should be flared.

The main costs of the Landfill Directive with regard to waste management are the treatment of waste prior to landfill and the limitation on the disposal of biodegradable wastes. The main costs with regard to landfill are the liner, leachate and gas systems. Liner costs quoted depend upon the availability of materials. For synthetic liner materials, which have become proven over the years, the costs have not varied, but for natural liner materials the costs have increased by the RPI or greater depending upon the availability of materials. (Table 3)

Landfill gas management costs include for gas wells with headworks, pipework, extraction equipment with flare and utilisation. The unit of this work can now be funded in the UK with income from Renewable Obligation Certificates (ROC). Prices currently paid for electricity generated from landfill gas are approximately 6.5 pence (€ 0.086) per kwh. Large landfills gas utilisation schemes had been previously viable at prices below 2.73p (€ 0.037) per kwh. The English and Welsh Government established the market for landfill gas utilisation (electricity generation) through the Non-Fossil Fuel Obligation (NFFO) schemes. While the government is no longer offering NFFO contracts, it is useful to observe that NFFO average prices for landfill gas utilisation projects declined steadily during subsequent NFFO bidding rounds: NFFO 1 – 5.68p/kwh (to 1998) (€ 0.077); NFFO 2 – 4.75p/kwh (to 1998) (€ 0.064); NFFO 3 – 3.76p/kwh (for up to 15 years) (€ 0.051); NFFO 4 – 3.01p/kwh (for up to 15 years) (€ 0.041); NFFO 5 – 2.75p/kwh (for up to 15 years) (€ 0.037).

Table 3. Examples of Liner Material Costs.

Material	1984, WMP26			1995, WMP 26B			2003, Tender		
	€	£	% increase ¹	€	£	%increase ¹	€	£	%increase ^{el}
HDPE	6-8.1/m ²	4.5-6/m ²	-	5.4-6.8/m ²	4-5/m ²	-14%	6.8/m ²	5/m ²	-5%
500mm stone	4.7/m ²	3.5/m ²	-	4.1-6.8/m ²	3-5/m ²	14%	11.8/m ²	8.75/m ²	150%
Bentonite enhanced sand (BES)	3.4-5.4/m ²	2.5-4/m ²	-	6.8-12.1/m ²	5-9/m ²	115%	23.7/m ²	17.55/m ²	440%

Notes: (1). Percentage increase on 1984

Table 4. Landfill Tax and Landfill Prices (Gate Fees)

Country	Tax Active Waste 2002		Landfill Rates		Total Prices	
	€/t	£/t	€/t	£/t	€/t	£/t
Switzerland	27	20	76-88	56-65	103-115	76-85
Austria	73	54	49-111	36-82	122-184	90-136
UK	17.5	13	17-31	13-23	35-49	26-36

Notes: Only high landfill taxes are quoted in this table, taxes in some EU countries are lower

3.3 Next 20 Years

Although landfill will no longer be a growth industry in the UK, it will remain a significant baseload facility for waste management options in the future. Examination of the effects of the Landfill Directive on costs of landfills themselves suggest an overall increase (over an otherwise modern landfill) of approximately 15% due to pumped gas controls, linings and capping, financial provisions and additional maintenance (J.N. Davies). This does not represent a significant cost increase in comparison to the four fold increase above inflation indicated over the past 20 years (Table 2).

Landfill costs will be affected over the next 20 years by land acquisition; requirements for engineering; scale of the landfill (void space); rate of filling; costs for daily cover/restoration; requirements for gas management, affected by gas income; financial provisions/aftercare; landfill taxes (Eunomia Research and Consulting). Costs can be expected to exhibit considerable evolution over the next 20 years as old landfills are phased out and new, larger sites dominate disposal.

So, how may landfill costs in the UK increase over the next 20 years? It is difficult to predict due to:

- acquisition costs. It can be argued that acquisition costs will be negative where the landfill company owns or acquires a quarry that needs to be restored. However, with a growing shortage of suitable sites, and the site owners will be able to charge a royalty for disposal;
 - landfill assessment cost. They could potentially double from 1% to 2% 1% of the total landfill in order to gain permission and permits;
 - development engineering cost, 15% increase; 15%
 - operational costs, assume these will be balanced 0% by economy of scale improvements in the landfill;
 - restoration and end use, allow an increase from 10% to 15% of the 5% total landfill cost;
 - aftercare and financial provisions, allow a 4% increase of the total 4% landfill cost above and current levels
- 25%**

Potential increases in aftercare and financial provisions are interesting. UK guidance is that aftercare funds should be calculated on 30 years and Escrow should be for up to 80 years (Environment Agency). However, waste in dry entombed landfills may take over 200 years to degrade. The landfill and their emissions may need to be managed and monitored for this period. Aftercare is typically 10% of the total landfill cost based upon 30 years. WMP26B recognises that aftercare costs in the first 30 years for restoration maintenance, leachate and landfill gas will be greater than subsequent years. If the cost is halved in subsequent years, a 200 year aftercare period represents almost a four fold increase in aftercare costs, $(1 + 170/30 \times 0.5 = 3.83)$, or the aftercare would increase to 24% of the total 2003 landfill cost $(3.83/15.67)$. However, the effects of interest rates above inflation and the use of sinking funds make the effect of longer periods much less significant than it otherwise appears.

To all of these additional increasing costs must be added landfill tax. Landfill tax was introduced in UK in 1996 under the landfill tax Regulation at £5/tonne for active waste. It was subsequently increased to £13/tonne (€17.5/tonne) by 2002/03, and the Chancellor in his Budget Report 2003 (HM-Treasury) will increase the tax to £35/tonne (€47.2/tonne) in £3/tonne (€4/tonne) increments by 2012/13. This represents a 161% increase on the current tax over the

next 9 years. The objective is to discourage landfill and make other options more competitive. Landfill tax in some EU States is already significantly greater than the UK (Table 4). Even with an increase to £35/tonne (€47/tonne) for landfill tax the UK landfill prices at £48/tonne to £58/tonne (€63 to €78/tonne) will be below those in some European countries. It is reported that UK treatment fees excluding tax are £20/tonne (€27/tonne) for composting and £40/tonne (€54/tonne) for EfW (Biffa Waste Services). This increase of landfill tax should make these processes viable against landfill tax.

The above indicates that landfill costs in the UK might increase 25% (a quarter) above the RPI over the coming years. If landfill tax increases are added, then this increases to 184% (approximately two times). These figures are considered a serious underestimate, based upon the increase in landfill costs in the UK over the last 20 years. It will not be surprising to see landfill prices in the UK continue to increase four fold above inflation over the next 20 years.

4. LANDFILL CONTRACTS

Landfill contracts have traditionally been disposal contracts with the operator being paid a gate fee of a price per tonne for the waste accepted. This encourages operators to maximise the quantity of waste accepted, to maximise their income and profits.

Waste management contracts in the UK are now becoming more integrated, with landfill only a part of the services offered. Lump sum annual payments are made on the services provided (collection, recycling, recovery and disposal), not the tonnage of waste arisings, with incentives for recycling and disincentives of landfill tax. This encourages the contractor to apply the waste hierarchy. It is in the best interests of the contractor to minimise the quantity of residual waste disposed, and maximise recycling.

Procurement of waste management services above a value of €214,326/year and works above €5,358,153 must follow the procurement Directives (92/50/EEC public services contracts and works contracts 89/440/EEC). Details of tenders across the EU are available on TED (Tenders Electronic Daily) (<http://europa.int/general/en>.)

Conditions for the application of environmental criteria in competitive tendering for public contracts have been set out by the EC Journal in a judgement welcomed by those campaigning for 'greener' public procurement (Council of European Communities). This seeks to consolidate the three procurement Directives (services, works, supply) under a single version, promoting modernisation (electronic age), simplification and flexibility. Some countries in the EU are against the negotiated procedure as they consider it can discriminate against contractors from other nations. However, the negotiated procedure is favoured in the UK for integrated waste management contract as it allows flexibility for the parties to the contract to negotiate and agree the optimum balance between the services, performance, price and risk transfer.

The issue with modern integrated DBFO (design, build, finance and operate) contracts is risk transfer. The greater the risks transferred to the contractor, the greater the cost. There needs to be a balance in risk transfer by ensuring that risk is transferred to the party best able to manage it.

What risks should be retained by the employer (client) and what risks should be transferred to the contractor? Interesting ones are landfill tax and landfill cost. The quantity of waste for landfill tax should be a contractor risk as this will encourage the contractor to limit waste for disposal. Changes in the rate of landfill tax should be an employer (client) risk because these are beyond the control of the contractor. Landfill costs have traditionally been a contractor risk, however, with the shortage and monopolisation of landfills in certain areas, and the high cost risks associated with landfills, some contractors are seeking landfill to be excluded from

integrated waste management contracts i.e. separate short term landfill contracts, or landfills included as nominated sub-contractors.

The economic cost of landfills is unlikely to be significantly affected in the long term by the implementation of the Landfill Directive and the IPPC Directive. The Landfill Directive and the IPPC require that the full costs of the landfill are charged in the price. Such information on cost and price must be supplied to the Regulatory Authority (Environment Agency in England and Wales), and it is an offence to fail to provide such information.

5. LANDFILL VIABILITY

Table 1 indicates a 2003 landfill cost of £12.8/tonne (€17.3/tonne) excluding site acquisition costs, whereas typical prices of £13-£23/tonne (€17.5- €31/tonne) are quoted (Biffa Waste Services), although prices as low as £8/tonne (€8/tonne) have recently be given to us. The difference between costs and prices may reflect funding, profit and risk. Consequently, landfills should be viable at prices currently quoted. However, the difference between cost and price is marginal when financing' taxation and profit are taken into account. There is a significant impact of market forces on marketing and accountability.

In our resource driven economy the viability of the landfill depends upon competition and cost of alternative technologies. At current landfill costs around £13/t (€17.5/t) together with the Landfill tax of £35/t (€47/t) by 2012/13, landfill is unlikely to remain viable against alternative technologies by 2013. This should be good for the UK in meeting the derogated Landfill Directive targets. It is considered that the UK should meet the 2010 75% biodegradable landfill limit by recycling and composting, but the 2013 50% limit will be more onerous and require many more new recovery facilities. The increases in the landfill tax, plus probable increases in landfill costs should make the alternative waste technologies more viable against landfill by 2013. UK landfill costs are converging with higher landfill costs in other EU countries.

6. CONCLUSIONS

We live in a resource driven economy where process outputs (waste and pollution) are not priced on the basis of their true long term cost. The UK now recognises that our historic reliance on a linear flow of raw materials into products, consumption and waste into landfill has to change. We are now moving towards a resource efficient economy where resources have to be fully costed. This should lead to landfill prices being costed on the whole life of the landfill.

The UK Government expects waste management costs to double from £1.6bn (€2.2bn) to £3.2bn (€4.3bn) by 2020 (without landfill tax increase) to develop the waste hierarchy and send less waste to landfill. Landfill tax increases will be applied to landfill to make waste recycling/recovery processes viable against landfill. In addition, there will be environmental landfill controls on the containment of waste and limit of emissions. In examples given in this paper, landfill costs have increased four fold against inflation over the last 20 years, and environmental controls and legislation may cause and require them to be increased by four fold over the next 20 years.

Landfills should be viable in the UK at prices currently quoted. It is questionable whether they will remain competitive against other waste technologies with the rise in landfill tax to 2013. The rise in landfill tax should make other waste technologies more viable against landfill, although this is dependent upon whether waste taxes are also be applied to other technologies. Landfill will however remain a long term disposal route for residual waste in the UK.

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