

Opportunities for cost reduction and improved environmental impact in the lead and lead/acid battery industries

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Abstract

The opportunities for cost reduction through improved environmental performance exist in many companies, but often are not realized. This paper describes the efforts of a typical firm — Calder Industrial Materials (CIM) — that is experiencing ever-tighter environmental controls and profit erosion through the effects of new environmental legislation. At the same time, however, CIM sees opportunities to reduce its environmental burden and cut costs. As the story unfolds, readers may well discover many parallels with their own companies. It may even spur some into action, for remember, every £1000 saved requires ten times the turnover to generate the same profit. © 1997 Elsevier Science S.A.

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1. Who, what, where, why and when?

The Elswick Works of Calder Industrial Materials (CIM) is principally a lead business. It is based in Newcastle upon Tyne in the North of England, and it has been there for 250 years. Why there? Because that is where the world's richest lead ore deposits were mined until the 1850s when the focus shifted elsewhere, particularly to Spain. Business growth and natural-fit acquisition led CIM into the position it is in today, namely: (i) the manufacture of 30 000 t of sheet lead per annum (for the UK roofing market) from scrap; (ii) the recycling of about 5000 t of polypropylene battery scrap into injection-moulding grade material; (iii) the production of the lion's share of the European market for pre-mixed negative expander, and (iv) the supply of a range of alloys to a CIM lead-engineering operation in Chester, UK, for battery-related products. CIM operates a rotary furnace to handle the lead wastes generated by its refinery and plastics wash plant, and the drosses from two sister refineries in mainland Europe. By virtue of these operations, CIM generates a wide range of wastes to air, land and water, and uses considerable amounts of energy — some of it wasted.

2. Pressures

There has been a tightening of environmental legislation — a pressure that all businesses experience in some way or other. For CIM in Newcastle, it is only one of a number of pressures that can be labelled 'environmental'. Others are listed in Table 1.

3. Location

The city of Newcastle has grown around the CIM site over 250 years. On a good day, one can smell the brewery and hear the roar of the Newcastle United crowds. At its southern boundary, runs a newly opened riverside walkway (used by fitness fanatics as a running track at lunchtimes). The river is the Tyne, one of Europe's most famous salmon-fishing rivers. CIM is permitted to discharge waterborne effluent into the river.

A further 800 m up the river, and still on the walkway, is located the headquarters of the Northumbria region of the UK's newly formed Environment Agency. The Agency

Table 1
Environmental pressures on CIM

Location
City centre
Riverside
Environmental Agency Regional HQ
Future developments
Improved city access
Biotechnology Park
Increasing legislation
Increasing costs
Public perception
Public register information
Possible enforcement action

is the national regulator for emissions into land, air and water, and has considerable powers. These range from: "You will do this" to: "You haven't done it, so we're taking you to court where fines can be unlimited and people might go to prison. Oh, and by the way, we've sent out a press release about it". Earlier this year, the author was sitting taking coffee in the Chief Inspector's office and noted the latter's marvellous view of the three CIM stacks. Now, is that a pressure or not?

To the east, and above the factory, passes the Redheugh Bridge. In the next few years, this is set to become a road route that will serve as the major artery into the city and, thus, will bring more traffic and people who can look down and over the CIM site. Also, in the next few years, CIM will be acquiring new neighbour, namely, a Biotechnology Business Centre and Genetic Science Museum. Construction is already underway on these high-profile initiatives. A final pressure is the burden of legislation, already mentioned, with its additional costs.

Consider now the question of public perception. The author lectures each year to a group of environmental students, the presentation usually starts thus: "Hello. I work in the metals industry. What phrases does the word conjure up in your minds?"

Without fail, of course, the answer is the single word: *toxic*. These are the same people — the public — who will visit the Museum and use the Bridge, and who have the mindset that lead is toxic. They also visit the Newcastle Arena, CIM's newest and most immediate neighbour on its northern boundary. This is a music, sports and exhibition venue that seats 10 500 people and aims to have a million patrons pass through its doors each year.

Are the above environmental pressures? The river? That is the river that Greenpeace and the Friends of the Earth have targeted in the past few years as part of their national anti-pollution campaigns. The office of the Agency? They hold on public register the details of emissions into air and water of licensed processes, and the applications and authorizations for the same.

4. Legislation

Much of the environmental legislation in the UK is published in documents bound in pastel-coloured covers that make it look innocuous. But this legislation gives life to the list given in Table 2, all of it environmental legislation that CIM must meet. The following sections give a more detailed examination of some of the regulations.

1. *The Environment Act*. This is an all-encompassing umbrella act from which many of the others spring.

2. *The Prescribed Processes Regulations*. These cover the refining and smelting practices of CIM. Under these regulations, the company has a licence to conduct business that entails the monitoring and control of process emissions to land, air and water. The monitoring of stack emissions are particularly important as they are reported to the Environment Agency on both quarterly and annual bases. Within the allowed authorizations, the Agency has set limits for these emissions together with a timetable for improvements. The aim is to encourage the gradual reduction of the environmental impact of the business, but to the company, of course, this is at a cost.

3. *The Waste Management Licensing Regulations*. These affect the plastics operation of CIM, and to comply, the firm needs another licence issued by the Agency. This licence describes how the facility is managed, how product and raw materials are stored, and requires that a responsible person is specifically qualified and holds a Certificate of Technical Competence, but again at a cost in both monetary and resource terms.

Table 2
A selection of UK environmental legislation

Environmental Protection Act 1995
Environmental Protection (Prescribed Processes and Substances) Regulations 1991
Environmental Protection (Applications, Appeals and Registers) Regulations 1991
Clean Air Act 1993
Waste Management Licensing Regulations 1994
Duty of Care — A Code of Practice (Revised) 1996
Water Act 1989
Water Resources Act 1991
Collection and Disposal of Waste Regulations
Landfill Tax 1996
Controlled Waste Regulations 1992
Special Waste Regulations 1996
Transfrontier Shipment of Waste Regulations 1994
Chemical (Hazard Information and Packaging for Supply) Regulations 1996
And to come
Air Quality Directive
Packaging and Packaging Waste Regulations
Solvent Directive
Integrated Pollution Prevention and Control Directive

4. *The Duty of Care Regulations.* These regulations involve the controlled movement of waste, and encompass Special Waste Regulations. A range of wastes are deemed Special — for CIM these include Negex waste, slags, leady plastic residue, and oil. These regulations came into force on 1 September 1996 and were so well structured that they were immediately amended! For each load of Special Waste that a company sends for disposal, it must notify the Agency and pay them £15 each time for the privilege.

5. *The Landfill Tax.* This tax was introduced in September 1996. It is aimed at taxing what goes to landfill and at encouraging firms to apply the mantra 'reduce, re-use or render harmless' to their wastes. The levy here is £7 per tonne for non-inert wastes and £2 per tonne for inert wastes. All of CIM's wastes fall into the first category, except its smelter slags which are classified as inert. The levy is set on the landfill operators who pass it on, possibly with their own administration fee. In each budget, the government can increase the fees in the same manner as it increases income tax.

6. *The Transfrontier Shipment of Waste Regulations.* These regulations control the movement of waste across national boundaries of EC countries and those who are signatories to the Basle Convention. These affect CIM and its movement of drosses from its sister companies in mainland Europe to its Elswick works.

7. *The Producer Responsibility (Packaging Waste) Regulations.* These are to be introduced in 1997 and are intended to encourage firms to assess first the packaging they handle in a year, and to determine if it is more than 50 tonne per year. If this is the case, the firms are then obliged to 'valorise' (i.e., re-use, recycle, or convert into heat energy) certain packaging waste streams to calculated percentage targets. Wood in the form of pallets and crates is not classified as a waste, but its weight can be used to offset a company's obligation. Once more, the regulations are confusing and costly.

8. *The EC Air Quality Directive.* The UK regulations

that interpret this forthcoming directive will be enforced by the local authorities, and monitored through the UK Air Quality Network of sampling sites. At present, in excess of eighty of these are in place, with at least nine dedicated to sampling lead in air. Three of these latter sites are in the vicinity of Elswick.

The above can be considered as environmentally legislative threats to CIM's business. Let us now examine what the site emits to the three environmental media, and what measures are being taken to address the corresponding regulations.

5. Emissions

5.1. Air

Under the requirements of the *Integrated Pollution Control Regulations*, the company has to monitor the emissions from its baghouse stacks and the flues from its gas-fired melting pots in the refinery. The monitoring of flue gas had not been conducted before these regulations came into being, and so a portable flue-gas analyser was purchased to measure CO, NO_x and SO_x levels and burner efficiency. This led to a full survey of pot and furnace burners that showed at least four different burner types to be in use, some obsolete, and with efficiencies that could have been better. The survey also resulted in an ongoing programme of burner upgrade and melting-pot insulation, and will ultimately lead to considerable savings in gas consumption. The next phase of the work will consider waste heat and what can be done with it, in terms of both cost savings and reduced environmental impact.

One of the main thrusts of the company's IPC licence is the reduction of fugitive emissions, and this is now considered whenever new plant is designed. As an example, special UN-classified dross boxes suitable for shipment around Europe are used to charge the smelter.

Furnace charging is fully abated, and this abatement has

Table 3
CIM waste disposal charges by stream (1995)

Description of waste	Charge type	Charge (£/tip)	Weight range dumped over year (kg)	Maximum skip payload (kg)
Slags	Haulage	40	16860–22840	20000
	Tipping	285		
Negex	Skip hire	8 (per week)	220–1500	7800
Packaging Waste	Tipping	158	10760–17360	15000
	Skip hire	12 (per week)		
Special (leady)	Tipping	340	2380–7360	15000
Plastics, general	Skip hire	12 (per week)		
Site, general	Tipping	120	2020–6040	15000
	Skip hire	12 (per week)		
Waste	Tipping	120		

Table 4
CIM waste disposal charges by stream (1995)

Description of waste	Haulier charge per drop (£)	Total skip rental (£)	Number of drops	Total cost (£)
Slags	285	2780 (as haulage)	71	23015
Negex packaging waste	158	384	23	4018
Plastics special waste (leady)	340	576	26	9416
Plastics, general	120	576	13	2136
Site, general	120	Part year	19	2280
Total				40865

been considered by the Agency to represent 'BAT' — Best Available Technology for such an operation. Anyone putting in such a furnace is now expected to meet at least the controls that CIM have in place. Therefore, application of BAT can give a firm a commercial advantage over its competitors, and improve the firm's image with the regulatory authorities.

5.2. Water

The Agency has issued consents to CIM to discharge into the River Tyne. These cover pH, lead, cadmium, zinc and suspended solids, with a volume discharge consent limit of 4500 m³ of water daily. In December 1995, a new effluent treatment plant was brought on stream to handle both waste process water and the rainwater caught for free over the site's six-hectare catchment area. The factory drainage system and effluent plant holding tanks have the capacity to hold water generated by an eight-hour storm. The major user of the facility is the plastics operation where wash water is recycled a number of times before entering the drainage system that leads to the treatment plant. After initial installation, the regulator was invited to inspect the system in operation and was so impressed that an offer was made to promote the firm as an example of good water-management. The site actually emits to the river a maximum of ~ 3 m³ per day of water against the 4500 m³ mentioned above, and saves in excess of £20 000 on water charges through recycling.

In setting up the system, CIM conducted a full mains and drainage survey and discovered that the plans were incomplete and that there were many hidden, costly leaks.

Such a survey is recommended as a starting point for any company that wishes to improve its water management.

5.3. Land

Much of the legislation referred to earlier related to waste, the majority of which, in the UK, finds its way into landfill. Such landfill sites are supposedly in short supply. There is an adage that claims that everything thrown away is paid for at least twice. With the advent of the Landfill Tax the adage should become: 'Everything thrown away is paid for at least x times, where x is greater than two and depends on how often the government has a budget.'

Aware that much costly waste-related legislation was on the horizon, CIM decided to examine the opportunities for volume reduction (and, hence, cost reduction) of its wastes. This strategy was also designed to lessen its environmental impact. A quick survey revealed that through lack of control (because waste just happens and is an accepted cost) the company was dealing with at least six firms to remove the wastes. Now, there are three firms: one for scrap metal (who is also a scrap lead supplier), one for slags, and one for everything else. The third firm also owns all of the region's landfill sites. This reduction in contractors immediately cut costs and improved control.

The next step involved conducting a survey of all waste streams, i.e. costs, quantities, and how tipped, as well as an audit of the landfill operation. An analysis of weighbridge notes and invoices showed anomalies with two of the hauliers. The landfill audit started by following two slag-laden lorries from the works to the tip. From a comparison

Table 5
CIM waste production for landfilling 1995

Description of waste	Amount sent to tip (tonne/year)	Frequency (times/year)
Slags	1429.56	71
Negex Packaging Waste	17.22	23
Plastics, special waste (leady)	366.28	26
Plastics, general	53.23	13
Site, general	66.78	19
Drums	70.36 (to scrap merchant)	20

of the weighbridge weights on departure from Elswick and those on arrival at the tip, it was found that, over the distance of a few miles, each lorry had gained in weight by 350 kg. This practice was traced back to September 1994 when the vehicle type regularly used was tared for the one and only time. Perhaps this was acceptable then, but imagine the cost with the Landfill Tax in place and using the landfill site weighbridge for cost calculation purposes. Both of these problems were resolved.

The remainder of the survey helped to clarify the cost of the waste to the company, and what the implications would be when the new legislation was in place. Since the data were hard to find, it was soon found that it was difficult to get an accurate picture of the situation. A range of waste types were identified, see Table 3. It is interesting to note the weight range for each waste, as well as the capacity of the skips used to hold the wastes. Astonishingly, the company was paying to dump fresh air! Moreover, in the case of plastics special waste, the company was paying to dump water and some recycleable lead. Take Negex waste as an example. It is nearly all cardboard, wood and shrinkwrap and is collected into a skip of 7.8 tonne capacity that, in 1995, took from 220–1500 kg of waste each trip to the landfill, no more! CIM was paying for its rental based on size and tipping frequency, and on the type of waste it contained, in this case classified as Special. The process was not cost efficient!

The total number of loads tipped and the cost for the year for all the identified waste streams are shown in Table 4. This cost relates to the number of loads and, of course, is now increased by the effect of the *Special Waste Regulations*. Table 5 gives the actual weights dumped and the frequency of tipping. Imagine the effect of the Landfill Tax, £2 per tonne on the first line, and £7 per tonne for the rest (excluding drums).

On the basis of the volumes in 1995, the two new regulations would have increased the expenditure of £40 865 by ~ £8000. Such a survey, as described here, has yet to determine the cost of disposal for ferrous scrap, tinny dross, rolling mill, and other oil wastes. A further survey will be needed in early 1997 to examine wastes that are specific to packaging under the *Producer Responsibility (Packaging Waste) Regulations*.

6. Environmental improvements and cost savings

6.1. Ongoing

CIM is currently looking at the wet lead waste from the plastics wash plant. All the polypropylene scrap used in this business is from lead/acid batteries and, thus, is contaminated. The waste contains a variety of polymers, pieces of wood, rubber, metal and traces of lead oxide and

Table 6
Environmental licensing costs (during 1996)

Plastics Waste Management Licence	application	£ 700
	subsistence	£ 725
	PCoTC fee	£ 725
Landfill Tax at £7/t and at £2/t		to come
Special Waste Notifications at £15 each		to come
Discharge consents		£ 7034.25
IPC Authorisation		£13750
IPC Subsistence		£ 9025
Total		£31574.25

lead sulfate. A simple additional separation process would yield a high calorific value, organic fraction as a possible furnace additive, the lead compounds could be smelted, and the water recycled. The lead fraction could represent as much as 250 tonne of furnace feed and save at least £7000 in disposal charges.

CIM's main waste contractor has recently set up a Materials Recycling Facility. This sorts and sells a range of wastes collected from customers and, thereby, eliminates the landfill tax charge. The contractor would supply the firm with specially identified skips to take only the agreed mixed wastes of cardboard, paper, plastic, aluminium and steel, and charge lower rental and emptying fees. Of course, the waste company is trying to keep its hands on as much waste as possible to maximize its revenue, counting on the human trait of laziness in not segregating the wastes. The following briefly illustrates this point.

Nearby the CIM factory is a manufacturer of kitchen worktops who uses waste wood as a raw material. The waste contractor is prepared to come and collect it for nothing, provided there is sufficient to fill a lorry and assistance is given to load the vehicle. But resistance to change prevails and CIM wood waste still goes to the tip and incurs skip costs, dumping charges and landfill tax. In the future, this wood waste could be used to offset some of the company's packaging waste obligations.

Consider baling. A straightforward, two-chamber baler was bought by CIM for £6500 at the end of 1995. It is capable of compressing cardboard, paper and plastic wastes

Table 7
Environmental costs — exclusions

As at August 1996, the cost of environmental conformance was £116,290. This excluded costs of:

New Plant
Employees
Utilities
Poorly recorded wastes
Consumables
Consultancy advice
IPC improvement programme

Table 8
Projects for reduced environmental impact and cost savings

Item	Potential saving
Reduction or elimination of Landfill Tax burden for range of wastes	> £30K
Generation of non-leachable slags	unknown
Reduction of dross volumes through improved refinery operation, and hence reduced slag volumes, emissions and monitoring costs	> 375K
Elimination of office/factory packaging and general wastes through recycling	> £10K
Substitution of refining/smelting raw materials	> £60K
Re-use of waste refinery heat	unknown
Improved plant and office utility management	unknown
Packaging review	unknown
Water consumption improvements	done

to one-ninth of their original size. The company's Nexeg operators now collect and bale all of their waste. Thus, less air is sent to the tip with an estimated saving of £5000 per annum. Moreover, some of the material is saleable, but this depends on the vagaries of the market for that commodity.

Before leaving the processes of the business, there is a set of costs that has not yet been examined. These are the licensing costs as laid out in Table 6. For the year to August 1996, the costs were in excess of £30 000. For the same period, the overall environmental costs were well in excess of £120 000, excluding those items listed in Table 7

6.2. Still to come

Table 8 gives a list of potential topics that could be addressed to both cut costs and lessen the CIM's environmental impact. These projects, together with the ones already described, are all well and good, but for them to be successful, management needs to stay abreast of current issues and keep its employees informed. How has CIM tried to do this?

7. Communication and initiatives

A few years ago, CIM introduced a 'suggestion scheme'. In its early days, many of the ideas were simple and environmentally related. Those taken up generated employee support and involvement for environmental initiatives, and have been ultimately useful for the company's file of 'green' credentials.

Many national initiatives exist and are being examined for suitability at Elswick. Some of the relevant authorities publish useful leaflets for employees, e.g. 'Help the Environment at Home'. The idea is simple — help your employees to save £250 per annum on their home energy bills and they will bring the philosophy to work. It is also important to keep employees informed. To this end, an occasional newsletter is published, and an Environmental Committee has been introduced along the lines of the existing inter-departmental Health and Safety Committee.

The managers who are driving the initiatives need to stay up to date, of course, and there are a number of ways to do this. Many excellent training courses exist and there are many informative magazines. At CIM, membership of a local environmental business network has proven invaluable; it offers topical seminars, lectures and training sessions for senior personnel, whilst providing them with a forum to mix and exchange ideas and experiences. At the same time, many of these events involve the local regulators, and offer a no-risk opportunity to meet them on friendly terms.

8. Why improve?

So why should a company improve its environmental performance? This study has concentrated, but only briefly, on the pressures and costs experienced by a typical company. In so doing, however, it is hoped that others will identify a number of opportunities to overcome these problems.

A UK initiative — the Environmental Technology Best Practice Programme — in a recent survey on attitudes and barriers to improved environmental performance, found that very often companies encounter no disadvantages at all, and yet still perceive the costs of improvement to be substantial. These opportunities have included improved environmental impact, the ability to always meet legislation, the reduced threat of enforcement, the reduced threat of bad publicity, prospects for good publicity, cost savings, improved employee involvement and morale, opportunities to capitalize on a 'green' image, and rapid payback on improvements. This paper should have gone part of the way to illustrate how these opportunities can be taken. Put quite simply, it is a case of a company having to review its current situation, to incorporate both ideas for improvement and the requirements of new legislation, and to start again.

The findings of the above survey within the non-ferrous

metals industry found the following perceived benefits in companies that had done little to improve their performance. In descending order, the benefits were: a safer working environment (27%); no benefits (21%); cost reductions (21%), and better image in the local community (17%). The actual benefits found in the same sector were: complied with legislation (51%); saved money (26%);

reduced waste (15%); increased efficiency (15%), and better image amongst employees (18%). All of the figures were based on a percentage of the companies polled.

It is hoped that this paper has demonstrated that there are benefits to a company in reducing its environmental impact. When the going gets tough, as it will, just remember the simple adage: "Where there's muck, there's brass".