ENVIRONMENTAL TECHNOLOGY BEST PRACTICE PROGRAMME

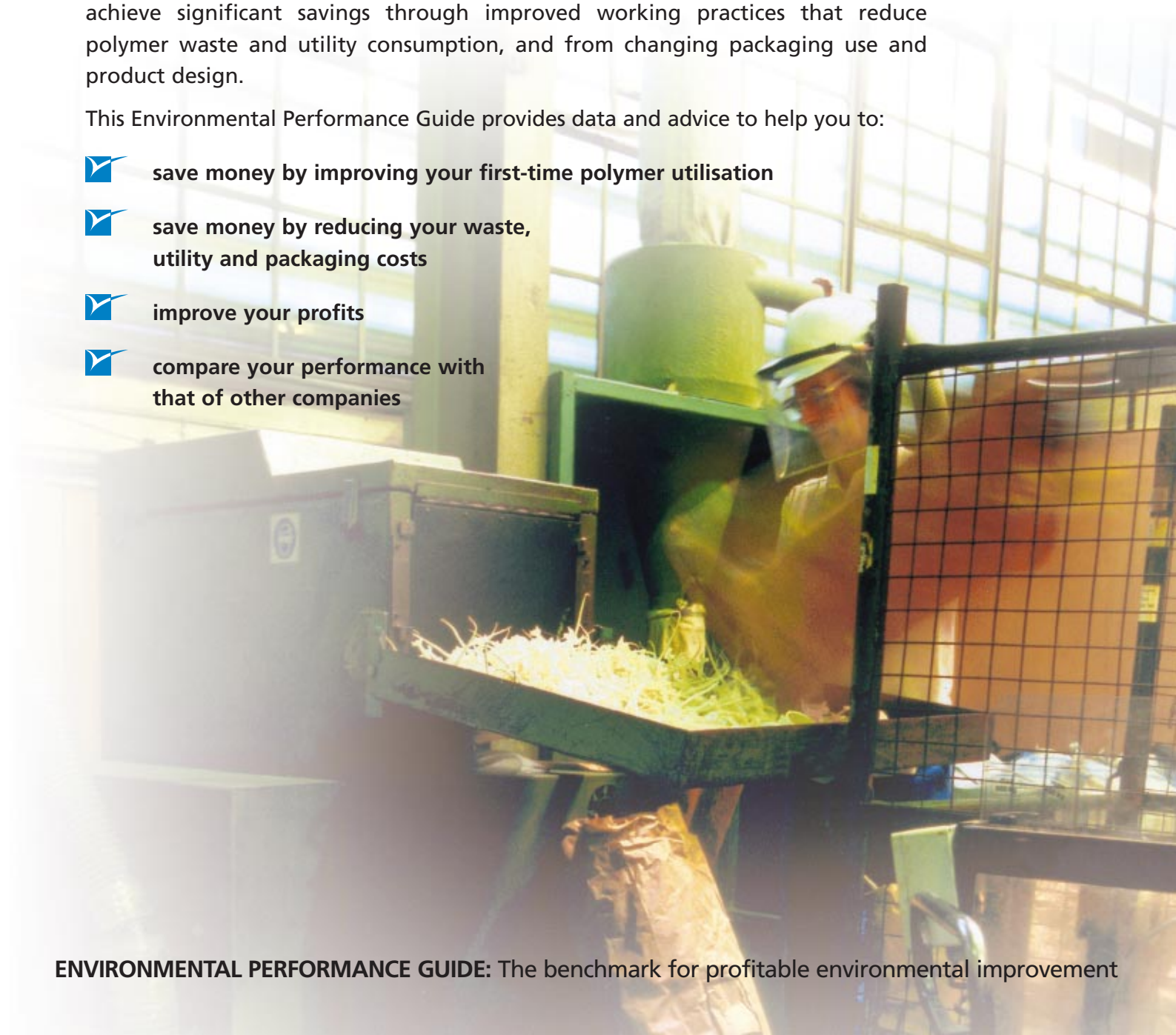
BENCHMARKING WASTE IN PLASTICS PROCESSING

EG252
GUIDE

Polymer purchase, utilities and packaging are significant costs for any plastics business. Most companies are aware of how much it costs to buy polymer, but few appreciate the true cost of polymer recovery (taking into account double processing, loss of capacity, loss of expensive additives, etc). Many sites could achieve significant savings through improved working practices that reduce polymer waste and utility consumption, and from changing packaging use and product design.

This Environmental Performance Guide provides data and advice to help you to:

- **save money by improving your first-time polymer utilisation**
- **save money by reducing your waste, utility and packaging costs**
- **improve your profits**
- **compare your performance with that of other companies**



ENVIRONMENTAL PERFORMANCE GUIDE: The benchmark for profitable environmental improvement

THE SURVEY

A confidential questionnaire was sent on behalf of the Environmental Technology Best Practice Programme to around 500 companies that use a range of plastics processes. A small number of site visits and telephone interviews were subsequently performed to clarify data. The aim of the survey was to obtain information about operating costs in the plastics processing industry and identify potential areas for improvement through applying waste minimisation techniques. The response rate to the questionnaires was around 10% from all sub-sectors. This may indicate that waste minimisation is not a high priority within the industry. The survey did show, however, that there is opportunity within the industry to reduce waste.

The main areas covered by the survey were:

- injection moulding;
- blow moulding;
- extrusion;
- vacuum forming;
- masterbatching/compounding.

The survey did not cover the calendering, spreading, blown film and roto-moulding sectors, as they have their own characteristics.

This Environmental Performance Guide:

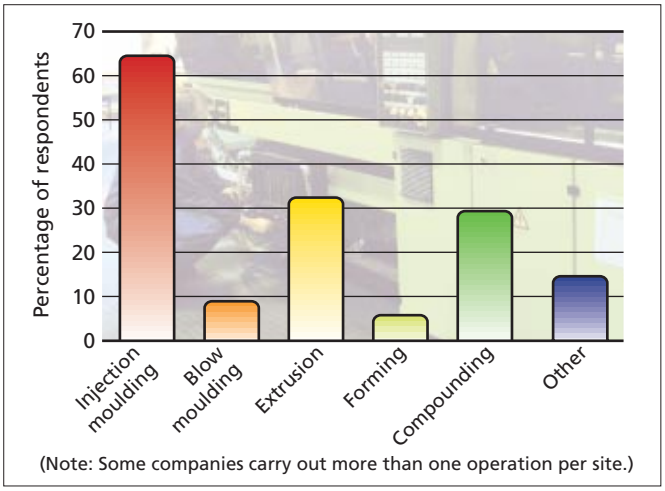
- summarises the survey findings and develops key indicators to allow you to compare your performance with that of your competitors;
- presents an Efficiency Index to help you identify the potential for improving your performance;
- presents an Action Plan and suggestions for reducing current operating costs and thus increasing your profits.

Profile of Respondents

Activities carried out by respondents

The response profile by sub-sector is shown in Fig 1. Over 60% of respondents carried out injection moulding. Nearly 20% carried out masterbatching or compounding in addition to other activities. In Fig 1 'other' includes toolmaking, structural foaming and fabrication.

Fig 1 Response breakdown by sub-sector

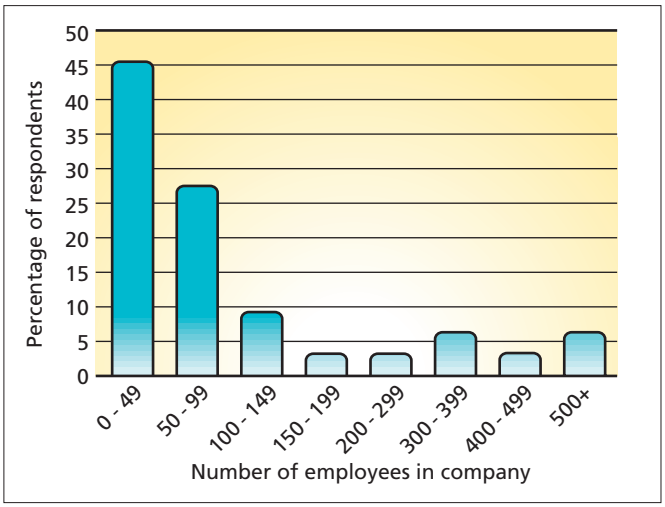


(Note: Some companies carry out more than one operation per site.)

Respondent size

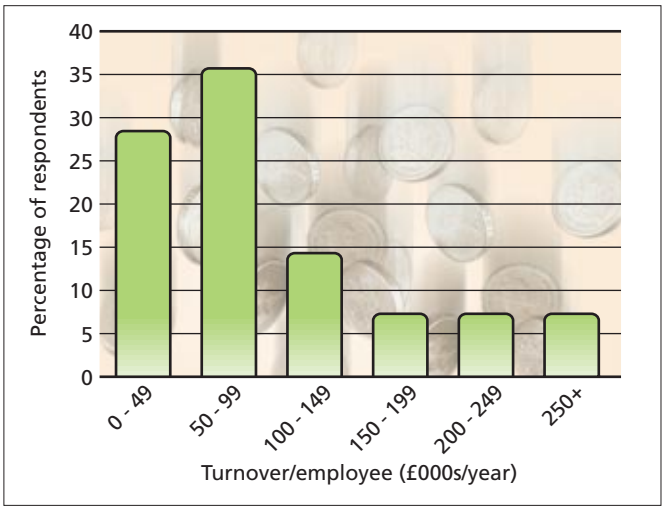
Figs 2 and 3 show the response breakdown by size of company and annual turnover per employee respectively. Over 45% of the respondents were small companies with less than 49 employees; only 6% had over 500 (see Fig 2). However, there was no correlation between company size and type of activities. For example, the smallest injection moulding company had just three employees and the largest around 1 100.

Fig 2 Size of company



There was a large variation in the annual turnover per employee between respondents (see Fig 3). This range reflects differences in labour requirements, material values and value-added in the process.

Fig 3 Turnover per employee



HOW THE INDUSTRY PERFORMS

Machinery, labour, polymer, waste, utility and packaging costs are the main factors that affect profitability in the plastics industry.

Polymer Costs

Not surprisingly, the survey found that the plastics industry uses a large number of different polymers at varying costs per tonne. Table 1 gives the range of costs found by the survey for the most commonly used polymers.

Table 1 Range of polymer prices (1999 costs)

Polymer	Cost (£/tonne)		
	Low[1]	Weighted mean[2]	High
Acrylonitrile butadiene styrene (ABS)	720	739	1 900
High density polyethylene (HDPE)	350	546	600
Low density polyethylene (LDPE)	200	395	500
Nylon	220	1 976	6 050
Polypropylene (PP)	315	345	600
Polyvinylchloride (PVC)	315	389	1 560

[1] These figures include companies that use recycled scrap polymer, and some prices may appear very low as a consequence.

[2] The average cost, based on the volume and cost data supplied by respondents.

For around two-thirds of companies, polymer costs were less than 10% of turnover, and for only one company did the cost of polymer approach 50% of turnover. Many of the companies responding to this survey, therefore, added value to the plastic in operations other than basic shaping. Variations in polymer costs as a percentage of turnover are due to different types of manufacturing operations being carried out. When adding plastics to materials such as metal, polymer costs can be lower than the other raw materials. But when producing generic plastic items, polymer costs will generally be higher.

Polymer Utilisation and Waste Costs

First-pass polymer utilisation, ie the conversion of polymer into product the first time through the processing plant, is an important variable and should be monitored to ensure efficient operation. Polymer that is not utilised first time represents waste. This is the polymer that is ground in-house and reprocessed, sent to a contract recycler and reprocessed, sold as scrap or disposed of as waste. Even waste polymer that can be reground in-house costs you money, eg labour costs, inspection costs, energy to run the regrinder, and wear and tear on the regrinder. Fig 4 shows the percentage of first-pass waste polymer for all respondents. The industry average for first-pass waste was found to be 10.5%, ie the average first-pass polymer utilisation rate was 89.5%.

A third of respondents wasted less than 4%. However, more than a fifth wasted more than 20%. For injection moulders, significant numbers wasted more than 20% (see Fig 5). For extruders, 43% wasted less than 4% and none wasted more than 19% (see Fig 6). Overall results show that many companies have the scope to make large savings by reducing first-pass polymer waste.

Fig 4 Waste polymer generated in one pass through the process by all respondents

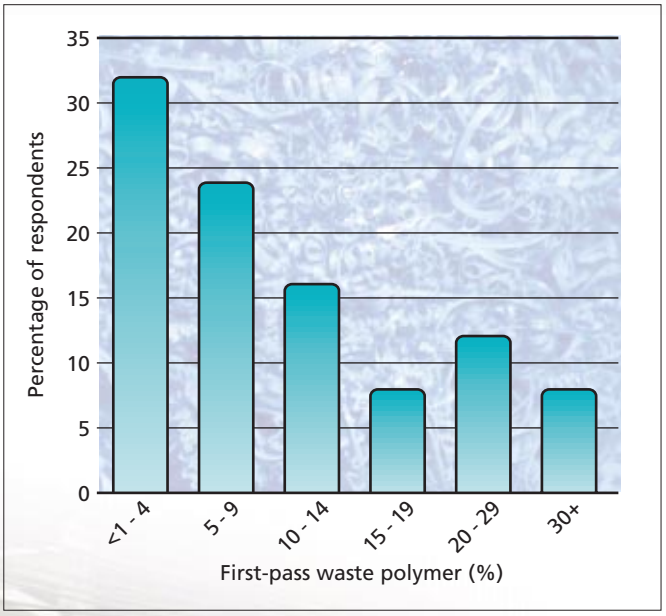


Fig 5 Waste polymer generated in one pass by injection moulding operations

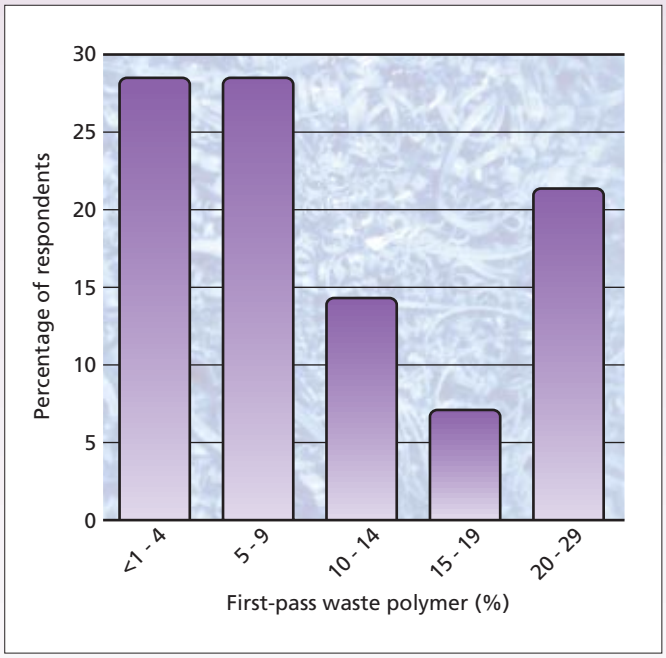
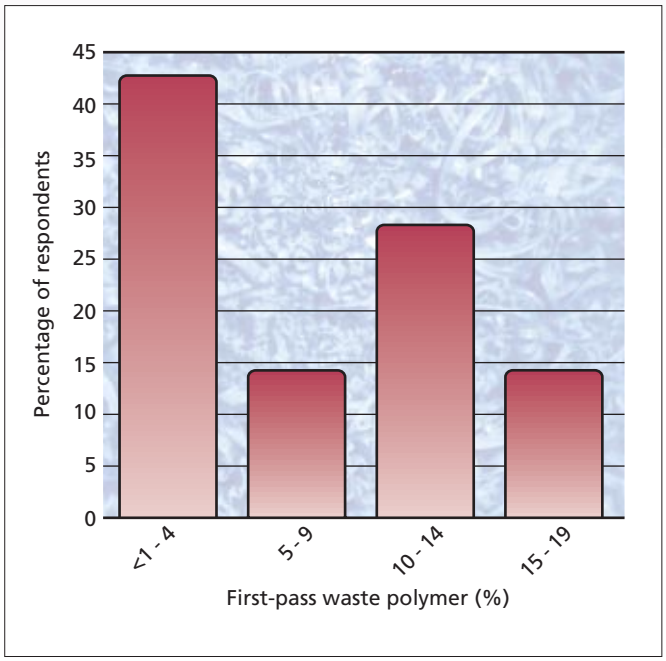


Fig 6 Waste polymer generated in one pass by extrusion operations



Waste management costs

Some 44% of respondents recycled their own polymer waste on site. Nearly 20% used a contract recycler to reprocess some polymer waste and 28% sold some of the polymer waste as scrap. Almost 70% of the respondents sent some polymer waste for final disposal. Table 2 shows the range of recycling and disposal costs found by the survey.

Table 2 Recycling and disposal costs paid by respondents

Disposal method	Cost
Contract recycling[1]	£100 - £300/tonne
Sale of scrap (value obtained)	£3 - £300/tonne
Waste disposal	£29 - £50/tonne
Skip removal	£34 - £225/lift[2]
Flat fee to local authority	£234 - £950/year

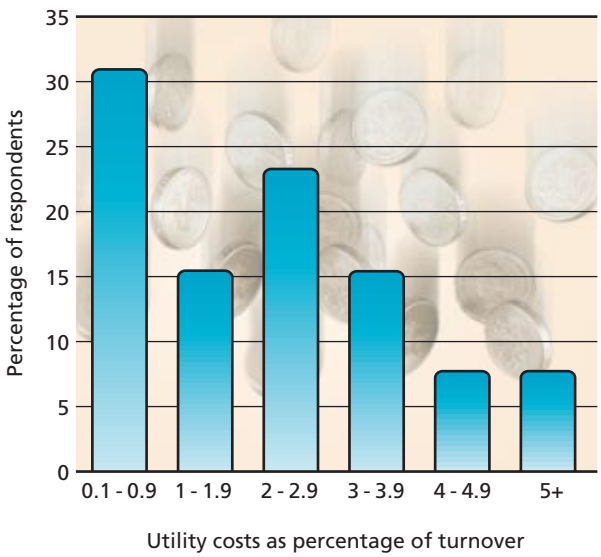
[1] Reprocessed material received back on-site for re-use.
[2] Depends on skip size.

Utility Costs

The costs of utilities and processing fluids (eg electricity, gas, fuel oil, other fuels, water and hydraulic oil) are generally more stable than polymer costs. Tracking these costs will give you a good indication of the efficiency of your company.

Fig 7 shows the specific utility costs for respondents. For 54% of respondents, utility costs were more than 2% of turnover. In the survey, the highest utility cost was over 8% of turnover and average utility costs were 2.5% of turnover.

Fig 7 Specific utility costs



Water costs

The survey showed a wide variation in the price paid for water in the plastics industry (see Fig 8). The average water cost was found to be 71.3 pence/m^3. Once all measures have been taken to reduce water use, smaller companies, in particular, should investigate the possibility of negotiating cheaper supply costs, although there will be regional variations.

Fig 8 Water costs

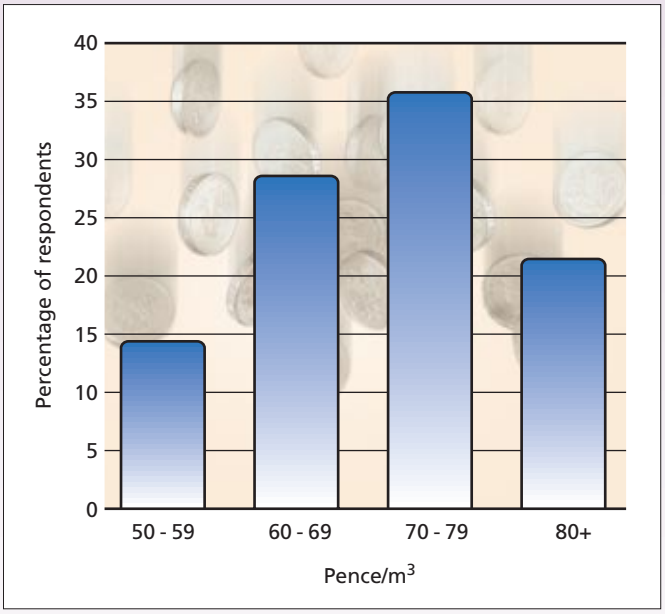
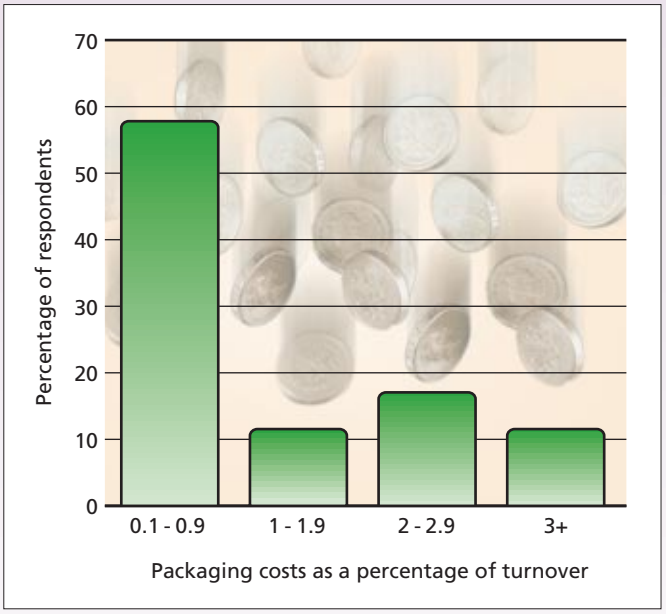


Fig 9 Specific packaging costs



Packaging Costs

Many respondents did not consider packaging to be an issue, could not obtain the information easily or had packaging provided by their customers. Fig 9 shows specific packaging costs for those companies that provided information.

The results indicate that packaging costs are significant for many companies. Over 40% of companies that knew their packaging costs were spending more than 1% of turnover on packaging.

Reducing the amount of packaging you pass on will help you to meet any obligations your company may have under the packaging waste regulations. For free advice and information about packaging reduction and re-use, contact the Environment and Energy Helpline on freephone 0800 585794.

HOW DO YOU COMPARE?

To find out how your costs and performance compare with the rest of the industry, use the instructions below to calculate your specific polymer costs, etc. The information needed should be easy to obtain:

- Your accounts department should have records of purchased material and copies of invoices for contract recycling, waste disposal, etc.
- Use production records to find out how much polymer is actually used, rather than how much is ordered and delivered to stores.
- Waste transfer notes (a legal requirement) will tell you how much solid waste has left the site. You may have to estimate the percentage of waste polymer sent for disposal if you do not segregate your wastes.
- Companies or suppliers covered by the packaging waste regulations should already have accurate data on quantities and types of packaging used.

Because the survey data cover a wide range of operations, they may not be directly comparable to your site. However, the benchmarks described below provide a useful base-line against which to measure improvement in your site's performance.

Working with the following waste tables:

Waste route 1: Waste reground on site

The cost of regrinding is estimated to be approximately 5% of the polymer cost. This includes reject product, trimmings, spares, etc which are reground. Some of these wastes may not be measured as a matter of course, and may, therefore, be 'hidden' wastes.

Waste route 2: Waste reground by contractor

Depending on the size of your company and the regrinding equipment available to you, you may use a contractor to regrind. This can be a cost-effective solution, but it is always worth re-examining the full financial case, as transport costs will inflate the price.

Remember:
If your costs are high, then consider ways of changing the disposal route of the scrap polymer in order to maximise its value, eg use a contract regrinder, or regrind in-house rather than selling as scrap.

Waste route 3: Loss from polymer sold as scrap

Sending polymer for scrap will reduce its value by at least 50% of the purchase price. This is an estimate based on information available. Therefore, any income from scrap actually represents, at best, a corresponding loss of revenue to the same sum. Fill in the amount received for your scrap, as the value lost will be at least this. (See Table 2 for example scrap prices.)

Waste route 4: Polymer sent for disposal

This may include extremely heavy items such as purgings which require specialist regrinding, or items which have become heavily contaminated with oil or dust. It may also include materials generated in quantities 'too small for anyone to bother dealing with'.

Identify your three main polymers (group the rest under 'Others') and complete the first part of Table 3. How do your costs (from column B) compare to the ones given in Table 1?

Table 3 Calculating your polymer use and the cost of polymer waste

Polymer	Amount used (tonnes/year) A	Cost (£/tonne) B	Annual cost (£) C = A x B
1			
2			
3			
Others			
Total polymer use (tonnes)			£

*Complete the **Polymer waste route** section of Table 3 to determine the cost of your waste polymer. How do your costs for contract recycling and waste disposal (from column E) compare to those given in Table 2 for the rest of the industry?*

Polymer waste route	Amount (tonnes/year) D	Cost (£/tonne) E	Annual cost (£) F = D x E
1 ***Waste/rejects*** Reground on-site			
2 Sent to contract recycler			
3 Loss in value of polymer sold as scrap			
4 Sent for final disposal, eg landfill of purgings, badly contaminated scrap			
Total polymer waste (tonnes)			£

*Use the last section of Table 3 to help you calculate your **First-pass polymer waste** rate. How does your waste percentage compare to the rest of the industry as shown on pages 3 - 4 in Fig 4 (Fig 5 for injection moulding operations and Fig 6 for extrusion operations)? Is your site better or worse than the industry average of 10.5%?*

First-pass polymer waste	
Waste percentage = $\frac{\text{Total polymer waste (from D)}}{\text{Total polymer used (from A)}}$ x 100	.....%

Table 4 Cost of general waste disposal

Use Table 4 to calculate the cost of general waste disposal (eg packaging, cleaning materials or containers).

General waste route	Amount (tonnes/year) G	Cost (£/tonne) H	Annual cost (£) I = G x H
Disposal charges, eg skip lifts			
Revenue from segregated waste (expressed as a negative cost) – remember, this does not account for the purchase cost of the wasted material			–
Total general waste (tonnes)			**£**

Estimating your potential cost savings

Identifying the scope for improvement and the potential cost savings will help you both to justify the need for a waste minimisation programme and identify specific areas for opportunity.

Most companies will find the greatest potential for cost savings comes from reducing waste polymer. How much could you save by eliminating the costs in the previous tables?

Efficiency Index

Completing the Efficiency Index devised for this Guide (see Table 6) will help you to determine the potential for improving your performance. Use Table 5 to find your scope for improvement - the lower your score, the greater the scope for improvement. The maximum score is 40 and the minimum is 0. How has your company scored? Why not consider implementing some of the higher scoring options from the Efficiency Index.

Table 5 Scoring system for Efficiency Index

Score	Scope for improvement
Less than 15	Considerable scope for improvements that could help you reduce your waste costs significantly and thus increase your profits.
Between 16 and 30	Although progress has been made, the true cost of waste could be much higher than you think. Still some scope for improvement.
More than 30	Improvements may be hard to identify, but are still worth looking for as they could produce some unexpected benefits. Find out what you are doing well and incorporate it into standard working practices.

Table 6 Efficiency Index for plastics processors

Area		Score		Your score
A	**Polymer handling**			
	How is polymer delivered to the site?	**0** **2**	Bags Octabins or in bulk	
	How is polymer delivered to the machines?	**0** **1**	Manually Suction feeder	
B	**Quality assurance**			
	Do you have a formal QA system?	**0** **1** **3**	No Yes Certified to ISO 9001	
	Do you track the reject rate?	**0** **2** **4**	No Yes, but monthly Yes, in real time	
	Is it standard practice to take action when variations in quality occur?	**0** **2** **4**	No No, but actions are often taken Yes, immediately	
C	**Waste handling**			
	What happens to waste polymer from your process?	**0** **2** **4**	Skip to landfill Sent to a contract recycler/sold as scrap Reground in-house	
	Do you segregate your waste streams?	**0** **2** **4**	No segregation Some segregation Extensive segregation	
	If you have a regrind machine, how often is it maintained?	**0** **2** **4**	Annually When problems arise On hours operated/volumes reground	
	Do you monitor the contents of your waste skips?	**0** **1** **2**	No Occasionally Regularly	
D	**Utility management**			
	Do you monitor consumption of all utilities?	**0** **1** **2**	No Some All	
	Are they tracked to identify excessive consumption?	**0** **1** **2**	No On an ad hoc basis Regularly	
	Do you relate consumption to production or turnover?	**0** **1** **2**	No Sometimes Yes, eg weekly	
E	**Packaging**			
	Do you re-use any packaging?	**0** **1** **2**	Never Sometimes In most cases	
	Have you raised packaging issues with your suppliers?	**0** **1** **2**	No Yes, but no improvements were found Yes, and packaging has decreased	
	Have you raised packaging issues with your customers?	**0** **1** **2**	No Yes, but no improvements were found Yes, and packaging has decreased	
Total score				

Material management

- Avoid spills by improving storage and polymer handling techniques.
- Record polymer utilisation wherever possible and track any variations.
- Monitor how much polymer has to be reground and how much is returned from your contract recycler.
- Review product design. Could less polymer be used? Could waste polymer, eg in sprues, be reduced? Could a cheaper polymer be used?
- Minimise the need for polymer recovery, regrinding and re-use. Apart from the additional processing, transport and administration costs, converting the recovered polymer into saleable product occupies process time that could be used to make more product.
- Plan production to minimise changeover losses.
- Establish total material loss over a given period, ie the difference between the weight of material bought in and the weight sold. Compare this with your polymer utilisation rate to determine the relative importance of process and material handling losses.

Waste management

- Identify the various waste streams produced on-site. For example, examine the contents of your skips. This may reveal unexpected problems and opportunities to save money.
- Optimise waste segregation and recycling to minimise the amount of waste requiring disposal.
- Avoid contaminating waste polymer as this lowers its value.
- Estimate the true cost of waste. For example, the cost of waste polymer is not just the disposal cost, but includes the purchase cost of the polymer and the embodied processing costs.

Utility management

- Implement no-cost and low-cost methods of improving energy efficiency. For example, insulating jackets on heated moulds can reduce energy losses and improve safety.
- Ask the Environment and Energy Helpline (0800 585794) to send you relevant publications to help you reduce your energy consumption, eg GPG 292 *Energy in plastics processing: a practical guide*.
- If you do not do so already, recycle cooling water rather than discard it after a single use.
- Optimise the use of water pumps distributing water around the site.
- Consider ways of reducing both the cost of chilling water and the volume of water needed to obtain optimum cooling in extrusion troughs.
- Consider installing a closed water circuit. Such circuits are usually more efficient, have less entrained air, can be pressurised and stay clean longer. Water supply and effluent charges are, therefore, lower than with open circuits.
- Review hydraulic oil purchase, storage, handling and disposal procedures.
- Consider the benefits to oil lifetime of installing bypass filters in all hydraulic equipment.

Packaging

- Re-use any packaging for your products, where appropriate.
- Discuss ways of minimising packaging use with both your suppliers and customers.

Other measures

- Ensure machines are suitable for the processes being carried out, set-up to obtain optimum polymer and energy consumption, and maintained regularly.
- Ensure employees are properly trained and understand the effects of their actions. For example, they are vital to the success of waste segregation. Employees also need to be made aware that, while regrinding waste polymer saves the company money, it does mean additional costs.

Areas of improvement

This Guide provides some ideas on how to improve your performance. For further advice and free publications, contact the Environment and Energy Helpline on freephone 0800 585794. Ask particularly for the following free publications:

- *Profiting from Less Waste* (ET206)
- *Finding Hidden Profit - 200 Tips for Reducing Waste* (ET30)

ACTION PLAN

- Calculate your specific waste cost, polymer utilisation rate, specific utility cost and specific packaging cost and compare them with the survey results.
- Calculate your potential cost savings from improving your performance.
- Complete your Efficiency Index to see whether there is scope for improvement.
- If you are performing among the best in the industry, try to identify why and then implement procedures to maintain good practice.
- If you are performing below the best in the industry or you think there is scope for improvement, take a closer look at your working practices.
- Monitor the amount of polymer used on each machine, how much is reground and how much is sent off-site for reprocessing or final disposal. Also monitor utility and packaging use.
- Find out where and why waste polymer is being generated by your process. Getting it 'Right First Time' is the easiest way of increasing your profits.
- Record your starting position and publicise improvements to both motivate employees and maintain commitment for the initiative from senior management.
- Contact the Environment and Energy Helpline for free advice and publications about all aspects of waste minimisation.

Remember: ***If you don't measure it, you can't manage it.***

This Guide was produced by the Environmental Technology Best Practice Programme.
Prepared with assistance from Entec UK Ltd and the British Plastics Federation.

For more information about the Environmental Technology Best Practice Programme and how its free services can help you, please phone the

ENVIRONMENT AND ENERGY HELPLINE 0800 585794

world wide web: http://www.etbpp.gov.uk **e-mail address: etbppenvhelp@aeat.co.uk**

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IS A GOVERNMENT PROGRAMME MANAGED BY AEA TECHNOLOGY PLC