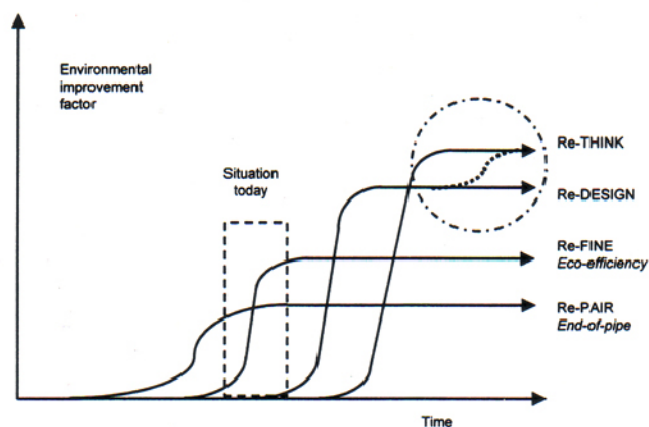


ECOTEXTILE '98

– SUSTAINABLE DEVELOPMENT

edited by
A Richard Horrocks



ECOTEXTILE '98

– SUSTAINABLE DEVELOPMENT

Proceedings of the Conference,
Ecotextile '98, The Bolton Moat House,
7&8th April 1998

edited by

A Richard Horrocks
Faculty of Technology
Bolton Institute



BOLTON INSTITUTE



BTTG

WOODHEAD PUBLISHING LIMITED

MEMBERS OF THE ORGANISING COMMITTEE

Christine Wilkinson	British Textile Technology Group
Dinah Wharton	British Textile Technology Group
Brian Bruce	BTB Associates
David Hill	Bolton Institute
Kiyoko Hay	Bolton Institute
Dr Mohsen Miraftab	Bolton Institute
Dr Mike Hall	Bolton Institute
Royston Dawber	Bolton Institute
Lesley Winters	Bolton Institute
Margaret Moir	Bolton Institute
Prof Richard Horrocks	Bolton Institute

Published by Woodhead Publishing Ltd
Abington Hall, Abington
Cambridge CB21 6AH, England

First published 1999, Woodhead Publishing Ltd

© 1999, Bolton Institute/British Textile Technology Group

The authors have asserted their moral rights

Conditions of sale

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without permission in writing from the publisher.

While a great deal of care has been taken to provide accurate and current information, neither the authors, nor the publisher, nor anyone else associated with this publication, shall be liable for any loss, damage or liability directly or indirectly caused, or alleged to be caused, by this book.

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

ISBN-13: 978-1-85573-426-5

ISBN-10: 1-85573-426-5

Printed by Victoire Press, Cambridge, England.

CONTENTS

Section 1: WASTE MINIMISATION

Waste Minimisation Challenges in the UK Textile Industry <i>Sandy Muirhead, ETSU, Harwell, UK</i>	3
The Environment and the Law <i>Victoria Joy, Environmental Consultant, UK</i>	13
Waste Elimination from Textiles <i>Mike Hewson, BTTG, Didsbury, UK</i>	23
Success with Energy Management <i>Mike Hewson, BTTG, Didsbury, UK</i>	33
The Requirements for Waste Water Treatment in the Textile Industry <i>Mike Hewson, BTTG, Didsbury, UK</i>	43
Initial Results from an EU-funded Research Reed Bed <i>Patrick Gaunt, Reuben Gaunt & Son Ltd., UK</i>	51
Minimisation of Formaldehyde Emissions <i>Mike Hall, Richard Horrocks and Dawn Roberts, Bolton Institute, Bolton, UK</i>	63
Saving Waste Makes Money <i>Brian Bruce, BTB Associates, Manchester, UK</i>	71

Section 2: PROCESS OPTIMISATION

Colour Removal from Effluent and Water Re-use in Courtaulds Textiles <i>Peter Cooper, Courtaulds Textiles, Nottingham, UK</i>	79
Biochemical Treatment of Recalcitrant Dyestuff Effluent <i>John Binkley, Joanne Hargreaves and Gillian Smart, Bolton Institute, Bolton, UK</i>	87
Decolourisation of Textile Waste Water by Photo-oxidation and Its Re-use <i>Ayşe Uygur, Marmara University, Istanbul, Turkey</i>	97
Decolorisation of Textile Waste-water by Means of Advanced Oxidation Processes <i>S Ledakowicz, R Maciejewska and J Perkowski, Technical University of Lodz,, Lodz, Poland</i>	105
Novel Applications of Biotechnology in the Textile Industry <i>Gordon Nelson, BTTG, Didsbury, UK</i>	111

Enzymatic Treatment of Man-made Cellulosic Fabrics
Jadwiga Sojka Ledakowicz and Aneta Skaskiewicz, Textile Research Institute, Lodz;
Rita Pyc and Edward Galas, Technical University of Lodz, Poland 121

The Optimisation of Processes and the Re-use of Water in the Dyeing of Cotton and Cotton/Polyester Blends
Jaime I N Rocha Gomes and Carlos J E Lima, University of Minho, Guimaraes, Portugal 129

Urea Reduction in Reactive Dye Printing
Miroslav Prasil, Technical University of Liberec, Liberec, Czech Republic 137

Distribution of Fibrous Particles Emitted during Simulated Handling of Basalt Weaves
Jiri Militky and Vladimir Bajzik, Technical University of Liberec, Liberec, Czech Republic 137

Section 3: RECOVERY, RECYCLING & RE-USE

Recycling for Charity's Sake
Andrew Stockwell, OXFAM, UK 151

Research Areas for Upgrading Textile Recycling
Hans de Groot and Anton Liuken, TNO Institute of Industrial Technology, Delft, Netherlands 159

An Overview of Activities on Recycling of Fibrous Textile and Carpet Wastes at the Georgia Institute of Technology
Youjiang Wang, Georgia Institute of Technology, Atlanta, USA 165

Carpet Waste, an Expensive Luxury
Mohsen MirafTAB and Richard Horrocks, Bolton Institute and Colin Woods, Environmental Management Consultants, Manchester, UK 173

Polymer Recycling in Technical Textiles
Philip Davies and Mohsen MirafTAB, Bolton Institute, Bolton, UK 183

Use of Enzymes in Textile Processing and Recycling Potential - Indigo Backstaining during Cellulase Washing
Artur Cavaco-Paulo and Rui Campos, University of Minho; and Jose Morgado, CITEVE, Portugal 191

Section 4: NEW PRODUCTS AND PROCESSES

Oeko-Tex Labelling of Textiles
Erich Zippel, Austrian Textile Institute, Vienna, Austria 197

Environmentally-Conscious Textile Design: Towards a New Approach <i>Jo Heeley, Manchester Metropolitan University, Manchester, UK</i>	203
Concurrent Product Development and Design for Environment in the UK Textile and Clothing Industry <i>Tracey Bhamra, Jo Heeley and David Tyler, Manchester Metropolitan University, Manchester, UK</i>	211
Innovative Knitted Structures from Waste Materials <i>Hilmar Fuchs, Rolf Arnold, Monika Seeger, Anna-Maria Bartl and Evelin Hufnagl, Sachsisches Textile Forschungs Institute, Chemnitz, Germany</i>	219
Novel Vegetable Fibre Geotextile Structures for Soil Reinforcement <i>Martin Pritchard, Subhash Anand and Robert Sarsby, Bolton Institute, Bolton, UK</i>	225
The Potential for Hemp: Locally Produced Organic Textiles <i>Sue Riddlestone, The Ecology Centre, Carshalton, UK</i>	237
Where Now With FR (Flame Retardancy)? <i>Peter Wragg, Schill and Seilacher, UK</i>	247

Section 5: ENVIRONMENTAL IMPACT ANALYSIS

Life Cycle Analysis: An Aid to Environmental Management as Applied to PET (Polyethylene Terephthalate) Containers <i>Vince Matthews, PETCORE (PET Container Recycling Europe), Brussels, Belgium</i>	259
Towards Environmentally Responsible Design in Textiles <i>Kate Fletcher, Chelsea College of Art and Design, London, UK.</i>	271
Impact of Commercial and Environmental Pressures on Dye Use <i>Brian Burdett, BTTG, Didsbury, UK</i>	279
Dyes and Microbes: Colouration or Decolouration? <i>David Wales and Debra Hobson, BTTG, Didsbury, Nicola Willmot, Courtaulds Fibres, Spondon, UK</i>	289
Environmental Consequences of Using Flame Retardant Textiles – A Simple Life Cycle Model <i>Richard Horrocks, Mike Hall and Dawn Roberts, Bolton Institute, Bolton, UK</i>	297
The Impact of Environmental Issues on Textile Education <i>Theresa Squires, Manchester Metropolitan University, Manchester, UK</i>	305

PREFACE

The papers in this edited text comprise those presented at the recent international conference **ECOTEXTILE'98**, which was organised jointly by **Bolton Institute** and the **British Textile Technology Group** and took place on 7 & 8th April, 1998 at The Bolton Moat House, Bolton, UK.

The conference received sponsorship and support from Dorma (CV Home Furnishings Ltd.), Terram Ltd., Courtaulds Textiles, TNO (Netherlands Organisation for Applied Scientific Research), EMPA (European Manufacturers Association) and the (UK) Government Office North West.

The theme of the conference was **Sustainable Development** and followed on naturally from the earlier conference **ECOTEXTILE'95 – Wealth From Waste In Textiles**, which was published in 1996 by Woodhead Publishing Ltd as “**Recycling Textile and Plastic Waste**”. This theme follows the realisation in the late 1990s that environmental awareness and practice by industry and commerce lead to financial savings if properly managed. Furthermore, if textile manufacturing processes and products are to be “fully green”, then it is essential that both financial and environmental sustainability are achieved. This means that the simple “end-of-pipe” solutions considered and implemented during this last decade of the twentieth century will not be acceptable for the twenty-first century. Both consumer pressures and legislation will force manufacturing industries to become environmentally sustainable, whether they are sited in Europe and the USA or are elsewhere and export into these areas.

The proceedings comprise thirty-six papers, which are divided into the five areas:

- **Waste Minimisation**
- **Process Optimisation**
- **Recovery, Recycling and Re-use**
- **New Products and Processes**
- **Environmental Impact Analysis**

and provide sufficient coverage of each for the reader to grasp and understand the current main issues as well as pointing towards future solutions. It is hoped that the content and balance of papers, which include overviews, personal opinion and original research, will go some way to increasing our knowledge of achieving full environmental sustainability of the textile and related industrial sectors.

Richard Horrocks
Bolton Institute

July 1998

Section 1: Waste Minimisation

This page intentionally left blank

WASTE MINIMISATION CHALLENGES IN THE UK TEXTILE INDUSTRY

Dr Sandy Muirhead

INTRODUCTION

Waste minimisation is the term used to describe the process of systematically reducing waste at source. But what is waste? - many consider it to be discarded materials but it includes wasted money, time, loss of materials (to air and drain), excessive use of energy and water, and product give-away through overfilling of packages and containers. Waste minimisation will save money - typically up to 1% of business turnover either as extra profit or as reduced operating costs.

A structured approach to waste minimisation will give a company more control over its disposal costs. It will be cheaper and easier for companies to comply with environmental legislation and it will improve a company's reputation with customers who seek assurance that their suppliers are operating on a sound environmental basis.

Every process in a company produces waste and is therefore a potential target for waste minimisation and increased profits. So how can the textiles industry, historically thrifty in sold waste, meet the opportunities and challenges of waste minimisation? Companies can take on waste minimisation and efficiency in environmental management can benefit the bottom line and so the environment; thus the need to meet legislation, is not always a cost. The Environmental Technology Best Programme can assist companies in achieving waste minimisation and hence improves overall performance. The Environmental Technology Best Practice Programme is a UK Government initiative which promotes the use of better environmental practices that reduce business costs for UK industry and commerce. The ETBPP's key objectives are to help companies become more efficient through waste management, thus reducing costs and assisting competitiveness.

The ETBPP is funded jointly by the UK Government Departments of Trade and Industry (DTI) and Environment and Transport and the Regions (DETR) and managed by ETSU and the UK's National Environmental Centre, NETCEN. The Programme covers eleven industrial sectors and two generic topics, waste minimisation and clean technology.

The clothing, textile and footwear sector is important in the UK economy representing just fewer than 7% of total customer expenditure - at £23 billion per year, it is a very significant market sector. The textile-manufacturing sector is also a significant employer, particularly in certain regions. However, the last few years have seen flat consumer consumption. It also appears that no more than modest growth in consumption can be predicted in the short to medium term future. While the industry is competitive and still undergoing restructuring, besides effective management both of the manufacturing process and the supply chain to remain competitive in world markets, the sector needs cost effective means to identify best practice techniques and technologies to further aid its competitiveness.

The UK clothing market is characterised by the dominance of the seven major chain store groups, which account for almost half the UK clothing sales. These include Marks and Spencer, the Burton group, Bhs, Next and Littlewoods. The fastest growing retailers

include smaller chains such as Oasis and New Look, while the most profitable are Burberry, River Island and Monsoon.

Imports of textiles and clothing into the UK remain high, primarily from low labour cost countries. Three quarters of UK imports came from outside the European Union in 1995. Comparatively exports represent a fraction of the value of imports resulting in a trade deficit of £2,339 million in 1995. UK textile production decreased by 2.8% in 1995, but this was a modest decrease compared to many European States. A slight improvement in production is forecast for 1997 and in the clothing sub-sector production has increased by 2.4%: the increase is particularly pronounced for knitted products.

Over the past few years there has been a perceived shift towards smaller order sizes as retailers are demanding shorter runs of higher numbers of fashion lines and as they sourced larger amounts of their basic lines from cheaper overseas suppliers. Additionally companies taking the route into higher value markets are expected to have to adapt to smaller order sizes from more exclusive retail customers. Paralleling the shift towards smaller orders has been the continued clear trend toward shorter lead times between manufacture of a garment for example and its appearance in the retail store. The sectors most affected by shortening lead times are the mid market retail chains, the corporate clothing market, the quality independent retailers and the discount and wholesale retail markets.

Underlying these developments is the changing relationship suppliers have with their retail customers, and the increasing demands the major retailers are placing on their domestic suppliers. For example the old two-season year is disappearing with products now having shorter life cycles. Many retailers expect to sell a series of stock ranges within any given six month selling period. As well as this there is an increased frequency of delivery now demanded by retailers? 87% of variety chains now replenish their stock often on a daily or weekly basis. Bhs's Director of Operations recently invited UK manufacturers to deliver products, which have a different edge from those of their foreign counterparts. In order to compete with overseas competition the opportunities for growth lie with manufacturers who can "add value to their products, get those products faster to the retailer at a consistent quality and when the retailer wants it". Bhs do not consider price to be the only criteria when choosing their suppliers. "In a climate where sales are unpredictable, styles have shorter life cycles and many retailers take big gambles and may be faced with having to mark down stock. Therefore the importance of sourcing suppliers who can deal with short lead times needs to be exploited," states this same spokesperson.

ENVIRONMENTAL PERSPECTIVES AND PRESSURES: ETBPP

Environmental issues are creeping into the supply chain as consumers and retailers are becoming more environmentally aware. Those particularly involved in textile automotive products are becoming increasingly aware of customer requirements to achieve ISO14001 the international environmental management system standard.

Companies are increasingly aware of the benefits, not just in terms of production efficiency, in taking a proactive stance on the environment. Key points in relation to environmental management are:

- good house keeping
- building customer confidence
- strategic considerations

Under the ETBPP issues are mainly of good housekeeping - e.g. minimising energy consumption, raw material use and other waste. Environmental Management Systems (EMS) - which provide comprehensive check lists of action for companies to guard against environmental risks - are part of good housekeeping and effective management.

In many cases, large companies can effectively manage their own environmental affairs but small and medium size enterprises (SMEs) often do not have the resources to examine environmental issues in detail. The ETBPP particularly targets SMEs and can provide assistance. The programme also tries and keeps companies up to date on cleaner technologies and so helps them look to the future.

The ETBPP is focused on the future and to the benefit of UK Plc with aims, which are to:

- save UK textile industry £15m per annum.
- increase the international competitiveness of the UK textile industry.
- promote waste minimisation and cleaner technology.

The role is therefore to identify and promote cost savings to all areas of the textile industry.

CASE STUDIES

The Programme works by highlighting case studies, which will benefit the industry; Table 1 below lists a few recent examples.

Packaging is a key area, particularly with the packaging directive coming into force. Although only companies using in excess of 50 tonnes of packaging will come directly under the regulations, there is on going discussion about how to encourage other companies to minimise their packaging. A case study (GC89) with a company in Northern Ireland illustrates that savings of £45,000/year can be made through the elimination re-use and recycling of various elements of packaging. The payback on the capital equipment involved was about a year. Added to this may be increased landfill disposal costs as the landfill tax is imposed and available holes become scarcer.

Traditionally the textile industry has been quite thorough in minimising its solid waste. However, in wet processing water has been cheap and plentiful - now it appears to be neither. Discharge costs are rising and the regulations regarding that discharge have tightened whether it is for pesticides, colour or BOD/COD.

In assessing water use, the start must be to assess outputs and inputs. One Leicestershire dyer's effluent cost was around £50,000 pa. However, under an audit as part of the Leicestershire waste minimisation initiative the true cost of waste was found to be over £150,000. Although not all the waste can be eliminated the audit helped to focus the company's attention on priority areas and they went on to reduce water and effluent costs by 19%.

Simple measures can include the installation of flow meters. Installation of such devices saved one small dyer over £2,000/year as it was discovered one machine was set to use more water than another does. Other simple systems can involve the use of the last wash water into earlier wash stages. This results in both energy and water savings as the water is already pre-treated. A Cheshire based company illustrated water and energy savings in the order of £30,000 by piping bleach wash water back to the scour wash bath. Energy savings can also be obtained through heat recovery from, for example, effluent.

Table 1: Examples of recent ETBPP Case Studies

GC63	Latex Recycling Achieves Substantial Savings For Little Cost <i>Case study demonstrating the economic and environmental benefits of using a latex recovery system at Ulster carpet Mills.</i>
NC139	New Technology Reaps Cost and Product Benefits <i>Case study demonstrating the economic and environmental benefits to a textile dyer of investing in cleaner technology</i>
FP70	Optimised Process Reduces Formaldehyde Emissions <i>A future practice report study aimed at reducing the formaldehyde emissions released during the application of a flame retardant finish to fabrics for cotton textile finishing.</i>
GC110	Water and Cost Savings From Improved Process Control <i>Reduced water consumption, for a textile company, of over 37,000m³/year, with little or no cost leading to savings of over £32,000</i>
GC89	Reduced Packaging Brings Significant Savings <i>Packaging waste minimisation programme saves worsted spinning company £47,000 in under 8 months</i>
GC16	Sites Set on Cost Savings <i>Demonstrates the financial and environmental benefits of a corporate approach to waste minimisation.</i>
GC18	Minimise Waste - Improve the Bottom Line <i>Demonstrates the success that can be achieved by involving financial managers/directors in company waste minimisation initiatives, and by networking with other local companies to share experiences.</i>
GC20	Environmental Review Helps Raise Profits <i>Demonstrates the cost savings and other benefits that a small company can achieve through an in house environmental review.</i>
GC49	Environmental Management System Improves Performance <i>Demonstrates the economic and environmental benefits of implementing an environmental management system at a medium sized manufacturing company.</i>
GC59	Environmental Improvements Reduce Costs <i>Demonstrates how incorporating environmental issues into existing management systems can result in cost savings and environmental benefits.</i>

Note: To order any of these case studies or other literature please call the free environmental Helpline on 0800 585794.

To improve efficiency companies are developing optimised dyeing processes; modern printing machines use less water and dye. The future may also bring more formaldehyde free finishing and water based coatings to minimise solvent use and VOC emissions.

Colour removal is another issue occupying the East Midlands in particular. Tied to this is the potential for treating on site and recycling the water resulting in significant cost savings. ETSU are trying to evaluate the various methods proposed in order to assess those which are most effective and worth promoting to the industry. Several methods have been proposed and one or two are now running at particular dyers and finishers resulting in significant cost savings through recycling of water, reduction in chemical use and energy savings. However, initial undertakings such as heat recovery from contaminated effluent can result in significant savings.

Waste minimisation clubs can also assist companies in reducing their waste. The benefits of clubs, whether they be exclusively for textile companies or mixed as in the Leicestershire waste minimisation initiative, are that they allow a good exchange of ideas with each company able to learn and the implement various methods of waste reduction. Similar to these Leicestershire firms mentioned earlier and the saving there, in the Aire and Calder river scheme, the involvement of Milliken Industrials led to substantial savings for the company. An example was a reduction in the waste produced from cutting carpet tiles. The measure to reduce the waste cost £2,000 per year the savings were worth £20,500 per year.

The benefits of working together are that each company may have one idea but discussing issues with others sparks off other ideas leading to greater cost savings. Recently a knitting plant was discovered using wool rags, which could be sold for some profit, to mop up oil dripping from knitting machines. A visitor suggested drip trays, which calculated out at a cost saving of £2,000 per year. Also with future tightening of legislation, the benefits of collaboration and its possible effect on competition worries UK companies, which consequently will not talk to each other - the real threat is from overseas not the UK. As yet there is no real collaboration on technical issues.

ROLE OF DESIGN

Those stages at the start of the fabric process are equally important and ETSU is currently undertaking a study to examine ways whereby designers can be made more aware of the impact of their designs on the environment. The designers are often seen as the weak link in the manufacturing chain. The study initially involved a questionnaire survey of designers. Early results indicate there is a gap between what is actually being done and what could be done to improve the environmental performance of the textile industry. Factors, which appeared to distance the implementation of environmental measures specified by a designer, include the following.

Barriers

These comprise:

- time pressures, overburdened with routine work to consider environmental factors;
- poor communication between functions (environmental personnel, manufacturing, design, marketing and production);
- lack of appropriate information/specialist knowledge to consider environmental concerns during the design process; and

- lack of control over materials and processes to be used.

Drivers

The drivers, which may be identified, are:

- cost savings associated with cleaner designs.

From these studies a number of conclusions were drawn of which in the main, lack of control and lack of communication were of prime importance. Some companies, however, were looking at the supply chain and the implications for design when taking into account environmental factors. Finally education during training is important in helping designers appreciate the impact of their designs on the environment.

ASSISTANCE FOR INDUSTRY: GOOD PRACTICE GUIDES

Tables 2 and 3 below list the currently available “Good Practice Guides” which relate to the UK textile industry.

On the dry textile processing side ETSU is producing a series of Good Practice Guides for the worsted, woollen, cotton and garment manufacturing sectors on how to minimise waste. The Guides bring together those waste minimisation and management ideas that are relevant to the management of solid waste. The Guides provide practical help and cite real case studies and the Guides quote both low cost and more high tech answers. Simple measures are often the place to start and can often result in significant savings. For example, one weaver in West Yorkshire used to use 30cm length of finished cloth per piece on which to mark the order number etc. The company realised that at £80 per metre, they were throwing away £24 per piece or around 0.5% wastage. This “mark up” has now been reduced to a maximum of 10cm; reducing waste to less than 0.2%.

To run the programme effectively, ETSU and ETBPP have sought to understand some of the key issues particularly for SMEs and the environment and to this end have organised and participated in a number of seminars and events across the UK. Table 4 lists the events held since 1996 until the early part of 1998. Issues raised include:

- the increasing costs of production particularly raw materials and in many cases water and effluent charges;
- increasing competition - more retailers are sourcing overseas; and
- buyers are becoming more demanding as the consumer becomes more unpredictable - quick response and smaller orders have become the norm. However, the buyer can assist the industry by working with the manufacturing sector to turn environmental friendliness into a positive marketing tool.

The environment is here to stay and industry should include it as part of its total business challenge. Problems remain but these may be summarised as below:

- legislation on the environment will not decrease and recently a Bradford Mill was fined £4,000 over the release of a red list substance. However, efficient environmental management can minimise the risk of discharge - if you scan the prosecution list fines are often due to operator error (perhaps through lack of education) or poor management of drainage systems;

- it is expensive to keep up with new technology and capital is not always easily obtained for investment in pollution control; and

the industry is still hierarchical in structure and management, therefore partnerships with suppliers or retailers are difficult to establish. The concept of teaming across functions doesn't come naturally to the textile industry. UK manufacturers need to start driving the agenda for benefits of UK supply by initiating partnerships rather than reacting to retailers.

Table 2: Textile waste minimisation and management guides

Ref	TEXTILES PUBLICATIONS
	Sector Specific Water Waste Minimisation Guides
GG62	Water and Chemical Use in the Textile Dyeing and Finishing Industry <i>This guide shows companies how to reduce their water and effluent costs, often by as much as 20% or more. Through implementing no-cost and low cost changes. Overall cost savings can be further doubled or trebled when associated savings in raw materials is taken into account.</i>
	Series of Four Sector Specific Solid Waste Minimisation Guides:
	Reducing Costs through Waste Management: <i>Comprehensive guides giving step by step instructions on how textile companies can achieve often significant reductions in operating costs. Contains simple low cost (or no cost) measures to reduce waste.</i>
GG42 (+ ET80)	Waste Management in the Worsted and Knitwear Sectors
GG79 (+ ET80)	Waste Management in the Woollen Sector
GG84 (+ ET80)	Waste Management in the Cotton and Man-made Fibre Sector
GG86 (+ ET80)	Waste Management in the Garment and Household Textiles Sector
	Benchmarking Information
EG98	Environmental Performance Guide for the Dyeing and Finishing Industry <i>This guide provides a benchmark for assessing specific water consumption compared to others in the industry. The guide is divided into four sub-sectors: woven cloth, fibre and yarn, knitted cloth and garments and will provide the impetus to implement a water minimisation action plan. The guide should be used in conjunction with GG62.</i>