Market Development for “Difficult” Materials and Non-core Recyclates in the Community Sector

Remade Scotland

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By: Caledonian Environment Centre
School of the Built and Natural Environment
Glasgow Caledonian University
5th Floor, Buchanan House
Cowcaddens Road
Glasgow G4 0BA
T: 0141 273 1416
F: 0141 273 1430

Contact: Colin Murchison
c.murchison@gcal.ac.uk
T: 0141 273 1368

The Caledonian Environment Centre is part of the School of the Built and Natural Environment, Glasgow Caledonian University and is supporting environmental research and policy development in Scotland.

The Remade Scotland Programme provides specific Scottish market intelligence, technical research and recycling performance support to Scottish Local Authorities and the Scottish Government. The Scottish Government contracts with the Caledonian Environment Centre for the delivery of the programme.
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1 Introduction

The community recycling sector plays an important role in recycling in Scotland. The sector is responsible for the diversion of approximately 73,000 tonnes of waste from landfill whilst providing 1100 full-time equivalent jobs to the Scottish economy (CRNS, 2007). The Community Recycling Network for Scotland (CRNS) represents 131 community groups in Scotland involved in waste and recycling activities.

This document recognises there may be opportunities for additional recycling activities and seeks to identify new business opportunities associated with waste materials which might be regarded as difficult or non-core recyclates, i.e. materials which the community sector do not have established business models for such as plasterboard and tyre recycling. To ensure the economic sustainability of new initiatives, this research focused on material reprocessing as well as material collection. This approach acknowledges that material processing will often achieve a higher added value for the final product than collection and sorting alone.

Innovative recycling practices within the UK are identified and reported together with a web search of worldwide practices. These practices target materials that have the capacity and properties desired to make them “available” as a viable recyclable commodity.
2 Background

The most recent mapping report by the Community Recycling Network Scotland (CRNS) identified 199 community organisations active in recycling, re-use and waste minimisation in Scotland during 2006 - an increase of 23 since 2005. Of these, 131 of these organisations are CRNS members. The sector currently employs 1,100 full time equivalent staff with 950 training placements. In addition, several community recycling groups serve an important role in the social inclusion agenda. The community groups are based throughout 32 Scottish local authorities and provide services which, because of their scale, can potentially be closer to source than private organisations – thus satisfying the proximity principle.

Activities and services that are offered by the community sector in Scotland focus on the following areas:

- Re-use: for instance clothes, furniture, white goods and paint. The service offered often includes repair;
- Collection provision: kerbside, civic amenity sites, recycling banks;
- Education; and
- Recycling: composting or passing material onto third party organisations for recycling.

Only 12 companies manufacture new products or goods.

A concern voiced by the community sector continuously relates to the long term financial security. There are barriers to further development such as funding cuts, lack of value added markets, dependence on a single income streams and competition.

Many private organisations’ primary focus is on producing high volumes of value added products and will therefore focus primarily on core recyclates such as glass, paper, metal and plastic streams.

Potential opportunities therefore exist for community groups to create new markets and divert non-core recyclates from the waste stream.

The following units therefore focus on a number of ‘Difficult’ or ‘Non-core’ materials which may present an opportunity for developing a community sector business model.
3 Non-core material review

3.1 Non-core material selection

A broad review was carried out using internet research to identify suitable difficult and non-core materials to take forward for analysis.

Materials and potential market applications were eliminated from further examination based on the following criteria:

- **Material availability** - volume availability limiting scope for market development.
- **Cost** - material recycling unlikely to offer adequate market return; cost of equipment too prohibitive.
- **Existing markets** - established markets in place to deal with material.
- **Legislation** - existing or forthcoming legislation in place to stimulate material recycling.
- **Existing support** - support for market development under existing Government programme.

Table 1 summarises the materials not considered appropriate for further analysis and the justification for excluding them from further examination.
Table 1 – Non-core material selection

<table>
<thead>
<tr>
<th>Material</th>
<th>Reason for Exclusion</th>
<th>Notes</th>
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<tr>
<td>Batteries</td>
<td>Legislation</td>
<td>Incoming European Battery Directive will make manufacturers and importers fund collections and recycling for spent batteries.</td>
</tr>
<tr>
<td>Bicycles</td>
<td>Existing markets</td>
<td>Existing established markets within Scotland (bicycle re-use and repair, metal recycling)</td>
</tr>
<tr>
<td>Cable drums</td>
<td>Material availability</td>
<td>Small volumes available - limited scope for market development.</td>
</tr>
<tr>
<td>Ceramics</td>
<td>Existing markets</td>
<td>Existing market recycling ceramics into aggregate.</td>
</tr>
<tr>
<td>Circuit boards</td>
<td>Legislation</td>
<td>Existing niche markets - coasters, notepads etc.</td>
</tr>
<tr>
<td></td>
<td>Existing markets</td>
<td>Under WEEE Regulations, producers of electrical appliances are responsible for collecting and recycling waste electronics.</td>
</tr>
<tr>
<td>Coat hangers</td>
<td>Material availability</td>
<td>Small volumes available - limited scope for market development.</td>
</tr>
<tr>
<td>Mixed plastics</td>
<td>Existing support</td>
<td>Focus of WRAP research.</td>
</tr>
<tr>
<td>Plastic fish boxes</td>
<td>Cost</td>
<td>Cost of equipment considered too high for community group.</td>
</tr>
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</table>

3.2 Non-core material overview

Individual units within the report have been produced based on innovative recycling practices in the UK as well as worldwide (identified from internet research).

Individual units have been completed for the following materials:

- Carpet;
- Expanded polystyrene;
- Plasterboard;
- Textiles; and
- Tyres.

The production of mulches for horticultural applications is also included within this report. These mulches can incorporate waste paper, textile and wood.
The individual units are structured in the same way to address the main issues of concern to the community recycling sector:

- **Introduction** - description of the waste stream and where it arises
- **Background** - how much is currently recycled and an overview of potential opportunities for recycling.
- **Processing option** - description of potential processing options that would be applicable to the community sector.
- **Technical considerations** - discussion of the technical issues associated with the option proposed.
- **Regulatory considerations** - discussion of the regulatory issues associated with the option proposed.
- **Cost benefit analysis** - where possible a simple cost benefits analysis has been completed to identify the potential to generate a profit from the option proposed. Where this has not been possible outline costs have been included where possible.
- **Market** - discussion of the potential markets for the products outlined.
- **Competition** - discussion of the current and potential competition in the market.
- **Conclusion** - summary of the issues and viability of option proposed.

Full references are given to allow organisations to follow up with relevant links.

Through including a discussion of factors such as competition the individual units have taken account of the factors that influence the success or failure of a recycling scheme. The assessment estimates, where possible, the cost implications, the skills and technology requirements for these schemes in addition to the feasibility of transferring these practices to community groups in Scotland. Summary details of the cost benefits assessments conducted (where possible) are given in each unit.

Each unit assessment facilitates the identification of viable projects. Projects likely to be suitable will vary according to the individual circumstances of community sectors organisations such as location, facilities and existing expertise. Discussion and conclusions are therefore general in nature.
4 Carpet

4.1 Introduction

The UK consumes 2.15 million tonnes of textiles per annum and discards 2.35 million tonnes of textiles each year (University of Cambridge, 2006). Textile waste includes used clothing, carpets, furniture, footwear, and nondurable goods such as sheets and towels. This unit relates to carpets only. Other textiles are discussed in the separate ‘textiles’ unit.

Carpets are made of either natural or synthetic fibres. The synthetic fibres used include nylon, polyester and polypropylene (PP) pile fibres, with most backings being a sandwich of PP fabric and latex. According to Greenspec, an organisation which provides a directory of sustainable products in the UK, nylon accounts for around 60% of the market with PP being the next most commonly used fibre. ‘Natural’ materials make up a smaller proportion of the market, usually in domestic applications. Wool accounts for the largest proportion of ‘natural’ carpets but other fibres utilised include sisal, seagrass, coir, jute and paper.

Although information relating to carpet waste arisings is scarce, Carpet Recycling UK estimates that approximately 400,000 tonnes of post-consumer waste and 70,000 tonnes of post-industrial waste is landfilled in the UK. According to a compositional waste analysis carried out by AEA Technology Plc for the Welsh Assembly Government (2003) carpet waste accounts for approximately 1.4% of Municipal Solid Waste (MSW). Based on this it is estimated that approximately 50,000 tonnes carpet waste arose in Scotland in 2005/06. Greenspec also report that 93% of carpet waste consists of used carpet, with the remaining 7% being post-industrial waste resulting from manufacturing and installation operations.

4.2 Background

Current markets for waste carpet include reuse, refurbishment, recycling fibre into new products, recycling carpet backing into new carpet backing, and "carpet-to-carpet recycling".

Some carpet is currently donated to community groups for re-use and refurbishment. In Scotland 22 CRNS community group members collect carpet for re-use. For example, Spruce Carpets, based in Glasgow, collects approximately 100 tonnes per year. It also collects carpet tiles from commercial properties, with these being refurbished and supplied back to market.

The routes for recycling carpet in the UK are currently limited. In the late 1990s a European ‘RECAM’ closed loop system was developed for the recycling of carpet. Equipment was available to recycle wool and PP. Significant capital investment was made but following unexpectedly high production costs a major US offshoot development was closed.

A recent carpet recycling initiative is Greenback Recycling in Wiltshire. Each carpet is inspected to remove contaminants before being sorted by the fibre type of its pile and backing using near infra-red spectroscopy. As standard, various fibre streams
are baled and supplied as feedstock material onto either the international plastics recycling market or the horticultural market.

In April 2008 an alliance was formed of carpet manufacturers, retailers and recyclers from across the UK called Carpet Recycling UK. The alliance has identified two short term goals. First is to explore the market for under-developed fibres such as wool and to establish a technical feasibility study on size reduction for bitumen-backed carpet tiles. In the medium-term it is also looking to establish a system of accreditation for carpet recyclers, which it hopes will support carpet recycling companies, and provide accurate information for anyone looking to use them.

4.3 Processing option

There is potential to develop businesses within Scotland working with companies already operating in the UK:

- Carpet re-use and refurbishment.
- Carpet recycling: collection and resale as feedstock.

There are also opportunities to develop niche markets, particularly for under-developed fibres such as wool.

Figure 1 – Carpet collection and sorting for re-use

Potential niche markets include use as insulation and mulch. For instance, carpet is already used informally by gardeners as mulch. Commercial applications will require further research and development; for example, specific fibre length may be required for a specific application. If using carpet as an insulation material it would need to be tested for thermal value and fire retardancy.

4.4 Technical considerations

Technical considerations will depend on the market area selected and will need to be addressed by research and development. For instance, use of carpet as insulation would need to consider aspects such as thermal properties, compaction, containment and fire retardancy.

4.5 Regulatory considerations

Cleaning of carpets will require chemical use. Compliance with the Manufacture and use of Chemicals - Registration, Evaluation and Authorisation of Chemicals Directive (REACH) may be necessary. Guidance can be found at NetRegs.
Further regulatory considerations will depend on market area selected. For instance any use in horticultural applications will need to ensure that product will not have a detrimental effect on the public or environmental health.

4.6 Costs Benefit Analysis

Market evaluation has demonstrated that the cost of collecting and sorting residential carpets can be offset, in part, by savings in landfill charges (Letsrecycle.com, 2008).

Basic requirements for a re-use and refurbishment organisation will be:

- Premises to clean, store, and sell carpet.
- Carpet cleaning equipment and machines e.g. sprayers, hoses, brushes, dryers and carpet vacuums, as well as carpet shampoo and treatment sprays.
- Van to both collect and deliver carpet.

Other cost benefit considerations will depend on the market area selected.

4.7 Market

Scottish Ministers are considering the regulatory requirement for Site Waste Management Plans in Scotland. The introduction of this requirement will potentially increase the number of construction firms seeking to find recycling options for waste carpet. This will be in the context of new carpets and avoidance of waste

Housing associations and Local Authorities are likely to have an interest in the purchase of refurbished carpet with the increased focus on sustainable procurement. In addition, businesses wishing to demonstrate their environmental credentials are likely to be interested in refurbished carpet. There is potential to work with carpet manufacturers, retailers and local authorities by organising take-back schemes. In addition, the existing network of carpet collectors within Scotland may be able to provide a collection service for carpets which are unsuitable for refurbishment if an alternative niche market is being pursued. It would be beneficial to work with Carpet Recycling UK to help identify opportunities.

4.8 Competition

22 community sector organisations currently accept used carpet within Scotland. However, there is clearly capacity to increase carpet collection and cover a greater geographical area within Scotland.
Table 2 – Community Groups which accept carpet waste

<table>
<thead>
<tr>
<th>Group</th>
<th>Local Authority Area</th>
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<tr>
<td>Aberdeen Forward</td>
<td>Aberdeen City Council</td>
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<tr>
<td>Bethesda Nursing Home Trust</td>
<td>Western Isles Council</td>
</tr>
<tr>
<td>Community Help &amp; Advice Initiative</td>
<td>City of Edinburgh</td>
</tr>
<tr>
<td>COPE</td>
<td>Shetland Islands</td>
</tr>
<tr>
<td>Edinburgh University Settlement</td>
<td>City of Edinburgh</td>
</tr>
<tr>
<td>Four Square</td>
<td>City of Edinburgh</td>
</tr>
<tr>
<td>Furniture Plus Ltd</td>
<td>Fife Council</td>
</tr>
<tr>
<td>HomeAid Caithness</td>
<td>Highland Council</td>
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<tr>
<td>HomeAid West Lothian</td>
<td>West Lothian Council</td>
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<tr>
<td>K&amp;D Voice</td>
<td>Aberdeenshire Council</td>
</tr>
<tr>
<td>Kingdom Housing Ltd</td>
<td>Fife Council</td>
</tr>
<tr>
<td>Launchpad Training &amp; Enterprise</td>
<td>Perth &amp; Kinross Council</td>
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<tr>
<td>Maxi Richards Foundation</td>
<td>Glasgow City Council</td>
</tr>
<tr>
<td>Moray Recycling Action Group</td>
<td>Moray Council</td>
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<tr>
<td>Moray Wastebusters</td>
<td>Moray Council</td>
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<tr>
<td>New Start Highland</td>
<td>Highland Council</td>
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<tr>
<td>North Mainland Recycling Centre</td>
<td>Shetland Isles Council</td>
</tr>
<tr>
<td>Recycling – Jura/Islay Group</td>
<td>Argyll &amp; Bute</td>
</tr>
<tr>
<td>Ruchill Furniture Project</td>
<td>Glasgow City Council</td>
</tr>
<tr>
<td>Spruce Carpets</td>
<td>Glasgow City Council</td>
</tr>
<tr>
<td>Lochbank Trust</td>
<td>Dumfries &amp; Galloway Council</td>
</tr>
<tr>
<td>Watch us Grow</td>
<td>North Lanarkshire Council</td>
</tr>
</tbody>
</table>

Source: Community Recycling Network Scotland

4.9 Conclusion

Current markets exist for waste carpet particularly in reuse and refurbishment, and recycling fibre into new products. However, the extent and coverage of existing businesses is limited and there are opportunities for community groups to further develop services in this area.

Opportunities also exist to develop niche markets for recycled carpets such as insulation and mulch but these are currently at a research and development phase. Companies already involved with carpet recycling could consider further investigation of these potential markets in collaboration with other organisations.

The main barriers are associated with carpet recycling is the lack of available information on arisings and markets as well as the need for further development of recycling technologies.
5 Expanded Polystyrene

5.1 Introduction

Pure solid polystyrene is a colourless, hard plastic which has limited flexibility. It is economical and is used for producing license plate frames, plastic cutlery, CD cases, and a range of other objects where a fairly tough and rigid, economical plastic is desired. Expanded polystyrene (EPS) is produced from a mixture of about 90-95% polystyrene and 5-10% gaseous blowing agent. The polystyrene is expanded into a foam through the use of heat, usually in the form of steam.

It is estimated that over 300,000 tons of waste EPS is produced on an annual basis in the UK. Common uses include packaging for foodstuffs, medical supplies, electrical consumer goods and insulation panels for building. EPS is very light; and according to the Expanded Polystyrene Packaging Group (EPPG) is made up of approximately 98% air, and hence the volume of landfill space it takes up compared to its weight is considerable. Due to the use of EPS in packaging it is a material which rapidly ends up in the residual waste stream. It arises from the householder at kerbside and recycling centres and also from commercial and industrial sources.

5.2 Background

Currently, Local Authorities in Scotland do not collect EPS for recycling. There are a few consumer recycling points that have been set up by manufacturers on a voluntary basis to provide a service to their local community. According to the EPPG there are 7 companies that accept compacted and uncompacted EPS in Scotland: 3 in the central belt, 1 in the borders, and 3 in the North. However a sizeable quantity still exists in the waste stream.

EPS has a high volume to low weight ratio. Hence, the collection of EPS for recycling involves high transport costs. These costs can be reduced with compaction of the material close to site. Compaction reduces the amount of space needed for storage as well as reducing transport costs.

There are two compaction methods: with cold compaction or thermal densification.

Cold Compaction

With cold compaction the EPS is pushed through a compactor to reduce its volume. According to the EPPG the volume can be reduced to approximately one-fortieth of the original following which it is formed into blocks and stored. The main drawbacks of this method are that it can be relatively noisy and can create significant amounts of dust. In addition a full time operator is usually required to feed the compactor and if foreign objects are introduced in error it can damage the machine itself leading to expensive repair costs and downtime. Contaminated EPS such as fish boxes cannot be compacted in this way unless they are first cleaned (of blood and organic matter) due to health and safety reasons. Many companies will collect EPS free of charge providing it is clean. Some recyclers will install a compacter on producer sites and then take the compacted material for recycling and according to EPPG the recycler will collect the compacted material if there is enough material to make the journey economically viable and in some cases they will pay for the
compacted EPS. Storing approximately 5 to 25 metric tonnes on site is common practice as this makes transport and distribution more cost-effective.

Figure 2 – Cold compacted EPS briquettes and bales

Pictures courtesy of www.eps.co.uk and www.polymersciences.com

Once EPS is compacted into briquettes it can be sold onto reprocessors for the following applications:

- Production of loose-fill packing or even for new EPS mouldings.
- Partial or direct substitute for virgin polymer. EPS can be used as hardwood replacement for making garden furniture, slate replacement for roofing tiles and new plastics items such as coat hangers, CD and video cases.
- Ground EPS can be mixed with cement to make a lightweight concrete material for insulating swimming pools, flat roofs, floors, etc (EPPG, 2008).

**Thermal Densification**

Thermal densification systems can also be used to recycle EPS. These systems produce a dense resin from EPS that can be recycled. This technology can deal with both clean and contaminated EPS.

The EPS is broken up and heated to melting point inside a controlled-temperature chamber. The temperature is accurately controlled to allow the EPS to melt without burning. The EPS releases all the air and other gases it contains forming a dense resin which is collected in a tray where it cools. The resulting resin block is removed from the tray and can then be stored for recycling. Fumes from the process are passed through a carbon filter system to ensure the exhaust air is clean. Using the thermal densification method the EPS is reduced by up to 95% of its original volume. The block is completely sterilised during this process so it can be stored indefinitely or until sufficient quantities exist for transport to market.

Thermally treated EPS can be used as a partial or direct substitute for virgin polymer or used for energy recovery. The reason for this demand for energy recovery is that incineration of polystyrene generates large quantities of usable energy –
approximately 142368 kcal/m³. There is also an emerging market for EPS blocks for the production of fuels such as green diesel and LPG.

5.3 Processing option

The processing option that has been assessed in this unit is to collect and reprocess EPS using thermal densification.

EPS could potentially be collected at Local Authority Recycling Centres. This would require the co-operation of the Local Authorities.

There is also potential to work with local businesses to establish other collection points. EPS is used in large quantities in the fish industry and other areas of the food industry. While some companies will already be working with existing EPS collectors and compactors there is potential to identify gaps. In addition, existing arrangements may be with companies based in England and a local facility may therefore be able to offer savings.

The material could be sold onto reprocessors for applications as outlined above. Investment would be required in recycling containers and transport. Machines are available to hire or buy.

5.4 Technical considerations

Training would be required in the use of the EPS recycling machinery.

According to the EPPG contaminants such as seafood waste, oil, excess moisture, ice and the presence of paper labels can create problems for recycling and reduce prices paid. This will need to be taken into consideration when developing clients and agreeing collection arrangements.

5.5 Regulatory considerations

Any company collecting EPS must be a registered waste carrier. The processing site will also need a waste management license.

5.6 Costs Benefit Analysis

It is anticipated that mechanical compaction of EPS would provide low return on investment due to the higher transport costs involved. Therefore a simple cost benefit analysis (CBA) has been completed for the collection and processing of EPS using thermal densification.
Table 3 - Cost benefit analysis for EPS

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Capital Payment (based on 10 year depreciation period)</td>
<td>£6,000</td>
</tr>
<tr>
<td>Annual Operational Costs</td>
<td></td>
</tr>
<tr>
<td>Staffing</td>
<td>£10,046</td>
</tr>
<tr>
<td>Materials</td>
<td>£0</td>
</tr>
<tr>
<td>Total Annual Operating Costs</td>
<td>£10,046</td>
</tr>
<tr>
<td>Total Annual Costs</td>
<td>£16,046</td>
</tr>
<tr>
<td>Total Annual Revenue</td>
<td>£19,669</td>
</tr>
<tr>
<td>Annual Profit / Loss Account</td>
<td>£3,622</td>
</tr>
</tbody>
</table>

Based on an annual tonnage of 131.12 tonnes of EPS and a resale value of £150 per tonne. Staffing costs are based on a single unskilled worker operating for 35 hours per week at minimum wage of £6 per hour.

The results indicated a profit margin of approximately £3,500/annum. This figure assumes the community group employ one member of staff. However, with 2 members of staff no profit margin is achieved. It is assumed that machinery would require 2 individuals to operate the equipment and check incoming materials for contamination.

However, the potential to achieve a profit margin would be greater if:

- Grants could be used to purchase equipment
- Higher revenue could be obtained for the product.

The assumptions used in the CBA are as follows:

- Equipment purchased rather than hired. The costs would be repaid over 10 years.
- A market price of £150/tonne. The price will be very market dependent as it is linked to world oil prices. It also varies according to location, quality, level of compaction and market situation.
- It is assumed that sufficient storage space would already be available for compacted EPS for processing.
- Individuals employed would be on minimum wage.

The main exclusions from the CBA are as follows:

- Collection costs. A collection service could be provided to customers. A charge would be required to ensure that fuel costs are covered. To maximise the efficiency of the collection bins/cages could be provided to large customers who use the service on a regular basis. These costs have not been included in the CBA.
- Site rent.
• Energy costs for heating, lighting and running equipment.
• Gate fee: potential to charge gate fee not included.
• Inflation: not accounted for.

5.7 Market

According to the EPPG, 7 companies collect EPS for recycling in Scotland – some are waste management companies and some are manufacturers of EPS.

Recycled EPS provides a substitute for oil derived polymers or an alternative energy source. Consequently the price paid for EPS is dependant on the price of oil. The current economic situation, where oil prices are rising steeply, is therefore favourable for this technology.

A future risk will be the potential for a decrease in EPS packaging appearing in the residual waste stream. EPS is not generally viewed as environmentally benign and work is ongoing to find alternatives. The Seafish Industry Authority (SEAFISH) states that alternatives include waxed cardboard and corrugated plastic. Some states in America are proposing legislation that will impose a ban on EPS.

To offset these risks EPS collection and compaction could be integrated into an existing recycling business so that it is supplementary rather than the sole income of the business. The thermal densification technology can also be used to treat plastic bottles.

Organisations which produce thermally compacted blocks can also take advantage of a service to collect the material in the UK free of charge subject to volume agreements (Personal Communication – Equipment Manufacturer, 2008).

5.8 Competition

7 companies are involved in the collection of EPS and the majority specify that materials must be clean and compacted/uncompacted. Thermal densification is a relatively new technology. However, established businesses are in existence throughout the UK. Remade Scotland has identified 2 organisations which currently utilise a thermal densifier to deal with contaminated material in Scotland. These however are small units which run on a 2 hour cycle which produce approximately 10kg/cycle.

5.9 Conclusion

End markets are available for both cold compaction and thermally densified EPS. Cold compaction is used to bale clean EPS. However significant quantities - both clean and contaminated – continue to be landfilled. Thermal densification is capable of processing both clean and contaminated EPS. No Local Authorities accept EPS in kerbside collections/recycling centres/recycling points. Before investing in equipment clear sources of EPS would need to be identified e.g Local Authority/ Commercial and Industrial and an efficient collection system would need to be established.
6 Mulch

6.1 Introduction

This unit discusses the potential to produce horticultural and agricultural products from waste materials. The focus is on waste paper but the potential for textiles and wood waste is also highlighted.

The annual arisings of the three waste streams in the UK are:

- Paper: 13.7 million tonnes (Defra, 2007).
- Wood: 10.5 million tonnes (WRAP, 2005)
- Textiles: 2 million tonnes (Cambridge University, 2006).

6.2 Background

In 2006 the total recovered paper and card arisings sent for reprocessing in Scotland was 196,709 tonnes and the total quantity of wood waste entering into waste management facilities was 223,235 tonnes (Remade Scotland, 2008). According to work carried out by Cambridge University (2006) total material recovery of textiles is approximately 300,000 tonnes per annum in the UK. This equates to approximately 30,000 tonnes per annum in Scotland if assuming 10% of UK figures.

An alternative market for the recycling of these wastes is the production of horticultural and agricultural products for use in various applications. As well as helping to drive increased recycling this outlet would also displace the use of plastics in this application and hence decrease the generation of plastic wastes.

Increased consumer awareness of food safety issues has contributed to growth in organic farming over the last few years. Environmentally sound weed management practices are becoming increasingly popular as communities become more conscious of the effects of alternative practices.

Organic farming precludes the use of synthetic herbicides and requires that organic farmers utilise practices that reduce harmful environmental impact. Many growers over the years have asked for an alternative to plastic mulch because of concerns about the environment and the labour requirement for field removal.

The Agricultural Waste Regulations (Scotland) 2005 brought agricultural waste under the same regulatory regime as other commercial activities (SEPA, 2006). Under the Regulations, all farmers have a duty to ensure that they do not treat, keep or dispose of agricultural waste in a manner which may cause pollution of the environment or harm to human health. Potential cost implications associated with this change in legislation could eventually force farmers to move away from the use of agricultural and horticultural plastic in order to save on collection and landfill costs.

6.3 Processing option

Mulching

Mulching the soil surface can reduce weed problems by preventing weed seed germination or by suppressing the growth of emerging seedlings. A mulch may take
many forms: a living plant ground cover, loose particles of organic or inorganic matter spread over soil, and sheets of artificial or natural materials laid on the soil surface.

Plastic sheeting and straw mulches have long been used in soft fruit such as strawberries. In perennial crops and some other situations mulches may be intended to remain effective for many years.

A black, woven, polypropylene mulch is expected to last for up to three crops (9-10 years). In freshly prepared seedbeds, short term mulching can be used to manipulate or reduce weed seedling emergence by, for instance, laying black plastic on the seedbed for 2 to 8 weeks.

In addition to weed control, mulches may be used to:

- **Prevent soil erosion** - mulches serve as physical barriers that dissipate erosive energy from raindrops thereby protecting the structure of the soil at the surface;
- **Reduce pest problems** - for instance in strawberries rain splash dispersal of disease spores like those of black spot is reduced by straw mulch;
- **Aid moisture** - mulches can serve as vapour barriers thus reducing evaporation of soil moisture;
- **Moderate soil temperature** - mulches can reduce heat loss from the soil in cold conditions and help to prevent frost heave. In hot weather the mulch slows down the warming of soil. In some cases, dark-coloured materials or clear plastic may be used to increase soil temperature to allow for early planting or to encourage early seedling emergence; and
- **Prevent nitrate loss.**

There are a number of organisations which supply paper mulch sheets. These sheets are employed in a number of countries as part of weed control. The effectiveness of the paper mulch depends on the application. In some applications it may be successful in suppressing weeds but may have a detrimental effect on crop yields.

An alternative paper-like material product being researched which consists of cotton waste, newsprint, gypsum and an adhesive. Results showed that this product would be effective in the suppression of weeds and grasses (Warnick et al, 2006).

A number of trials have been carried out over the years to determine the effect of paper mulch as a weed suppressant and also the effect on crop yields. Paper mulch has shown favourable results in terms of suppressing weeds which in turn helps to increase survival of seedlings (Ecocover, 2008). Work done by Radies et al. (2004) has shown increased yields of green bean and tomato and further tests by Jenni et al. (2004) has shown increased yields of lettuce when using paper as mulch.

There are a number of options available which differ dramatically in terms of costs; using newspaper or kraft paper in gardens or allotments is one of the most basic forms. However, paper in the form of processed sheets or a pulp can be used on a larger, more commercial scale.
Hydroseeding

Hydroseeding is a procedure that consists of spraying a mixture of water, seed, mulch and, if required, fertiliser and binding agents onto a prepared site through a hose. When sprayed on to the ground, the mulch forms a protective coating for the seeds, allowing them to germinate. This coating not only creates a bond with the soil it also protects them from sunlight, wind and soil erosion.

The mixture can also supply the seeds with crucial nutrition by adding a wide range of nutrients during its own decomposition. The mulch breaks down giving way to the emerging shoots. Using this spraying method also means that planting can be carried out on a number of land surfaces, whether sloped or uneven. The growth is fast due to the boost received from the degrading mulch. Hydroseeding has several advantages:

- Growth is fast;
- Improves soil quality;
- Large areas can be completed in a very short period of time;
- Helps with erosion control;
- Fibre mulch accelerates the growing process by maintaining moisture around the seeds thereby increasing the rate of germination.

Hydroseeding should only be done just prior to the growing season for best results. Currently hydroseeding in the UK utilises mulches made from recycled wood, paper or cotton. The mulches containing recycled paper are manufactured in America. A summary of the products available is given in the table below:

<table>
<thead>
<tr>
<th>Company</th>
<th>Mulch</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoenix Amenity Supplies</td>
<td>- 70% wood fibre, 30% recycled paper</td>
<td><a href="http://www.phoenixamenity.co.uk">www.phoenixamenity.co.uk</a></td>
</tr>
<tr>
<td></td>
<td>- 100% wood fibre</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Recycled paper + corn starch.</td>
<td></td>
</tr>
<tr>
<td>Groweb</td>
<td>Processed cotton</td>
<td><a href="http://www.groweb.co.uk">www.groweb.co.uk</a></td>
</tr>
<tr>
<td>Hydroseeding Products</td>
<td>100% wood fibre</td>
<td><a href="http://www.hydroseedingproducts.co.uk">www.hydroseedingproducts.co.uk</a></td>
</tr>
</tbody>
</table>

6.4 Technical considerations

Companies have reported that attempts to use recycled paper in the UK to produce hydroseeding mulches have been unsuccessful. Currently mulches incorporating recycled paper are imported from America. An integrated business could investigate manufacturing mulches including UK sourced recycled paper. One way to do this would be to investigate the possibility of producing the product under license from
America. Alternatively further research and development would be required partnering with other organisations.

The correct quality of paper for use in these applications should be considered. There have been concerns regarding inks in waste paper. Many printing organisations now use starch based inks however coloured inks can be a problem due to heavy metal content and should be avoided.

Some mulches may be unsuitable in particular applications. This will need to be considered when looking at potential markets.

6.5 Regulatory Considerations

The Soil Association (SA) is the most well known of 12 Certification bodies currently licensed by the UK government to enforce organic standards set by the European Union. The SA aims to set the ‘gold standard’ for organics. The Soil Association symbol is recognised by consumers as an important mark of organic integrity and often demanded by retailers for the organic products they stock. The association promotes the use of biodegradable alternatives to the plastic mulches however it does not place a ban on this particular method of weed control.

As a general rule any products used on land which will be used to produce crops should be of a standard which will not cause harm to the environment or to human health.

6.6 Costs Benefit Analysis

A simple cost benefit analysis (CBA) has been completed for a business conducting hydroseeding. These costs are based on capital spend of £4,187 on hydroseeding equipment (Turfmaster, 2008) and £2,000 on a suitable vehicle to carry the equipment.
Table 5 – Cost benefit analysis for Hydroseeding

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Capital Payment</td>
<td>£619</td>
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<tr>
<td>(based on 10 year depreciation period)</td>
<td></td>
</tr>
<tr>
<td>Annual Operational Costs</td>
<td></td>
</tr>
<tr>
<td>Staffing</td>
<td>£10,046</td>
</tr>
<tr>
<td>Materials</td>
<td>£21,953</td>
</tr>
<tr>
<td>Total Annual Operating Costs</td>
<td>£31,999</td>
</tr>
<tr>
<td>Total Annual Costs</td>
<td>£32,618</td>
</tr>
<tr>
<td>Total Annual Revenue</td>
<td>£72,090</td>
</tr>
<tr>
<td>Annual Profit / Loss Account</td>
<td>£39,472</td>
</tr>
</tbody>
</table>

Based on an annual tank spraying of 892 units at a revenue price of £81 per tank. Staffing costs are based on a single unskilled worker operating for 35 hours per week at minimum wage of £6 per hour.

Having collected information on capital costs it seems that hydroseeding could be an attractive and achievable option for a small social enterprise.

The results for hydroseeding indicated a profit margin of approximately £39,000/annum.

The main assumptions used in the CBA are as follows:

- 1 unskilled employee;
- Individual employed at minimum wage;
- Costs for equipment paid off over 10 years.

The main exclusions from the CBA are as follows:

- Gate fee: assumed no income from gate fee;
- Collection costs: no costs for collection included;
- The manufacture of mulch is not included;
- Site storage: assumed area available for site storage;
- Site rent: assumed no rent;
- Energy costs for heating and lighting: no costs included (depends on whether incorporating into existing business);
- Inflation: not included.
The CBA did not take into account:

- Implications regarding the amount of water used in spraying.

### 6.7 Market

Increasing world-wide environmental concerns relating to both the disposal of plastic waste and the use of non-renewable resources employed in the production of plastic products, has created an extremely favourable climate for biodegradable alternatives such as paper based mulch mats and hydroseeding. In addition, the price of oil continues to rise thus increasing the cost of petroleum based products.

Some products already have a number of identified markets; the size of market varies from country to country.

The UK, including Scotland, has a large agricultural and horticulture industry base. The UK has 608,952 hectares in agriculture in 2005. In addition, the UK accounts for approximately 10% of all organic crops in the EU-25 (Eurostat news release, 2007).

In addition, there is a trend towards the use of more environmentally benign products as a result of Government policy and legislation as well as media attention. These products have potential application in a variety of situations:

- Garden centres;
- Local Authorities (parks and gardens, highways);
- Nurseries;
- Sports Grounds;
- Bowling Greens;
- Contractors.

Hydroseeding is not yet used extensively in the UK but it is an expanding market.

### 6.8 Competition

These organic-based products will face competition from both the more familiar inorganic mulches on the market and organic mulches.

This unit has outlined the pressures on the use of inorganic mulches and that their use is likely to decline. The use of alternative organic mulches is therefore likely to increase. There may also be competition for feedstock from other industries which utilise waste paper. However, the paper reprocessing market is dominated by News and PAMS and therefore by the three large newsprint mills; all located in England - Aylesford, UPM Kymmenene (Shotton) and Abitibi Consolidated (Bridgewater). The economics of developing an alternative market for recycled paper within Scotland could therefore be favourable.

### 6.9 Conclusion

The CBA demonstrated that there is potential to create a viable business using hydroseeding. The main barrier would be identifying and securing clients for the use of the product. The product may need to be tailored to the market available. Rather than a stand alone business this would fit well with community groups already
involved in the manufacture of compost from green waste/food waste or collection of paper waste. Community groups could carry out the preparatory work on the lawn/grounds using own compost thus finding a market for the material and then seed the area thus providing further training in landscaping.
7 Plasterboard

7.1 Introduction

Plasterboard is made of a gypsum plaster core with a paper facing. Over 2.5 million tonnes of plasterboard are manufactured and used in the UK each year, and this is increasing. Plasterboard is used in construction for a range of applications including lining walls and ceiling and forming partitions.

Plasterboard waste arises primarily through construction and demolition activities. Waste from new construction arises during installation through wasteful design, off-cuts, damaged boards, and over-ordering. Plasterboard waste from demolition and refurbishment activities is generated, from refurbishing wall and ceiling linings, repairing damaged linings, and from soft-stripping prior to demolition of a building (WRAP, 2006).

Wastage of 10%-35% often occurs on sites, leading to around 300,000 tonnes of plasterboard waste being produced each year from this source. WRAP estimated that in total more than one million tonnes of plasterboard waste is produced in the UK each year.

The EU Landfill Directive requires that plasterboard must be disposed of in separately engineered cells at landfill sites. In Scotland this means non-hazardous landfill sites, in cells where no biodegradable waste is accepted (SEPA, 2004). Only a small number of landfill sites are able to provide this facility and according to Midrecycling UK the disposal costs range from £80 to £120 per tonne.

The need to recycle plasterboard is also driven by rising Landfill Tax and the increasing requirements for construction firms to develop Site Waste Management Plans.

To make collection and processing of plasterboard commercially viable then there has to be a value added end market. WRAP has a plasterboard programme aimed at stimulating markets for recycled gypsum. The programme focusses on:

- Segregation and collection
- Developing end uses in construction
- Developing end uses in other areas.

7.2 Background

Figures on plasterboard waste arisings are scarce but as previously highlighted approximately one million tonnes of waste plasterboard is produced per year.

There are several companies who offer a recycling solution for plasterboard across the UK. The outputs from this process are gypsum, paper and metal. In 2005 the UK supply of recycled gypsum was estimated to be 0.07 Mtpa. Current capacity for recycling was estimated to be 0.175 Mtpa. The plasterboard recycling industry reported that it intends to expand capacity to a total in the region of 0.4 Mtpa (WRAP, 2006). At the beginning of 2008 Letsrecycle.com published an article which stated that the recycling industry was planning to increase capacity.
Gypsum can be reused time and again without altering its properties. Recycled gypsum can therefore be used as a replacement for virgin gypsum in a variety of applications.

According to AEA Technology the destination of UK plasterboard arisings in 2005 was estimated as follows:

- Landfill 0.9 Mtpa
- Recycling 0.07 Mtpa
- Land Spreading 0.02 – 0.03 Mtpa

In the UK recycled gypsum is now also in the following applications:

- New plasterboard (but quality issues exist);
- Cement manufacture (MID Recycling); and
- Paving, blocks and bricks

Research is ongoing on the use of plasterboard in other applications:

- Improve soil conditions for growing crops such as potatoes (recycled gypsum) (WRAP, 2007);
- Mushroom compost (WRAP, 2007) (recycled plasterboard);
- Compost (recycled plasterboard); and
- Road building (recycled gypsum and plasterboard). Gypsum can also be used in the following applications although these areas have had less investigation regarding use of recycled gypsum (Market Transformation Programme 2006):
  - Glass manufacture;
  - Paint, plastics and chemicals;
  - Pharmaceuticals;
  - Sludge drying (bulking and drying),
  - Water treatment (settling of dirt and clay in murky water),
  - Cattle food additive (boost milk production),
  - Animal bedding (moisture absorption and odour abatement),
  - Flea powder (replace virgin gypsum use),
  - Cat litter (moisture absorption and odour abatement) and
  - Athletic field marking

Research elsewhere in the world has identified other novel applications for recycled plasterboard. The University of Victoria in New Zealand carried out research into the potential of recycling plasterboard. A number of students undertook projects to identify potential markets. These focused on the acoustic and thermal properties of plasterboard. The applications are summarised in Table 6.
Table 6 – Novel applications for recycled plasterboard

| Gypsum / concrete thermal store tile | A reusable recycled gypsum and concrete layered tile that would work as a thermal mass storage device. |
| Planter Winstone Wallboards          | Biodegradable planters for seedlings made from a mixture of earth, compost and crushed gypsum waste. |
| Eco Bin                              | Compost bin system made from crushed gypsum waste sandwiched between layers of fabric. |
| Laminated bricks                     | Uses waste plaster board off cuts to make laminated bricks. These form interior wall or ceiling systems that have good acoustic properties and high thermal mass. |
| Wall panel                           | Composite wall panel and screen system for demountable internal partitions form waste plasterboard pieces, polystyrene off cuts and natural cellulose and plant glues. |

The following list identifies potential areas community groups could explore with regard to plasterboard recycling and the drawbacks and opportunities associated with each:

1. **Recycle plasterboard to recycled gypsum**: existing competition and necessary to identify secure end markets for product.

2. **Use of recycled gypsum in new products**: new plasterboard and cement are the main markets and have established manufacturers in place. Other applications are emerging e.g. use in road construction and blocks. Unless existing expertise exists within community groups considerable investment in equipment and training would be required.

3. **Provision of collection from construction sites**: identified need from small Scottish construction companies wishing to improve environmental credentials and save on landfill tax. To be cost effective this operation would require collaboration with existing plasterboard recycler or direct processing into a new product.

4. **Use of shredded plasterboard in new applications**: This requires less expensive equipment. However, markets are emerging. WRAP has undertaken ‘Proof of concept’ work on its use in road construction and soil stabilisation. There is potential to use shredded plasterboard in compost.

5. Points 3 and 4 are further explored below.

### 7.3 Processing options

Although this unit focuses on processing technology and not on collections, work has identified some unique and successful collections in terms of plasterboard waste. Oakdene Hollins (2006) identified a collection system known as the ‘mosquito fleet’ method. This method involves the collection of small loads of waste plasterboard from sites and delivery to a waste transfer station. Material is then delivered direct to the recycler. Having a number of small vans to collect the material can cut down on collection costs which would be associated with using large vehicles. In addition, a community group could consider processing the plasterboard waste themselves if suitable markets were identified. The viability of this system has been shown in
London in a partnership between a waste management company and a plasterboard recycler (WRAP, 2007).

Alternatively, if intending to carry out primary processing of plasterboard there would be potential to work directly with waste management companies that supply the construction industry. They can provide the collection service, bulk the material and send onwards for reprocessing. According to WRAP this has been demonstrated to work elsewhere in the UK.

It is likely that community organisations are most likely to be interested in applications that use shredded plasterboard. Processing of plasterboard into recycled gypsum involves investment in expensive equipment.

With this in mind there is potential for community organisations to incorporate plasterboard recycling into existing composting operations.

There are locations in the USA that are adding waste plasterboard to their composting system. Many of these facilities do not focus solely on composting as an activity but carry out a combination of material recycling with composting activities. Incorporating gypsum produces calcium and sulphur rich compost (Market Transformation Programme, 2006)

A study in the US showed that incorporating plasterboard waste can be beneficial to the composting process and will not affect the process or the product quality adversely if used in the proper proportions. The pH of the finished compost was well within the acceptable range for end use in most situations. All of the mixes trialled met the Environmental Protection Agency’s (Environment Agency equivalent in the USA) pathogen reduction requirements. The end product contained more visible gypsum (whitish chalky powder) as the ratio of plasterboard in the initial mix was increased. According to the Market Transformation Programme, 2006 the end use of the material is dependent upon the aesthetics and the desired organic content.

A WRAP study investigated the viability of including shredded waste plasterboard from new build/refurbishment and demolition projects in new mushroom compost. Gypsum has been used in the production of mushroom compost for many years.

The study found that waste plasterboard gypsum presented no operational or cultural problems to the cultivation of mushrooms. The yields obtained were in line with those obtained with the conventional gypsums used in the mushroom industry.

Analysis of the shredded waste plasterboard and the composts produced with this material showed that there were no health and safety concerns. Analysis of the mushrooms themselves showed that there were no food safety concerns. The WRAP, 2007 study also found that waste plasterboard have applications in other composts.

7.4 Technical considerations

The waste plasterboard must be collected and screened so that it remains dry and free of contaminants. Contaminants such as nails, screws, and glass will interfere with the shredding machine and present health risk when incorporated into compost. During shredding operations plasterboard should be kept free of contaminants such as oil and fuel. Shredding of plasterboard will produce dust and
presents a health and safety issue. The proportions of plasterboard in proportions greater than those recommended could diminish the quality of the product so that composting does not occur or it is rendered unsuitable for use. A provisional specification was drawn up in the WRAP study covering overall quality, gypsum particle size, paper particle size and elemental quality.

### 7.5 Regulatory considerations

Any company collecting plasterboard is required to be a registered waste carrier. The processing site will also need a waste management licence. The Environment Agency Waste Protocols project is producing a protocol to cover the use of recycled gypsum in new plasterboard and cement product. However, this will not cover the use of shredded plasterboard in applications such as compost.

Currently the shredded plasterboard from waste plasterboard from construction or demolition remains a waste – even though the product produced can be prepared under quality controlled conditions and to a defined standard. Discussions with the Environment Agency for the WRAP study identified that the perceived way forward is to register the recycling facility as a waste licensed site with the necessary approbations to allow the shredded plasterboard to be classed as a product for the purposes of the manufacture of mushroom compost.

Waste plasterboard is not one of the permitted wastes under compost quality protocol as this only covers biodegradable wastes.

Discussions with SEPA would be required to resolve permitting issues relating to the use of waste plasterboard in compost.

### 7.6 Costs Benefit Analysis

No cost benefit analysis has been completed for this unit due to the emerging nature of the processing options considered. Income could be generated from charging a gate fee (and collection fee if collecting from site) as well as sale of the compost produced.

The Market Transformation Report on plasterboard identified that recycling facilities do not provide haulage and charge about £25/tonne gate fee for plasterboard waste. Some arrangements have been agreed with waste managers to provide skip and haulage services. A cost of around £80/tonne has been indicated for the collection, transportation and reprocessing of waste plasterboard.

### 7.7 Market

The increase in landfill tax, landfill restrictions and the focus on Site Waste Management Plans are encouraging the recycling of plasterboard. In addition, the WRAP materials flow project highlighted that there is a predicted increase in the demand for gypsum. Currently agricultural and horticultural applications of gypsum use mined and synthetic gypsum. The production of synthetic gypsum is predicted to increase with the increased use of flue gas desulphurisation (the source of synthetic gypsum). However, recycled plasterboard could provide an alternative source.

More specifically, in terms of using plasterboard in compost manufacture, there is demand for the increased production of compost from green waste. The collection...
and composting of garden waste from households is an effective way for Local Authorities to divert organic materials from landfill. Recently however Quality Meat Scotland (QMS), the National Farmers Union Scotland (NFUS) and the National Beef Association (NBA) have voiced concern over the use of compost derived from green waste or food waste on agricultural land. The organisations have stated that the compost could potentially harbour pathogens and weeds which could have a detrimental effect on crops and livestock. This potentially limits the agricultural market in the near future. There has been a drive to increase the use of green waste compost in landscaping as an alternative to topsoil. WRAP has published specifications for the landscape industry (New British Standard Specification for Topsoil (BS3882:2007)) which is designed to drive suppliers, specifiers and users of topsoil, to take into account the intended use of the topsoil and ensure it is fit for purpose. The horticulture market has seen a 21% increase in the sale of peat-free compost between 2005 and 2006 (Remade, 2008).

Overall, there is a trend for the increase use of green waste compost although issues over specification threaten the viability of certain markets.

As organisations become PAS 100 certified there could potentially be an increase in competition if companies focus their attention on similar markets. As such there may be a need for diversification in the marketplace in terms of product outputs (Remade 2008).

The use of plasterboard in compost could provide an opportunity to produce a unique product to distinguish a company from other competitors (for instance compost suitable for mushroom growing).

### 7.8 Competition

PBR:UK charges £110 per tonne for the provision of a 40-yard skip and haulage in the Glasgow and Edinburgh area and is currently the only company known to offer plasterboard recycling in Scotland. This situation is the result of there being no plasterboard manufacturers in Scotland, therefore the plasterboard has to be hauled back to England, comprising the bulk of the cost (MTP, 2006).

### 7.9 Conclusion

This unit has identified that there is an opportunity for community groups to provide collection services for plasterboard. There may also be potential to use recycled plasterboard in conjunction with existing composting activities. However, permitting and specification issues remain around this application.
8 Textiles

8.1 Introduction

Textiles incorporate used clothing, carpets, furniture, footwear, and non-durable goods such as sheets and towels. This unit relates to used clothing and nondurable goods only. Carpets are covered in a separate unit.

The UK generates approximately 2 million tonnes per annum (2006) of clothing and textile waste. Of this approximately 1.7 million tonnes enters the household waste stream going to landfill, 300,000 tonnes is recovered and the remaining fraction remains unaccounted for in what is assumed the “national wardrobe” (Cambridge University, 2006).

Increasing affluence combined with ‘value’ clothing and textiles is causing a significant increase in the number of textiles consumed in the UK. Furthermore Oakdene Hollins (2006) states that new clothing sales volumes in the UK have increased by 60% in the last 10 years.

8.2 Background

Only a fraction of textiles disposed of each year is recycled or reused in the UK. According to Cambridge University the total recovery of textiles is approximately 300,000 tonnes per annum in the UK. This equates to approximately 16% of UK arisings. Oakdene Hollins (2006) goes on to state that approximately 40,000 tonnes of recovered textile waste is reused in the UK – primarily as second-hand clothing and the market for recycled textiles in the UK amounts to approximately 60,000 tonnes per annum. Approximately 200,000 tonnes of material recovered is exported.

Presently the second hand clothing market is well established and many community groups already deal in this market. 26 Community Groups collect textiles throughout Scotland – collecting from kerbside, recycling banks and charity shops. Many of these groups sort the textiles and distribute to the community. Any remaining material will be sent to textile merchants.

According to Oakdene Hollins, 2006 the falling price of new clothing coupled with reducing product quality is resulting in higher volumes and lower qualities of used clothing being generated. This is driving down the price of used clothing. One of the largest textile recyclers in Scotland has stated that transport costs associated with collection of low cost textiles are being subsidised by the second hand clothing markets.

Textile reclamation factories will sort textiles to establish main end destination. Worn or damaged textiles will be processed within the factory for use as wiping cloths and other suitable materials will be graded for other recycling applications.

The largest recycling applications are for mattress/upholstery products, carpet underlay and automotive applications (mainly sound insulation materials). Other smaller application areas include horticultural basket liners, capillary matting and thermal insulation (Oakdene Hollins, 2006).
In Scotland, and assuming 10% of UK figures, approximately 30,000 tonnes of textiles are collected for resale and recycling and 135,000 tonnes are landfilled. Some material is unaccounted for and is assumed to be part of the ‘national wardrobe’.

The current markets for wiper cloths and shoddy for stuffing are low value and face competition from UK and overseas.

**8.3 Processing option**

There are several emerging opportunities to work in the textiles market as concern regarding this waste stream increases along with the amount being generated in the household waste stream.

There is wide recognition that there are potential markets that need to be researched further. The Scottish Textile Strategy 2007 – 2010 states that more focus need to be made on the production of more technical fabrics – aiming at niche markets. Oakdene Hollins highlighted the following as potential markets which need to be researched further:

- Low-modulus fibre reinforced composites and bio-composites;
- Capillary matting;
- Automotive headliner and bootliner components;
- Automotive flooring component systems;
- Pre-seeded horticultural matting; and
- Air filtration.

The above markets need to go through a research and development phase and hence no present markets are in place.

Some research and development for the use of recycled textiles in pre-seeded horticultural matting and capillary has already taken place. This is a market application that can also incorporate other waste materials such as newspaper waste and gypsum waste. The aim is to produce a material which is effective in suppressing weeds with no detrimental effect on crop yields and according to the paper mulch manufacturer Ecocover (2008) the material will need to break down sufficiently. A Defra study however concluded that because of the low technical application of pre-seeded matting this attracts low added value. Conversely it identified that the technical feasibility for capillary matting to be very high.

As part of Defra’s work on Sustainable Consumption and Production (SCP), they are developing ten product roadmaps to reduce the environmental and social impacts across the life cycle of a range of priority products - clothing is one of these products. Clothing and textiles is recognised as a high impact product category a situation which has been exacerbated by the high volumes of clothes consumed in the UK.

Focusing on local markets there is an opportunity to examine recycling opportunities in the production of new clothing and other textile products such as bags, rugs etc. This would involve close working relationships with Local Authorities and other organisations involved with textile collection (e.g. charity shops and Recyclatex...
members) to source suitable materials. There is increasing demand for designer ‘green’ products.

**Figure 3- Examples of products produced from recycled textiles**

![Examples of products produced from recycled textiles](Pictures courtesy of dollyrocker.de)

8.4 Technical considerations

It is important that collections prevent contamination of the textiles. Contamination from other materials can make textiles unsuitable for both re-use and recycling.

Whatever the recycling option it is likely that the textiles in question will need to be shredded before further processing. Textiles, whether they come in the form of rolled carpets, furniture, mattresses, or cloth, tend to unravel and wrap around the shafts of conventional shredders, causing them to jam. Shredding systems will need to be selected that can deal with this problem.

Different quality specifications (e.g. fibre type and length) depend on the market applications being considered. Fire resistance and user friendliness need to be addressed. If looking at horticulture applications there would be a need to ensure that contaminants such as heavy metals are not introduced to the soil.

It will be necessary to identify the specific fabrics that are appropriate for any chosen application.

8.5 Regulatory considerations

Any company collecting waste textiles must be a registered waste carrier. The processing site will also need a waste management license.

8.6 Costs Benefit Analysis

It has not been possible to do a cost benefit analysis for this market as the potential markets are still at the development stage.

Likely equipment requirements would include:

- Transport;
- Sorting/Cleaning Equipment;
- Storage;
• Shredding Equipment;
• Testing of material to reach health and safety standards.

8.7 Market

Local Authorities will be under increasing pressure to provide collection schemes and to source reprocessing outlets for recovered arisings as the proportion of textiles in the household waste stream increases.

Defra has identified clothing as a priority product and much work is ongoing to help further develop the markets for recycled textiles. An action area within the roadmap is to maximise reuse, recycling and end of life management. Defra are proposing to undertake feasibility assessment on closing the loop on end of life clothing which will examine:

• collection and sorting infrastructure;
• reuse outlets in UK and overseas;
• upcycling opportunities (fibre types, role of blends/composites, solving consistency and contamination problems, design for disassembly and technologies, markets);
• downcycling opportunities (existing secondary markets, creating new markets for recycled grades technology and capacity issues).

Any organisation wishing to become involved or extend its involvement with textile recycling should stay in touch with developments within the roadmap programme.

8.8 Competition

There are a number of well established organisations in the textile recycling industry. If wishing to break into a specific market it will be necessary to work in cooperation with others in the industry. Opportunities are likely to be focused on materials which are currently not recycled and/or finding higher value markets.

8.9 Conclusion

Opportunities exist to develop new businesses around textiles but currently new markets are underdeveloped and require further investment in research and development.

8.10 Further Information

Textiles Recycling Association: http://www.textile-recycling.org.uk/

9 Tyres

9.1 Introduction
The Landfill Directive banned the disposal of all tyres to landfill from 2006 (excluding oversize and bicycle tyres).

Used tyres arise from cars, trucks and motorcycles as well as bicycles and specialist vehicles such as tractors. Used tyres arise from a number of sources, including scrapyards, garages and specialist tyre retailers providing a network of collection points.

In 2006 the quantity of car and truck tyres arising in Scotland was 30,000 tonnes (Remade, 2008).

9.2 Background
Remade Scotland indicated that in 2006 the total recovered arisings of end of life tyres at waste management facilities in Scotland was 11,767 tonnes - 56% of tyres entered into a stage of final utilisation, with the remaining 44% sent onto further processing locations.

Existing recovery routes include ambient size reduction (production of tyre shred and crumb); tyre bale production and energy recovery (in cement manufacture). Tyre shred, crumb and bales are used in a variety of applications.

The UK Waste Strategy 2007 highlighted that sufficient reprocessing capacity exists to deal with all arisings, although there may be localised difficulties. According to Remade Scotland this is reflected by the fact that Scotland has the capacity to reprocess 47,500 tonnes of tyres – a great deal more than are generated in Scotland. The reprocessing capacity is reliant on a relatively small base of outlets (and can consequently be considered to be fragile). This is particularly the case in Scotland where 46% of the reprocessing capacity rests with only one cement facility.

In addition, the geographical nature of Scotland means that used tyres are arising in remote areas and gate fees are charged by reprocessors. The current level of gates fees in Scotland is actually making it more economic in some cases for tyres to be transported to facilities in the North of England.

These factors suggest that there may be potential to develop niche alternative markets within Scotland.

9.3 Processing option
The processing options proposed in this unit takes into account the triple bottom line; encompassing environmental responsibility, social awareness and economic profitability.

Novel products have been developed from used tyres such as swings for children, planters for a variety of plants/trees and tough and durable carriers. Swings can be hand crafted from a single tyre and come in a number of different designs including a Reindeer, T-Rex Dinosaur, Sea Dragon or a Motorcycle. Providing they meet specific safety standards they are suitable for all ages from 3 years upwards.
However, they will have a weight limit. They are supplied to the customer fully assembled and ready to hang from a tree bough, beam or an existing swing frame.

**Figure 4 – Example swings produced from whole tyres**

![Example swings](image1)

*Pictures courtesy of www.hibbitt.co.uk*

Planters and carriers currently available on the market are made out of both whole and parts of waste tyres. Planters can be used for planting shrubs or alternatively could be used to protect tree saplings.

**Figure 5 – Example planters and pots produced from whole tyres**

![Example planters and pots](image2)

*Pictures courtesy of www.henandhammock.co.uk*

### 9.4 Technical considerations

Care has to be taken to source the correct tyres for these applications. Tyres are either of radial or cross-ply construction. Radial tyres contain steel wire in the wall which can cause problems when cutting – which can be both time consuming and hazardous. Radial tyres are the most common and are used on all modern cars. Cross ply tyres use fabric instead of steel for reinforcement. Cross ply tyres are still manufactured for classic cars and motorcycles. Smaller or specialist retailers may be amenable to source separating radial from cross-ply tyres prior to collection.

These will also be less desirable for use as energy recovery in cement manufacture as the steel content is an important component of the process. The silica and steel cord in tyres are used as secondary raw materials in the cement production replacing the natural resources glass sand and ferric oxide (Remade Scotland, 2008).
The products currently on the market are likely to be subject to patent restrictions. The products would either need to be produced under licence or new designs would need to be produced. The potential exists to design products which are not currently on the market. All designs will require a template.

Care would need to be taken to ensure the products are strong enough for their intended use. For instance, the stitching and handles for the carriers need to withstand loading.

9.5 Regulatory considerations

Waste tyres must be collected and transferred to reprocessors by a registered waste carrier. Sites processing tyres will need a waste management license. Currently in Scotland, tyre-derived materials and products are still considered as waste by SEPA and use requires a waste management licence/exemption.

A Quality Protocol has been produced for the production and use of tyre-derived rubber materials. Consultation on this document was completed in March 2008. The protocol defines the point at which waste tyres may become a non-waste product or material that can be either reused by business or industry, or supplied into other markets, enabling recovered products to be used without the need for waste regulation controls. In addition, two Publicly Available Specifications (PAS) are available for tyres: BSI PAS 108: Specification for production of tyre bales for use in construction and BSI PAS 107: Specification for the manufacture and storage of size reduced tyre materials. Currently no protocol or specifications exist for the production of manufactured items from whole tyres. Discussions would be required with SEPA to determine the implications of this.

Most of the tyre industry is covered by a voluntary producer responsibility scheme to ensure tyres are reprocessed in an environmentally responsible way. The Tyre Recovery Association provides an externally audited and legally compliant system to track tyres that are sent for reprocessing rather than disposal. Defra has carried out a consultation on the duty of care system including introducing statutory reporting for used tyres in England and Wales. A second consultation is due to be released in 2008 setting out new regulations. No such proposals are in place in Scotland.

All swing designs would have to be independently tested and approved for safety. The British Standards Institution (BSI) estimated that in the UK swings were involved in 6,731 injuries in 1999. The new toy safety standard BS EN 71-8:2003 safety standards relates to a number of indoor and outdoor toys (for family domestic use) including swings, slides and similar activity toys. The British Standards Institution states that tests address mechanical and physical properties, flammability and toxicity and if satisfying the new standard the product will be approved to BS EN 71-8:2003. In addition, BSI states that CE marking a product is required by law if the product falls under one of the European Union New Approach Directives and by adding the mark, the manufacturer declares that the products meet all the essential requirements of all applicable EU directives.

Tyres are renowned for picking up grease. It will therefore be necessary to use a degreaser to clean the waste tyres prior to the next stages in the product manufacture. Compliance with the Manufacture and use of chemicals - Registration,
Evaluation and Authorisation of Chemicals Directive (REACH) may be necessary. Guidance can be found at NetRegs.

### 9.6 Costs Benefit Analysis

A simple cost benefit analysis (CBA) has been completed for the production of waste tyres into swings or containers.

The table below summarises CBA for tyre swings.

**Table 7 – Cost benefit analysis for tyre swings**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual Capital Payment</strong></td>
<td>£79</td>
</tr>
<tr>
<td>(based on 10 year depreciation period)</td>
<td></td>
</tr>
<tr>
<td><strong>Annual Operational Costs</strong></td>
<td></td>
</tr>
<tr>
<td>Staffing</td>
<td>£10,046</td>
</tr>
<tr>
<td>Materials</td>
<td>£15,680</td>
</tr>
<tr>
<td><strong>Total Annual Operating Costs</strong></td>
<td>£25,727</td>
</tr>
<tr>
<td><strong>Total Annual Costs</strong></td>
<td>£25,751</td>
</tr>
<tr>
<td><strong>Total Annual Revenue</strong></td>
<td>£29,269</td>
</tr>
<tr>
<td><strong>Annual Profit / Loss Account</strong></td>
<td>£3,518</td>
</tr>
</tbody>
</table>

Based on selling 390 tyre swings units at a revenue price of £75 per swing. Staffing costs are based on a single unskilled worker operating for 35 hours per week at minimum wage of £6 per hour. There is an additional exceptional cost in gaining safety accreditation for the swings.

The results indicated a profit margin of £2,083/annum in first year and £3,518/annum in subsequent years.

The table below summarises CBA for tyre containers.
Table 8 – Cost benefit analysis for tyre containers

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Capital Payment (based on 10 year depreciation period)</td>
<td>£79</td>
</tr>
<tr>
<td>Annual Operational Costs</td>
<td></td>
</tr>
<tr>
<td>Staffing</td>
<td>£10,046</td>
</tr>
<tr>
<td>Materials</td>
<td>£15,782</td>
</tr>
<tr>
<td>Total Annual Operating Costs</td>
<td>£25,828</td>
</tr>
<tr>
<td>Total Annual Costs</td>
<td>£25,907</td>
</tr>
<tr>
<td>Total Annual Revenue</td>
<td>£27,318</td>
</tr>
<tr>
<td>Annual Profit / Loss Account</td>
<td>£1,410</td>
</tr>
</tbody>
</table>

The results indicated a profit margin of £1,410/annum in first year and £1,465/annum in subsequent years.

The main assumptions used in the CBA are as follows:

- 1 unskilled employee;
- Individual employed at minimum wage;
- 4 hours manpower per swing.
- 3 hours manpower per planter
- Independent Safety tests required per design and all costs incurred in first year.
- Swings retail at £75.00. However swings currently on market retail at up to £100.
- Planters retail £35.00. However planters currently on market retail at up to £50.00.

The main exclusions from the CBA are as follows:

- Gate fee: assumed no income from gate fee;
- Collection costs: no costs for collection included;
- Site storage: assumed area available for site storage;
- Site rent: assumed no rent;
- Energy costs for heating and lighting: no costs included (depends on whether incorporating into existing business);
• Costs for patent of design and/or licence of design from another company;
• Inflation: not included.

9.7 Market
In Scotland, the market price for reprocessing of tyres for recycling via ambient size reduction or baling is £50.00-£65.00.

The Blue Circle cement works in Dunbar takes large volumes of tyres (22,000 tonnes). According to one cement works a gate fee of £85.00/tonne of tyres delivered to site is charged.

If community groups are able to accept tyres without charging a gate fee then it could prove attractive to organisations attempting to find outlets for waste tyres particularly in remote areas. However a collection service may need to be offered. Costs for collection have not been included in the CBA.

There are a number of outlets available for these particular items ranging from large organisations attempting to improve their ‘green’ credentials to individual domestic use. The ‘novelty’ factor makes the products attractive in the marketplace.

Community groups would need an effective marketing strategy including website sales and local sales.

Developing partnership working with Local Authorities may lead to orders for local authority run parks and gardens. Local Authorities are increasingly having to implement sustainable procurement including the purchase of recycled goods. Markets are also likely to exist at local garden centres.

9.8 Competition
A number of online organisations sell these swings and planters throughout the UK. At present it appears that most of these products are imported from outside of the UK and therefore UK based companies may be interested to find more local suppliers or add additional products to their range. In addition, there is the potential to access more local markets.

9.9 Conclusion
The CBA has illustrated the potential to make a profit from the production of tyre based novelty products. Any such enterprise would strengthen the market for used tyres within Scotland.

The main barriers to be overcome are:
• Regulator issues regarding the definition of waste.
• Sourcing of appropriate tyres.
• Collection arrangements.

Providing these issues can be overcome and an effective marketing strategy can be put in place any such enterprise could successfully provide local employment and divert waste from landfill. Also move waste further up the waste hierarchy (away from energy recovery). There would be the potential to work with schools and colleges.
10 Discussion

10.1 Feasibility

Table 8 summarises the opportunities and barriers associated with each unit relating to technical considerations, regulatory consideration, costs, market potential and present competition. An assessment of the overall potential for each opportunity explore is given.
### Table 9 – Summary of Barriers and Opportunities Associated with non-core materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Technical</th>
<th>Regulatory</th>
<th>Cost</th>
<th>Market</th>
<th>Competition</th>
<th>Overall Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpet</td>
<td>Potential market areas subject to research and development. Technical issues will vary.</td>
<td>Potential market areas subject to research and development. Technical issues will vary.</td>
<td>Lack of information to make assessment.</td>
<td>Need for market applications for recycled carpet identified.</td>
<td>Existing companies who collect carpet would provide some barriers to new players. Potential for current organisations to expand the applications they offer for carpets. Additional competition will be dependant on potential market area explored after further research and development.</td>
<td>LOW</td>
</tr>
<tr>
<td>Material</td>
<td>Technical</td>
<td>Regulatory</td>
<td>Cost</td>
<td>Market</td>
<td>Competition</td>
<td>Overall Potential</td>
</tr>
<tr>
<td>----------</td>
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<td>------------</td>
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<td>--------</td>
<td>-------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Textiles</td>
<td>Dust control. &lt;br&gt;Suitable collection arrangements to prevent contamination. &lt;br&gt;Quality specification and selection of appropriate material.</td>
<td>Permitting issues. &lt;br&gt;Waste management licence. &lt;br&gt;Health and safety.</td>
<td>Lack of information to make assessment.</td>
<td>Need for market applications for recycled textiles identified.</td>
<td>Well established industry in certain areas. &lt;br&gt;Opportunities focused on developing niche areas.</td>
<td>LOW</td>
</tr>
<tr>
<td>Tyres</td>
<td>Sourcing of correct type of tyre for application. &lt;br&gt;Patent considerations. &lt;br&gt;Safety requirements.</td>
<td>Waste management licence. &lt;br&gt;Permitting. &lt;br&gt;Safety regulations. &lt;br&gt;Health and safety.</td>
<td>Potential to make sufficient profit margin.</td>
<td>Adequate reprocessing capacity for tyres available in Scotland. Therefore, market opportunities likely to be greater in more remote areas of Scotland (further from large reprocessors).</td>
<td>Similar products widely available via internet – require effective marketing strategy.</td>
<td>MEDIUM</td>
</tr>
</tbody>
</table>
10.2 Funding Options

There are funding opportunities in Scotland for community groups looking to develop their facilities and capacity.

Details of two of the main funds, INCREASE and the Climate Challenge Fund, are given below. Details of other National funding sources can be found at: http://www.sepa.org.uk/nws/funding/national.htm#anchor-increase.

**Increase Fund - http://www.increase-programme.org.uk/**

The INCREASE Programme is delivered in partnership with the Community Recycling Network for Scotland (CRNS) and aims to support not-for-profit, community-based recycling, reuse, composting, waste minimisation and waste education projects, across Scotland. The programme runs a two-tier grant scheme supporting small projects between £5k to £30k and larger more strategic projects from £30 to £200k.

**Climate Challenge Fund (CCF) - http://www.keepscotlandbeautiful.org/ccf.asp**

The Scottish Government has ambitions to deliver an 80% reduction in Scottish emissions by 2050. The Climate Challenge Fund, of £18.8m over three years (2008-11), is designed to enable communities to come forward with their own solutions to make a significant reduction in carbon emissions. There is no set grant and no minimum level of award but a £1,000,000 maximum has been set. Applicants must be Scottish based and by the time a grant is approved they must also be legally constituted, not-for-profit community groups.

CCF grants are primarily designed to help communities reduce their carbon emissions. The projects funded will be expected to be ambitious in their work to reduce emissions, for example aiming for 30% reductions or more in carbon emissions over three years. However, priority will also be given to ideas that also help strengthen local economies, improve community cohesion, and other social objectives alongside making significant carbon emissions reductions.

Funding is available for projects to reduce carbon emissions e.g.:

- Support community organisations to develop carbon emissions reduction action plans
- Pay for costs associated with feasibility studies or community engagement for carbon reducing projects and action plans.
- Pay for community capacity building (awareness raising around carbon emissions reduction, relevant training and skills development)
- The costs of a community establishing a partnership, setting up a company or project management costs related to the community carbon emissions reduction project or action plan

The grant scheme specifically requires that the community be the lead player in any partnership with the community at the heart of all decision making relating the project. The guiding principals of the fund are:

- Makes significant carbon emissions reduction as the central focus, but also brings wider environmental, social and economic benefits;
• Be community based, and have the community at the centre of decision making;
• Seeks to improve quality of life now and for future generations.
11 Conclusions

This study has undertaken a broad review of difficult and non-core recyclates to consider the potential for future market development in recycling by community groups. From this broad review 6 areas were identified meriting further research and 6 detailed units have been produced. There are clear opportunities and barriers associated with each of these market applications.

Each case study has been assessed for potential to take forward as high, medium or low. No material applications were identified as high potential to take forward. Tyres, EPS and mulch were identified as medium potential to take forward. Carpets, plasterboard, and textiles were identified as low potential to take forward.
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