

PAPER MAKING AND PAPER MILLS IN SCOTLAND

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1 The Papermaking Process

1.0 Introduction

Before examining factors influencing paper recycling in Scotland it is necessary to have an understanding of how paper is produced, along with knowledge of the recycling process. There are 16 paper mills in Scotland (see table 1.1), with approximately 50% of these using recycled fibres as a raw material to varying extents. The basic papermaking process (including pulping) is shown below (from Paperonline 2000).

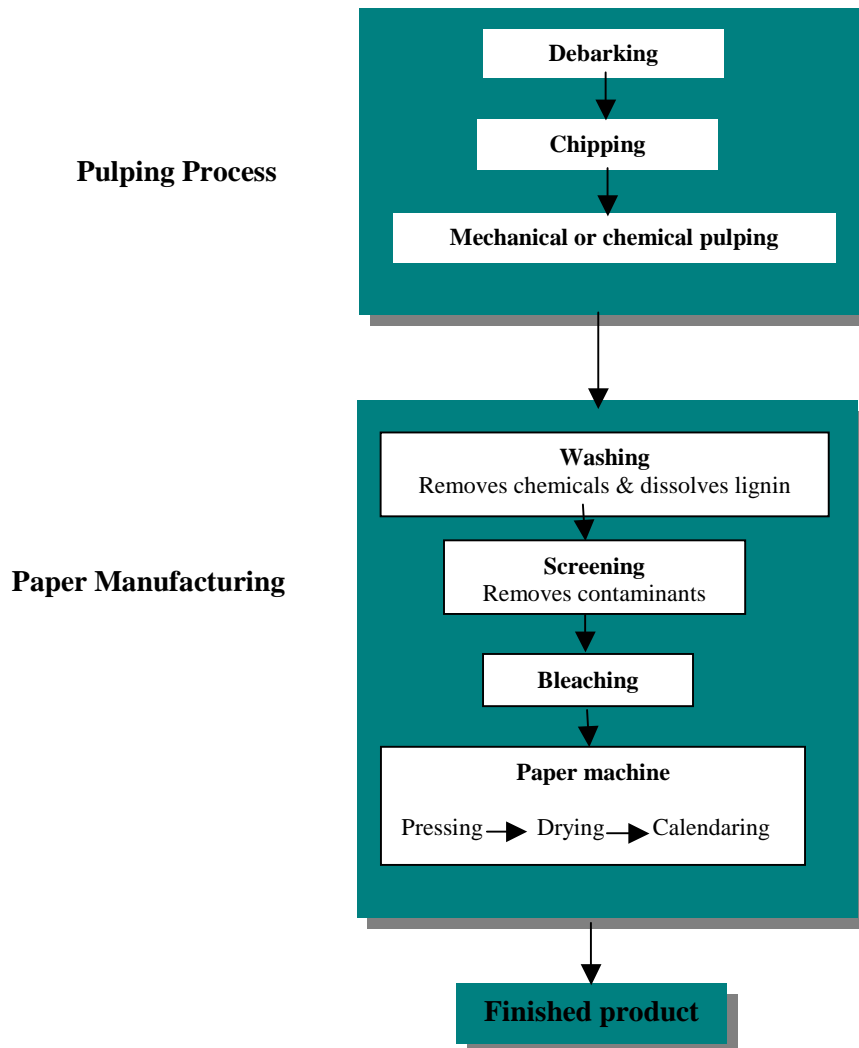


Table 1.1: Paper Manufacturers in Scotland

Company	Mills	Products	Production (tonnes p.a.)	Raw Material	Grades
Arjo Wiggins	Aberdeen, Fort William	Graphics, carbonless copy paper	150,000-250,000	100% virgin pulp at Fort William, 90% virgin, 10% recycled at Aberdeen	Virgin wood pulp, sorted office
BPB Paperboard	Aberdeen	Packaging boards	250,000	99.7% recycled fibre, 0.3% virgin pulp	OCC, KLS, News & Pams, Virgin wood pulp
Caledonian Paper ***	Irvine	Coated papers	100,000-250,000	100% virgin pulp	Virgin wood pulp
Curtis Fine Papers	St. Andrews & Penicuik	High quality graphics, recycled range	40,000	80% virgin, 10% recycled, 10% non-wood fibres (Esparto grass)	Virgin Wood pulp, De-inked Office Grades
Dexter Non-Wovens	Chirnside	Non-woven products e.g. sausage casings, teabags	10,000-25,000	Virgin pulp, non-wood fibres, synthetic fibres	Virgin wood pulp
Donside Paper Company	Aberdeen	High quality graphics, recycled range	50,000-100,000	95% virgin pulp, 5% recycled	Virgin wood pulp, de-inked grades
International Paper	Inverurie, Aberdeen	High quality graphics	100,000-250,000	100% virgin pulp	Virgin wood pulp
Inveresk Plc	Alloa, Denny, Bathgate & Inverkething	Graphics, Coated boards	140,000	90% virgin pulp, 10% recycled	Virgin wood pulp, Sorted office
Sappi UK	Glenrothes	Carbonless copy paper	30,000	100% virgin pulp	Virgin wood pulp
Smith Anderson	Leslie, Fife	Packaging papers, Paper bags	100,000	95% recycled, 5% virgin pulp	News & pams. Sorted office, OCC, KLS
Tullis Russell	Glenrothes	Graphics, coated board	100,000-250,000	100% virgin pulp	Virgin wood pulp

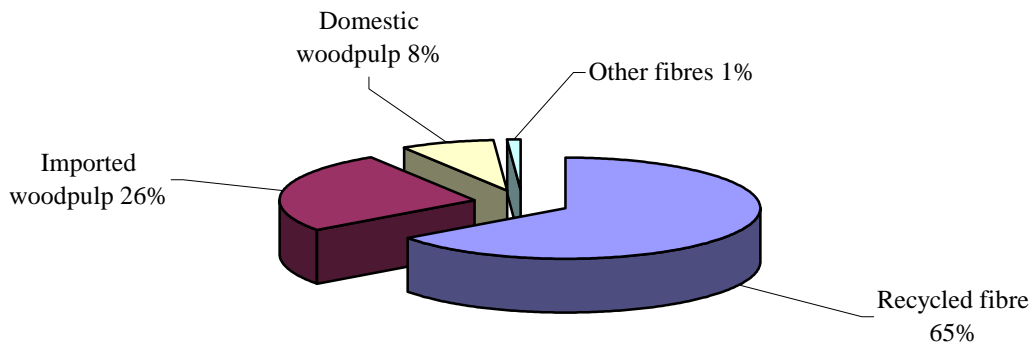
*** Only integrated mill in Scotland

Paper can be produced in either integrated mills, where pulping and papermaking are carried out at one site, or, more commonly in the UK, in separate virgin pulp and paper mills. The only integrated mill in Scotland is Caledonian Papers, with the remaining 15 mills producing paper from imported virgin wood pulp. Fibre used in papermaking comes from two major sources, virgin wood pulp and recovered paper. Minor sources include non-wood fibres such as esparto grass.

1.1 Virgin Wood Pulp

Virgin wood pulp makes up approximately 34% of the raw material used in UK mills (see figure 1.1), and is primarily imported from Scandinavia, and North and South America (Paper Federation, 2000). The wood used in papermaking is predominantly sourced from sustainable, managed forests, and uses thinnings, toppings, and sawmill waste that other commercial users, who make solid wood products, reject. The *furnish* (see glossary available from http://www.remade.org.uk/paper_docs.htm) used in the majority of mills consists of a combination of hardwood and softwood pulp. Hardwoods such as eucalyptus have short fibres (e.g. eucalyptus, 1mm), but impart good formation characteristics to give paper a superior finish, while softwoods such as spruce have longer fibre lengths (e.g. Scandinavian Spruce, 3.5mm), giving tear and strength properties (UNEP, 1996).

Figure 1.1: Raw Material Use in UK Mills 1999



There are two main technologies used to produce virgin wood pulp, mechanical and chemical (Paperonline, 2000).

a) **Mechanical pulp** production uses the mechanical processes of grinding and refining to separate the fibres. Production yields are high, making the process highly cost-effective, but quality constraints mean that mechanical pulp is predominantly used in the production of lower grades of paper, particularly newsprint. Such short-life use is essential as the process retains lignin, which reacts with UV wavelengths in sunlight to discolour paper and make it brittle.

b) **Chemical pulp** production uses heat and high-pressure steam to soften the woodchips, while lignin is removed by the addition of chemicals, either through the sulphate (kraft) or sulphite processes. Yields are as low as 50%, making the process expensive compared to mechanical pulping. However, quality is high due to the removal of lignin, and the pulp can be utilised in the production of high value graphic papers. Chemical pulp is often referred to as “woodfree”, signifying that chemical as opposed to mechanical pulping techniques have been used.

A combination of chemical and mechanical methods can be used to produce combination or semi-chemical pulp, where chemicals partially dissolve the resins, and mechanical means separate the fibres.

1.2 Recovered Paper

Post-consumer wastepaper makes up 65 % of raw material used in UK mills (Paper Federation, 2000). There are 4 general categories and over 30 specific grades of recovered paper –

- a) **Pulp substitute grades** - high quality wastes that can be used as a substitute for primary pulp in the manufacture of products such as printings and writing papers. The wastepaper used consists largely of trimmings and off-cuts that need little cleaning.
- b) **De-inking grades** - where ink is removed from fibres prior to processing. Consists largely of long-fibred office grades used to produce new graphic papers, or waste newspapers and magazines for newsprint.
- c) **Bulk grades (packaging grades)** - used in production of packaging materials, where the use of virgin pulp is largely uneconomic. Consists largely of brown unbleached packaging materials that have long strong fibres e.g. testliner (recycled) used for cardboard box production instead of kraftliner.
- d) **Lower grades** - mixed papers that are often uneconomical to sort due to heterogeneity or high levels of contraries (non-recyclables). Mainly used to produce middle packaging layers.

Although not strictly included in the definition of recycled fibre, mill broke and pre-consumer waste make up part of the furnish, with mills traditionally recycling the maximum amount possible to maintain profits.

Post-consumer household paper waste is generated as a heterogeneous mix of different paper grades, while industrial and commercial waste is more likely to consist of homogenous paper grades. Wastepaper merchants frequently sort mixes of paper into categories to recover the higher value constituents' e.g. white office paper grade. A significant proportion of wastepaper weight may consist of non-fibrous materials, which cannot be utilised in recycling. This is termed "shrinkage", with an average shrinkage for newspaper / magazine waste being 15-20% of the purchased weight (City of Glasgow, 1992).

1.3 Paper Recycling Process

Reprocessing of secondary fibre involves either a wet or dry process. Dry processes involve the wastepaper being shredded or pulverised, with the product used for animal bedding, cat litter, bulking agents, hydro-seed mulch or packaging materials. The more frequently used wet process involves the recycled paper being re-pulped and cleaned to produce sheet paper, moulded pulp or composites. The wet process is detailed below (International Paper, 2000), with the first two steps common to the production of all paper grades. The de-inking process is necessary for the production of grades such as graphic papers and newsprint, but is not essential for packaging grades.

1. **Pulping** – wastepaper mixed with water and chemicals, and pulped to a slurry.
2. **Cleaning** – pressure screens and wire mesh machines are used to remove large contaminants such as paper clips, plastics, staples, and problematic contaminants such as glues, which ball up into globules in the pulp slurry.
3. **De-inking** – essential to remove inks and toner fluids, contaminants such as adhesives, labels and plastic envelopes, and fibres too short to be utilised in paper production. Two alternative processes are available:
 - a. **Washing** – where chemicals are added to separate ink particles from the paper, then large amounts of water are used to drain the ink away. This process recovers approx 80% of fibre, and has been used most successfully on wood free wastes. It is more efficient at removing small ink particles than flotation
 - b. **Flotation** – surfactants are added, which froth on top of pulp. Air bubbles are then blown through the slurry. These carry ink particles to the surface, where they are trapped by the surfactants, and can be removed by surface skimming. This process yields up to 90-95% of the original material. Performance indicators include paper brightness, ink speck coverage, and tear strength. In newsprint mills around 30% magazines are included during de-inking as the clay from coated papers binds ink particles, increasing removal efficiency (Inveresk, 2000).
4. **Bleaching** (only for high quality products) – to brighten paper, and remove any discolouration. Due to the harmful effects of chlorine many pulps are now total chlorine free (TCF) or elemental chlorine free (ECF), using alternative bleaches such as ultraviolet radiation.
5. **Additives** – finishing materials added to enhance appearance, quality, fitness for purpose e.g. coatings, waxes, dyes, pigments, or fillers. Coatings such as clay give a smooth writing / printing surface, while alum can be added to prevent liquid absorption.

1.4 Classification of Paper Grades

Wastepaper can be classified into specific grades according to quality, taking into account factors such as potentially recoverable fibre content and extent of contamination. There are 11 standard UK wastepaper grades, as follows (Paper Federation, 1999) –

Grade 1 - white, woodfree, unprinted e.g. white printer shavings, envelope cuttings

Grade 2 - white, woodfree, printed e.g. white carbonless copy paper

Grade 3 - white, lightly printed mechanical e.g. white unprinted news

Grade 4 - coloured woodfree e.g. best pams, coloured shavings

Grade 5 - heavily printed mechanical e.g. news and pams

Grade 6 - coloured crafts and manilas e.g. kraft liner

Grade 7 - new kraft lined (KLS)

Grade 8 - container waste

Grade 9 - mixed papers

Grade 10 - coloured card

Grade 11 - contaminated grades e.g. plastic/ laminated waste, telephone directories.

The Bureau of International Recycling has recently published a classification of paper grades that will be recognised throughout Europe, with the aim of harmonising grading systems to facilitate international trade in recovered paper. This is likely to replace the traditional UK grades (Bureau of International Recycling, 1999).

Wastepaper grades can be used as a feedstock for differing types of paper product, with recovered paper having to meet specific quality requirements for individual product types. Fitness for use is important, with lower grades such

as mixed papers unsuitable for incorporation into higher quality products such as graphics papers. Table 1.1 below illustrates the typical end-uses for the main wastepaper grades (UNEP, 1996).

Table 1.2: End-Uses for Wastepaper Grades

Wastepaper Grade	Pulping Process	End-Use
Mixed Household Papers	Screening and Pulping	Corrugated Packaging
Old Corrugated Containers	Screening and Pulping	Corrugated Packaging, Testliner
Old Newspapers	Screening, Pulping, De-inking, Bleaching	Newsprint, Low-grade Printing & Writings
Mixed Commercial Papers	Screening and Pulping, De-inking for Higher Grade End-Uses	Printings & Writings, Packaging Boards
Sorted Woodfree	Screening, Pulping, De-inking, Bleaching	High Quality Graphics Papers

In general, paper products can be split into seven broad categories (Key Note Ltd, 1999) –

1. Newsprint - predominantly manufactured in integrated mills globally (but in recycled mills in the UK), the majority of fibre used is mechanical pulp, with a small percentage of chemical pulp used to impart the necessary strength for speed printing. China clay is added to give bulk and opacity. The 3 UK mills (all in England) use a very high proportion (over 90%) of wastepaper as a feedstock, with the small quantities of virgin pulp required being imported from North America and Scandinavia.

2. Printings and Writing Papers - largely dependent on imported chemical market pulp due to a lack of domestic chemical wood pulp mills. Requires a high quality fibre source, though significant quantities of wastepaper can be used if quality specifications are adhered to. Consists of uncoated boards/sheets for stationary, wallpaper, banknotes, etc. and coated products (one or both sides) for books and advertising material. Coating materials include mixes of starch, latex, china clay, or other binders.

3. Corrugated Case Materials – brown packaging materials are manufactured almost entirely from recycled waste in UK.

4. Packaging Papers/Wrappings – bleached and unbleached kraft pulp used to manufacture bags, sacks, wrappings, etc. Most packaging papers use imported market pulp.

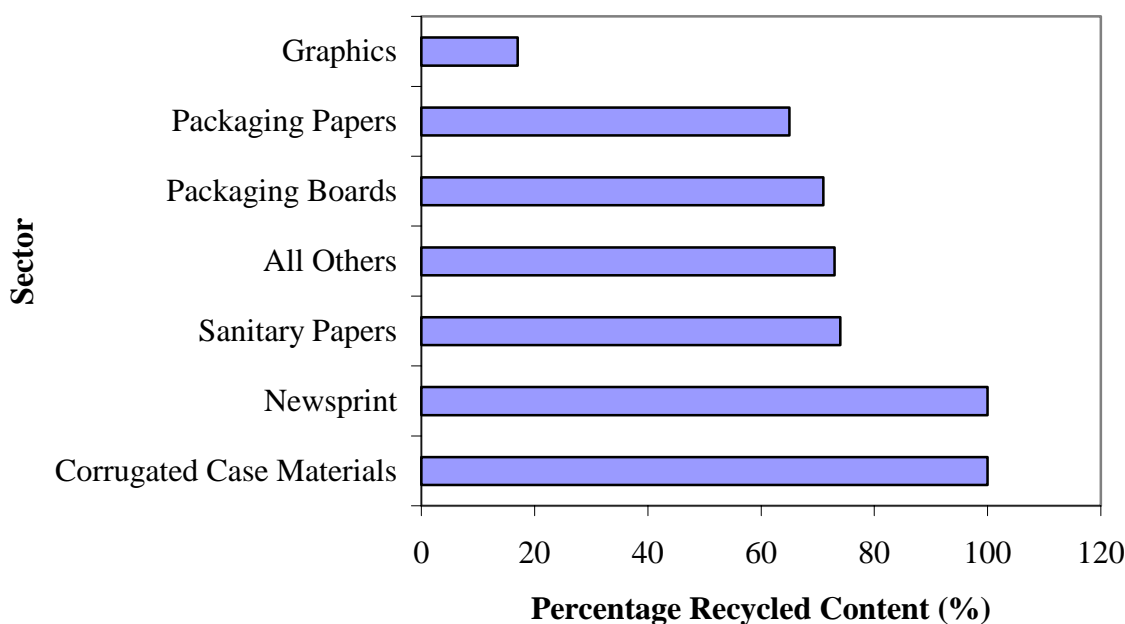
5. Packaging Boards – made from chipboard and fibreboard of varying thickness and weights (coated or uncoated). Cartonboard uses a combination of recycled waste and imported chemical pulp, while greyboard uses mainly recycled materials.

6. Toilet and Tissue Paper - wastepaper makes up a high percentage of fibre use, the rest being chemical market pulp.

7. Specialities/ others - mainly plasterboard liner, which is produced entirely from wastepaper.

The amount of recycled fibre used in the manufacture of each type of product varies significantly (see figure 1.2), ranging from corrugated packaging materials and newsprint which achieve almost 100% recycled fibre use to higher grade graphics papers which average only 19% (Paper Federation, 2000).

Figure 1.2: UK Recycled Fibre Use by Sector 1999



2 Paper Mills in Scotland

2.1 Range of Products

The 16 paper mills in Scotland are owned by 11 companies (see table 1.1) and manufacture a range of products from corrugated packaging materials to high quality carbonless copy paper. Scottish paper mills utilise recycled fibre to varying extents (see table 2.1), with recycled fibre use being strongly linked to the type of product manufactured. The mills can be split into four groups on this basis: packaging, printing and writing papers, carbonless copy paper and speciality mills.

Table 2.1: Recycled Fibre Use in Scottish Paper Mills

Paper Mill	Products	Recycled Fibre Use
BPB Paperboard	Packaging boards	99.7%
Smith-Anderson	Packaging materials	95%
Inveresk	Graphics paper, coated papers & boards, recycled range	10%
Curtis Fine Papers	Printing & writings, recycled range	10%
Arjo Wiggins, Aberdeen	Printings & writings, recycled range	5-10%
Donside Paper	Printings & writings, Recycled range	5%
Tullis Russell	Printings & writings	0%
International Paper	Printings & writings	0%
Arjo Wiggins, Fort William	Carbonless copy paper	0%
Sappi UK	Carbonless copy Paper	0%
Dexter Non-Wovens	Non-Woven Products	0%
Caledonian Paper	Coated papers	0%

a) Packaging Grades

A high percentage of secondary fibre (95-100%) is used in the two mills producing packaging materials. This high utilisation rate is possible as packaging grades have less stringent raw materials requirements than other grades, and so can use almost 100% recycled fibre without significant problems. Wastepaper is also lower cost than virgin material; crucial in keeping costs down in the production of a material with a lower selling price than higher grades.

There is little opportunity to increase the use of recycled fibre in these mills, as a minimum percentage of virgin fibre will always be essential to provide longer fibres for strength. There may, however, be a possibility of the mills using differing grades of recycled fibre. BPB formerly used mixed papers from the local councils (Aberdeen, Aberdeenshire and Moray), but discontinued this grade following problems with reliability, quality and contamination. This has left the aforementioned councils with collection systems in place, but no market for the material, resulting in collected paper being disposed to landfill in some cases. Although BPB have no plans to incorporate this grade in the future, they could possibly be persuaded if a reliable supply of quality, sorted paper could be established.

b) Printings & Writing Papers

The mills producing this grade of product incorporate 0-10% recycled fibre into the fibre mix. This use is linked with the production of recycled stationary ranges, which are generally produced from 100% post-consumer waste. The exceptions are Tullis Russell and International Paper, neither of whom produce a recycled range or utilises recycled fibre. The experience gained in utilising recycled fibre for recycled stationary ranges may be valuable in persuading companies to increase the recycled fibre content of the raw material mix up to an upper technical limit. Further study is essential to determine an maximum limit for recycled fibre use for each type of paper product, i.e. the maximum recycled content that can be included before quality is reduced to an unacceptable level.

Tullis Russell carried out a 6-month trial using recycled fibre (de-inked grades purchased from Inveresk), but were forced to discontinue due problems with cleanliness. A second attempt failed this year, as Inveresk were unable to produce de-inked fibre for sale. This stemmed from a shutdown of their de-inking plant caused by difficulties in sourcing adequate quantities of wastepaper of the required quality. The only other potential source of de-inked fibre in Scotland is Smith-Anderson, who currently doesn't sell de-inked fibre on the open market.

Tullis Russell did however estimate that they, and presumably other mills manufacturing similar products, could use up to 10% recycled fibre in all products without any significant problems. Donside Paper formerly used a higher percentage of secondary fibre until contamination and quality problems resulted in recycled fibre use being limited to the production of recycled stationary. International Paper has expressed interest in using recovered paper as a feedstock if a guaranteed supply of high quality paper became available locally.

c) Carbonless Copy Paper

Both Sappi UK and Arjo Wiggins (Fort William) use 100% virgin woodpulp in production, primarily resulting from the high quality standards required for carbonless copy paper. If either were to incorporate recycled fibre it would have to meet strict specifications, and be from the highest grades such as unprinted kraft shavings.

d) Speciality Mills

Dexter Non-Wovens can be seen as separate from other Scottish paper mills, manufacturing speciality products such as teabag papers, sausage casings and medical wipes. The fibre mix utilised is also unique, with a high percentage of non-wood (manila, hemp) and synthetic fibres (polyester, rayon) being used in addition to virgin wood pulp. No recycled fibre is incorporated due to the specialised nature of the production process.

Caledonian Paper is the only integrated pulp and paper mill in Scotland and as such can be viewed on an individual basis. The incorporation of recycled fibre is viewed as unlikely by the company since they produce high quality woodpulp on-site, and would have to alter their entire production process to use secondary fibre.

2.2 Potential to Increase Recycled Fibre Use

The printing and writing papers sector can therefore be seen to provide the greatest opportunity for increased use of recycled fibre. Even if the mills in this category only used 10% recycled fibre, this would create demand for an additional 45,000 tonnes of recovered paper. Effective collection and sorting systems would have to be put in place to meet the high quality demanded by these graphics sectors. Commercial collections of sorted office paper are likely to be required, as the heterogeneity and high proportion of low grades in household waste would not meet the exacting specifications. Consistently high quality papers of the required quantities, along with reliability of supply are seen as the most important factors by mills. There are signs that mills are increasingly willing to enter into contract agreements with collectors if these conditions can be fulfilled.

A lack of de-inking capacity can also be seen as a limiting factor, with facilities available only at Inveresk (Kilbagie) and Smith Anderson. Investment in new capacity is unlikely in the current economic climate, with many mills struggling financially and dealing with very tight margins. Similarly, a lack of newsprint capacity is a major shortfall in the Scottish paper industry. With newsprint mills able to utilise almost 100% used newspapers, a facility in Scotland would represent an important market for recovered paper. Once-read newspapers make up a significant

proportion of household waste, and are also one of the most difficult to find markets for due to their low quality and mechanical content.

Currently the majority of newspapers collected in Scotland are transported south to one of the three UK newsprint mills (Bridgewater, Shotton and Aylesford). A newsprint mill has been proposed at Gartcosh in the past, where it would be conveniently adjacent to Cheshire Recycling, the company who constitute the largest collector of old newspapers in Scotland. However, at least partial funding would be necessary to build such new capacity, with a modern facility with a capacity of 250,000 tonnes costing in the region of £250 million (Glasgow City Council, 1992). Such a project is unlikely to attract Government assistance due to the disparity between the high capital investment and low number of jobs the facility would provide. Funding of this sort may be construed as politically unacceptable, and the only alternative would be to attempt to attract foreign investment.

2.3 Problems Arising from Recycled Fibre Use

In parallel to the wastepaper reprocessors, a major problem mills face when using recycled fibre is that of contamination, with contraries such as staples, adhesives and plastics causing problems in respect of quality and lost production time. All three mills visited (BPB, Inveresk and Smith Anderson) were keen to have quality standards and specifications produced, and saw producer education as essential in the quest to establish separation of grades at source and lessen contamination.

A related issue is the availability of wastepaper stocks, with Inveresk in particular having difficulty in sourcing adequate volumes this year, leading to a temporary closure of their de-inking plant. Smith Anderson also experienced difficulties in sourcing paper, with the local Fife council reluctant to put paper collection systems in place. The underlying problem here is the wide variability of wastepaper prices. Many organisations, councils in particular, were forced to abandon wastepaper collections when paper prices collapsed in the mid-1990s. They are understandably reluctant to restart collections even when prices and demand are high due to the unpredictability of the market.

A stabilisation of market demand and prices would be difficult to achieve due to the worldwide nature of the paper market, although the availability of long-term contracts with fixed or minimum prices would go a long way towards restoring the confidence of local authorities to proceed with paper collections. Smith Anderson have established their own recycling facility in an attempt to achieve security of wastepaper supply, aiming to source at least 50% of their annual requirements. Inveresk attempted to establish a similar scheme in the mid 1990s, but the collapse of paper prices led the to abandon the project. However, in the correct economic climate such a scheme is likely to be a success, and provide the company with a guaranteed raw material supply. Another problem is that of wastepaper merchants exporting to the continent and Asia when prices are favourable, leading to domestic wastepaper shortages.

A further issue is the reduction in quality associated with the repeated use of recycled fibres. Fibre lengths shorten with each successive use, leading to a loss in strength of the fibre mix. Concern was also expressed that the long-term use of recycled fibres may be unsustainable, as the overall quality of the fibre-stock would progressively deteriorate, and eventually a high input of virgin fibres would be necessary to restore fibre quality and strength. Sources at Smith Anderson claimed that the average fibre length for KLS (recycled cardboard) has fallen from 1.6 to 1.0 millimetres in the 6 years, causing problems as short fibres are weaker, and slow production rates as they take longer to dry, an effect particularly unwelcome in an industry where yield is of utmost importance in maintaining profitability. Research in this area would provide valuable insights into recycled fibre use, and may yield solutions to the strength loss problem.

A final issue associated with the dependence on recycled fibre is the haphazard and ever-changing nature of the portion of the supply system that is comprised of collection schemes run by local authorities. Pulp and paper mills are very large and capital intensive manufacturing operations that must operate continuously at very high operating rates to remain economically feasible. They simply cannot afford to have unreliable sources of supply that might force them to curtail operations. Local authorities must become part of a fundamentally reliable supply infrastructure if the mills are to recognize their participation as legitimate, let alone base additional investment upon it.

Table 2.2: Potential for Increasing Recycled Fibre Use – Company Responses

Company	Potential to Increase Recycled Fibre Use	Problems with Recycled Fibre Use	Additional Information
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Company	Potential to Increase Recycled Fibre Use	Problems with Recycled Fibre Use	Additional Information
Arjo Wiggins	High with appropriate technology & assured quality supply	Quality & Contamination	Need advanced technologies to incorporate recycled fibre into carbonless copy paper production
BPB Paperboard	Minimal as always need small % virgin	Contamination with plastics, polystyrene a major issue	Would welcome standards/specifications for each grade. Formerly used mixed grades in furnish, stopped due to contamination.
Caledonian Paper	Limited potential related to on-site pulp production	N/a	
Curtis Fine Papers	High with appropriate technology & assured quality supply	Quality & Contamination	Recent job losses following financial difficulties due to competition from Europe and exchange rate
Dexter Non-Wovens	Minimal due to speciality nature of production process	N/a	Lack of recycling technology appropriate for specific products
Donside Paper Company	High with appropriate technology & quality assured supply	Quality & Contamination	Formerly used higher % recycled, but decreased due to contamination, and problems sourcing high quality supplies
International Paper	High if appropriate technology & assured quality supply	Quality problems as need long fibres for strength	Would consider use of recycled fibre if local supplies of high quality segregated office waste could be guaranteed
Inveresk Plc	High with assured quality supply	Contamination Difficulties securing sufficient quantity & quality supply	Had to temporarily close de-inking plant due to shortage of wastepaper supply. Would welcome development of specifications. Experiencing financial problems, job losses
Sappi UK	Potential if new technologies developed	Contamination & quality	Advanced technologies needed to incorporate recycled fibre into carbonless copy paper
Smith Anderson	Minimal as always need small % virgin	Quality problems due to spiralling decline in recycled fibre lengths, Contamination	De-inking plant on-site. In-house wastepaper collection to achieve security of supply. Need grade specifications & producer education to decrease contamination
Tullis Russell	High with appropriate technology and assured quality supply	Quality & Contamination	Pilot use of recycled fibre phased out due to contamination problems. If guaranteed supply of quality de-inked grades would use 5-10% recycled with no problems

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