FACTORS INFLUENCING A HIGHER USE OF RECOVERED PAPER IN THE EUROPEAN PAPER INDUSTRY

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Europe is one of the global leaders in paper recycling. Recovered paper is an indispensable raw material (around 50% of the fibrous raw material is recovered paper), which contributes to the sustainability of the sector. However, certain factors do have a limiting influence on the possibility of an extended use of recovered paper, such as the quality of the recovered paper, the poor sorting activities, the price for recovered paper, the acceptance/demand of recovered paper-containing products by the consumers, the recyclability of the paper products, etc. Against this background, the COST Action E48 – "The limits of paper recycling" – has analyzed the issues that predominantly influence the competitiveness of the paper and board recycling industry, and detected potentials for an extended use of recovered paper in the European paper industry. The analysis has been carried out on the basis of a detailed and comprehensive questionnaire aiming at collecting experiences and opinions on the situation of the different European countries, related to paper recycling.

Keywords: European paper industry, paper recycling, recovered paper, competitiveness, COST Action E48

INTRODUCTION

Over the past decades, the recovery and utilization of recovered paper in the paper and board industry has increased throughout the world, and this trend will continue. In Europe, after the success of the first European Declaration on Paper Recycling (2000-2005), a new voluntary commitment of the paper recycling chain was signed[1] for the period 2006-2010, with the challenge of achieving a recycling rate of 66% in 2010. By 2008, this objective was already achieved (66.8%), making paper the most recycled product and Europe the global champion in paper recycling.[2]

Papermaking is one of the oldest and leading recycling industries, because virgin and recovered fibres complement each other perfectly.[3] Nowadays, recovered paper accounts for about 50% of total papermaking fibres used at a worldwide level.[4]

Generally, the overriding challenge of the paper sector and of the paper recycling sector particularly, is to maintain and improve its competitiveness, as a net contributor to the European Union trade balance. There are, however, several factors directly affecting this competitiveness on an ongoing basis, ranging from energy costs to exchange rates or from the demand to environmental regulations, *e.g.* countries with lower raw material, energy and labour costs, where the business sector is much less regulated, in particular from an environmental perspective.[5] Only some of these aspects can be controlled by the paper industry, others are beyond their influence. The industry knows that it has to undertake any reasonable effort for boosting competitiveness in the

areas they can directly influence, *e.g.* research and development (R&D), along with recognizing the need to work with legislators and other stakeholders to assure a competitive position – and to continue to deliver superior environmental performance.[6]

The present study overviews the paper and board recycling sector in Europe and the factors that might possibly limit the use of recovered paper, and discusses the most important restrictions for different countries.

METHODS

The methodology applied for the identification of the factors influencing the paper and board recycling industry in Europe and the possibilities of a higher usage of recovered paper as raw material have been based on collecting experiences and facts from experts from 19 different European countries, through questionnaires, as well as from their comments and discussions.

The general goal of the questionnaire has been to identify the most relevant issues influencing different aspects of the recovered paper processing chain. In this case, the importance of social, economic, technical, environmental and legislative issues has been considered related to the collection of recovered paper, the sorting of recovered paper, paper production and treatment technologies, as well as printing and converting (Fig. 1).

The questionnaire here described has been developed as an extension of other previous questionnaires to clarify some aspects, to obtain more relevant information and to check the previously identified conclusions. It focuses on obtaining more relevant information on four aspects affecting the whole recycling paper and board industry, namely, collection systems, sorting systems, paper production and structure, and printing and converting industry. Specific data were asked from the respondents on the importance of the different collection systems applied in their countries, the main obstacles to extended sorting of recovered paper, the degree of awareness in the printing and converting industry in terms of recyclability of their products, and how all these affect paper recycling, etc. Respondents were also asked to determine how the paper and board industry addresses the different constraints.

The questionnaire was distributed by the members of COST E48 in their respective countries (19 different countries: Bulgaria, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Norway, Poland, Romania, Slovenia, Slovak Republic, Spain, the Netherlands and the United Kingdom) and the answers were compiled and analyzed. The data collected reveal a great variety of situations in different regions of Europe.

RESULTS AND DISCUSSION

Paper and board collecting in Europe

Recovered paper collecting is already very high in Europe. In 2008, the collection rate (*i.e.*, the percent ratio between the recovered paper collected and paper consumption) was 67.0%, which means a collection of 59.0 million tons of recovered paper.[7] This year, the European paper recycling industry consumed 48.6 million tons of recovered paper, the rest (a net trade of 10.4 million tons) being exported, mainly to the Far East (China).

Although the average collection rate is already high in Europe, important differences are to be noticed among different countries (Fig. 2): some of them are very close to the limit for the collection of recovered paper, *e.g.* Germany, the Netherlands or Norway, with collection rates between 70% and 80%, others are still far away – for example, Poland has a collection rate below 40%. Consequently, there is still an important potential to recover the used paper in Europe, mainly in the Eastern countries.

However, as the collection rate increases, further increments become more difficult, not only because the easy-to-exploit and higher quality sources are the first to be exploited and are mostly tapped, but also because there is an intrinsic limit on paper recovery – there is a share of non-collectable/non-recyclable papers. These are products that have been released on the market, but can not be collected or recycled, either for technical reasons or because of their use in permanent applications (cigarette paper, tissue paper, wall papers, archives, etc.). This share can be as high as 19% of the total consumed paper and board. Consequently, the maximum collection rate would not attain 100%, but rather 81%, or even less.[8] The exact collection rate value is really difficult to estimate, since many factors influence these limits; for example, the packaging paper coming with the goods imported from China and the Far East can represent around 10-15 million tons at a global level (data used in calculations), thus increasing the availability of recovered paper for collection, apart from the apparent consumption of paper and board products.

If we consider 80% as the maximum collection rate achievable and the total paper and board consumption (87.9 million tons in

2008), recovered paper possibly collected in Europe would rise to 70.3 million tons, *i.e.* 11.3 million tons more than the 59 million tons collected at present, which means a potential of 20% more recovered paper available.

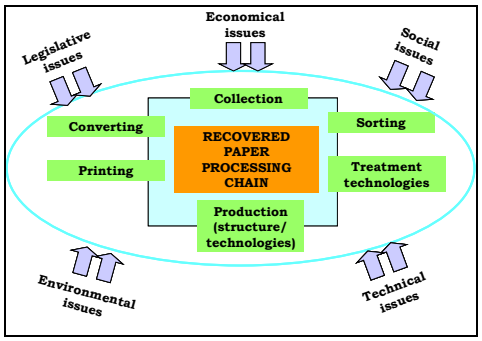

Figure 1: COST E48 approach for determining the most relevant factors influencing the recycling paper and board industry in Europe

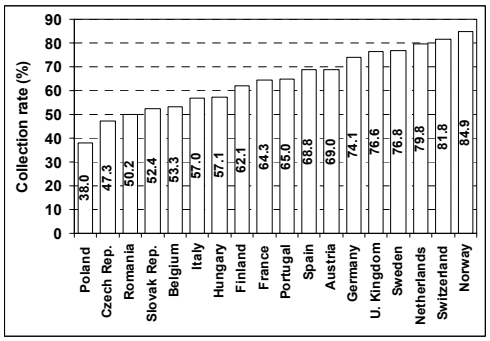

Figure 2: Collection rate in CEPI countries in 2008: adapted from 2008 CEPI Statistics

However, one of the major threats of an extended collection is its influence on the quality of the recovered paper collected.[9,10] The reason is that, firstly, the easy-to-collect sources of used paper of the highest quality are already exploited (high volumes of recovered paper generated at individual points) while, by an increased demand, the collection rate would increase by exploiting other sources, of lower quality and more disperse generation, such paper recovered from households. Some years ago, recovered paper merchants were able, for example, to sort out and sell free-of-adhesives materials, in spite of the fact that the changes occurring in the recovered paper collection system and the growing use of post-consumer recovered paper made this approach illusive.[11]

Another threat is represented by the commingled collection systems, in which all recyclables (plastics, cans, paper, glass, etc.) are collected together and are further separated in a materials recycling facility (MRF). The quality of the recovered paper from this source is, in many cases, too low to recycle in the paper industry.[12] The change from selective collection to commingled collection can be so detrimental to production that it could justify the shift to virgin fibres as raw material. In the US, for example, W. K. Sacia and J. Simmons[13] reported that a 42% substitution of recovered paper from selective collection by recovered paper from commingled collection for old newsprint (#8 grade, according to US standards) produced an increase of the unusable materials from 0.25-0.50 to 5.7%, and of non-paper components from 0 to 1.3% (0.1% is glass). Even more, this change also resulted in a 300% increase of the maintenance costs (glass and other abrasive contaminants), an 800% increase of the pulper rejects, a 740% increase of the costs, due to the lower proportion of fibre in the recovered paper, and a lower quality product (57% increase of macrostickies in the final pulp). For this reason, the shift from source-separated to commingled collection systems has been considered as one of the worst changes in the recycling industry in the last years. In Europe, the commingled collection systems were spreading in France and especially in the United Kingdom;[9] however, this threat to the quality of the recovered paper was minimized by the new European Waste Directive,[14] according to which the separate collection of paper, metal, plastics and glass will become mandatory in all member states by 2015.

The first topic analyzed by the questionnaire was the identification of the reasons of the poor or medium collection rates in some European countries. To this end, the effects of the type and variety of the collection systems in different European countries were investigated and classified according to the organizations collecting the recovered paper as municipal (or state) organizations, private companies and others (charity organizations, schools, churches, etc.). In 17 of the 18 countries, collection of used paper is carried out by both municipal (or state) organizations and private companies while, in 8 out of the 18 countries, the collection is also carried out by other institutions (charity organizations,

etc.), apart from municipal and private companies. The organizations charged with the collection of used paper are mainly the same in all European countries, although their collection rates differ largely (from around 40 to 80%). Consequently, neither the type nor the variety of the collection systems seems to have a significant influence on the collection rate.

Further on, the role of rewarding consumers for increasing the collection of recovered paper was analyzed. National representatives were asked if consumers in their country were rewarded for bringing their used paper and board products back to recycling centres. The results showed that only countries with low collection rates try to improve paper and board collection by rewarding consumers, *e.g.*, in recycling centres. It has been demonstrated not only for paper collection, but also for other recyclables that, in the case of non-developed countries or countries with low recovery rates, education and information do not improve the recovery rates, and need to be complemented by direct and targeted incentives.[15-17]

In a following step, the questionnaire focused on the situation of recovered paper and board collected from the industry and offices. At a European level, a rough estimation of the different sources of recovered paper indicates that 50% of used paper and board are collected from industry and trade, 40% from households and 10% from offices,[18] although these percentage values can differ greatly among countries and collection systems. First, the representatives were asked to check whether the used paper and board from industry and offices were collected separately. This was the case of all countries involved, indicating that collection from this source is well-established in most European countries. When respondents were asked if an extended collection of recovered paper from industry and offices was possible, with 84% of all respondents the answer was "yes". Consequently, improvements are still possible. In this respect, rewarding could be an important issue: only in 9 of the 19 countries investigated, the industry and administration are rewarded (47%), which is not the case in the other 10 countries (53%).

Another topic addressed by the questionnaire inquired whether improvements in the collection strategies were considered instrumental for a significant increase of the utilization rate in various countries. To this question, 12 of the 19 representatives answered "yes" (63%) and 7 answered "no" (37%). Countries like Germany, Spain or Finland, *i.e*. those with the highest utilization rates in Europe (except Finland, whose high paper production is based on virgin fibres) belonged to the latter group. It may be therefore concluded that collection is a really important issue for increasing the utilization of recovered paper, except the cases in which the utilization rate is already very high.

Finally, respondents were asked to assess different strategies in terms of their potential to improve paper and board collection efficiency in their countries (the most important = 1, the least important = 4). The options expressed were as follows:

a) improving the acceptance (convenience) of the collection system,
b) improving the environmental awareness of the consumers,
c) rewarding the consumer for collecting used paper and board products, and
d) others.

The results were very clear: environment awareness (with an average rate of 2.1 points) was regarded as the most important issue to improve the collection rates around Europe. 8 of the 19 countries (Hungary, Latvia, Norway, Poland, Romania, Slovak Republic, Spain and Slovenia) rated this issue as the most important one.

Improvement of the acceptance (convenience) of the collection systems and rewarding of consumers for collecting paper and board were considered less important (average rates of 2.4 and 2.5, respectively). Improvement of the acceptance of the collection system, and others, were ranked only by two countries as the most important issue. Rewarding consumers was considered the main issue in improving recycling in 6 of the 19 countries, surprisingly, in countries with a high environmental consciousness (Bulgaria, Croatia, France, Germany, the Netherlands and the UK). Other means were rated only as 3.1 points. The results obtained concerning this issue are presented in Figure 3.

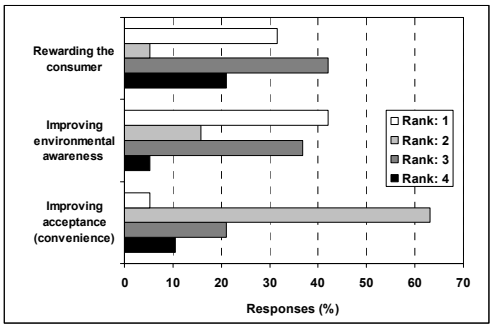

Figure 3: Means to increase paper and board collection rates in Europe. Ranks vary between 1 (the most important) and 4 (the least important)

Thus, a high environmental awareness within a country seems to be a crucial prerequisite for increased paper and board collection rates. In the case of developed countries, the propensity to recycle is mainly motivated by environmental values, which were developed in time by public education programmes.[15] The extrinsic motivation of the consumer will last longer and is more effective than rewarding him. On the other hand, rewarding can be an effective approach to start the development in countries with low recovery rates. Previous studies within COST Action E48 have also demonstrated environmental consciousness of the citizens as one of the main driving forces for obtaining a higher volume and quality of recovered papers.[17] Social and legislative aspects were considered the most important issues influencing the collection of recovered paper, while environmental and economical issues record an average, and the technical issues – only a rather weak influence.

Besides the importance of the collection strategies in increasing paper recovery, the collection systems are of vital importance as to the quality of recovered paper. The method of collecting recovered paper has a direct impact on the composition of recovered paper and determines the further steps of recovered paper processing (sorting processes). The collection systems vary in the analyzed countries and, obviously, depend on the source employed. Each source involves different collection channels, yielding different grades and qualities of the recovered paper with different characteristics. These systems can be very different in the municipality, region or country considered. This variety is justified by the fact that there is not an optimal collection system that can be considered as universal, because it depends on social and economic factors, different at regional and even local levels. The application of suitable recovered paper collection strategies is the key to safeguard the supply and quality of secondary fibre and to reduce the sorting costs.[19]

Sorting of recovered paper and board in Europe

As already mentioned, extended paper recovery is always detrimental to quality, as sources of lower quality have to be tapped. Manufacturing process innovations could probably contribute to keeping the current quality level, even at a (slightly) lower quality of the recovered paper. However, papermakers are urged to gradually improve the quality of their final products, no matter how much recycled pulp they use. The main potential for an extended use of recovered paper lies in graphic papers, for which the quality requirements for the final product have always been high. These products have to respond to the new challenges set by the rapid technological developments in printing and converting techniques. That is why, an improved and extended sorting of the recovered paper is of great importance for an extended recycling of paper in Europe.

Sorting can be carried out at different locations, *e.g.*, at the source (households), in industry/offices, collecting centres or sorting plants and paper mills. No matter where it is performed, the main advantages of sorting are: a) reduction of the content of unwanted components in recovered paper and increased homogeneity of the raw material, and b) the provision of tailor-made recovered paper grades for the best possible re-use in paper and board products.

Basically, three main sorting strategies are in use: manual, semi-automatic and automatic. Despite the new technological developments, sorting of recovered paper in Europe continues to be mainly a manual,

labour-intensive process, requiring only an inclined conveyor and a speed-adjustable sorting belt.[20] Progressive automation of the process reduces sorting costs, *e.g*. a 10-15% reduction in the recovered paper price can be obtained in automated plants, compared to manual sorting plants,[21] improving the quality of the sorted paper, although some problems remain to be solved, such as application of optical systems, especially NIR, or the fact that automation generates grades that do not correspond to the EN 643 list.[22] These plants are based mainly on mechanical screening, but new optical technologies are being incorporated (Vis/IR); nevertheless, they still have in common a final sorting step at the end of the process. However, dry-sorting costs and paper quality depend largely upon the degree of mixing in the collecting systems.[9]

The questionnaire started with an estimation of how much of the collected paper and board in Europe is sorted. There is a lack of statistical data on this topic, so that only a rough basis can be established by estimations. The result was that approximately 51% of all paper and board collected in Europe is currently sorted. The values range from around 10-40% (Bulgaria, Latvia, Poland, Slovak Rep., etc.) to more than 70% (and even 100%) (Finland, Norway, Germany, etc.).

Next, the questionnaire analyzed the state-of-the-art of sorting in different countries, in terms of the type of sorting (in households, industry/offices, collection centres or mills). The respondents were given the possibility to assess the situation in their respective country from weakly developed (value = 1) to highly developed (value = 4). The results showed that the dominating sorting system currently practised in Europe is sorting at collection centres, with an average degree of importance of 2.7 points. The second most important was sorting at industry and offices (2.4 points), while sorting at mills (2.1 points) was ranked the third. Sorting of paper and board in households is the least developed sorting system (sorting at source) with a 1.9 rate on the average. In fact, it was only the Netherlands and Denmark that rated this sorting system as very developed (4 points on the scale). The low-developed sorting at households is one of the main difficulties for an extended use of recovered paper in Europe, therefore household activities should be considered an important source for increasing not only the volume of recovered paper to be collected, but also its quality.

Further on, respondents where asked if intensified sorting, which would generate "tailor-made" recovered paper grades could contribute to increasing paper recycling. In this case, 75% of the respondents answered "yes", 15% answered "no" and 10% did not know. "Tailor-made" grades, adapted to the domestic paper and board industry, seem to have a clear impact on an increased paper recycling in Europe, indicating that sorting can have a great importance in increasing paper recycling.

After that, respondents analyzed if better sorting systems would help to significantly increase the utilization rate of recovered paper. Only 5 out of the 14 respondents answered "yes" (36%), 8 answered "no" (57%) and one did not know (7%). Similarly to other issues approached in the questionnaire, although sorting activities were believed to increase paper recycling in Europe, when only utilization rate was considered, some of the respondents answered "no", as their domestic utilization rate is already high and difficult to increase.

Next, respondents were asked to determine whether the paper industry would use more recovered paper if this had not been sorted into graphic and packaging grades (if such a fraction was available). The background of this question is that, in some countries, where packaging paper is the main paper product, an intensified sorting to isolate deinking grades and packaging grades could not have too much effect on the recycling activities, while in countries where graphic papers are predominant, only better sorting could improve the use of recovered materials. The respondents gave the following answers: 9 out of 17 answered "yes" (53%), 7 answered "no" (41%) and one did not know (6%). These results indicate that more intense sorting activities would not be equally effective in all countries in increasing paper and board recycling, although, in a great number of countries, sorting would be required. Respondents who answered "yes" come from countries where recycling is less developed, like Bulgaria, Croatia, Poland, Romania, Latvia, Slovenia, etc., while those from countries with recycling activities strongly or at least more developed, like Germany,

France, Finland, Spain, the Netherlands, etc. answered "no". Consequently, improved sorting activities should have a great influence in a significant number of European countries.

The next topic in the questionnaire focused on the analysis of the most important obstacles to be overcome in extending sorting activities. The options given were costs, legislation and technology, which had to be ranked according to their respective importance, between 1 (the most important) to 4 (the least important). The answers, as shown in Figure 4, indicate that the most important obstacle is, without any controversy, the cost (average rate of 1.5 points): 50% of the respondents answered that cost is the most important (rated as 1), and the other 50% ranked it as the second most important (rated as 2). The second most important obstacle is technology (average 2.4), rated as the most important by 25% of the respondents. The last two obstacles, with similar importance, are legislation (2.8), which was not considered the most important by any of the participants, and others (2.9), *e.g.* consumers' awareness, etc., cited by only two respondents as the most important issues.

Consequently, better sorting could increase the use of recovered paper in the paper and board industry, although to different extents, depending on the country analyzed. However, the sorting costs are, in many cases, the main obstacle for more intensified sorting. The lack of technology is also an important issue. Costs and technology are interrelated facts. The use of new technologies for the automatization of the sorting process can reduce the sorting costs, compared to manual sorting, although the extent of investment is still rather high, *e.g.* complete installations (mechanical sorting + sensor-supported sorting systems) with throughputs of up to 7 tons per hour can cost more than one million Euros.[19] One of the largest sorting plants in Europe, built by Carpa by the end of 2007 in Madrid (Spain), to sort the recovered paper coming from selective collection from households, required an investment of around 8 million Euros. The plant, with a throughput of 200000 tons per year (23 tons per hour), has a system based on mechanical sorting, optical sorting (IR) and manual sorting (in the final stage).

Regardless of the investments made in new installations for extended sorting activities in Europe and the research carried out on sensor-based sorting technologies, *e.g.* the FP7 project "Recovered paper sorting with innovative technologies" (SORT IT) (2008-2001), it is necessary to emphasize that sorting at source and separate collection are always the best ways to ensure a good recovered quality, thus allowing an extended use of this raw material by the paper and board industry.

Paper production structure and technology in Europe

First, the respondents were asked to describe the current situation of the paper and board industry in their countries in terms of production shares and utilization rates for different paper products. This was necessary as, although most of the countries are integrated in CEPI, some of them are not, and consequently, no statistics is available – in spite of the fact that during the COST Action, many of these countries eventually joined CEPI and are now covered by regular statistics, issued annually. In 2008, the average utilization rate in CEPI countries was of 49.1%, which means that 48.6 million tons of recovered paper were used in the paper and board industry.[7] The utilization rates vary largely around Europe, within a range of 5-90% (Fig. 5). The lowest utilization rates are in the Nordic countries, with a higher production of paper and board from virgin fibre: Sweden (17.3%), Finland (5.5%) and Norway (24.7%). The Slovak Republic and Portugal also have very low utilization rates, of 22.6 and 23.2%, respectively. The highest utilization rates are recorded in Hungary (91.3%), Romania (92.2%), Spain (84.8%), the United Kingdom (80.1%) and the Netherlands (75.0%).

The utilization rates by grades are also very different, varying from 10.3% in graphic papers other than newsprint, to more than 90% in newsprint (91.0%) and case materials (91.2%). It is important to notice that an increasing part of the recovered paper collected in Europe is utilized elsewhere in the world. In the last five years, for example, the exports of recovered paper from CEPI countries to other regions increased from 5.59 million tons in 2004 (net trade of 4.77 million tons) to 11.52 million tons in 2008 (net trade of 10.38 million tons), Asia being the destination of more than 95% of exports.

After examining the present situation, respondents were asked if they believed in a possible potential to increase the recovered paper utilization rate in their domestic paper and board production. 14 out of the 19 respondents answered "yes" (nearly 75%) and only 5 answered "no" (about 25%). The latter come from Denmark, Finland, Germany, Spain and the Netherlands, where the utilization of recovered paper is among the highest in Europe (between 70-85%) although, as in the case of Finland (as commented before), it is the lowest in Europe (5%) because of the high production of materials based on virgin fibres. Any improvement in the utilization rate of recovered paper is really difficult in these countries.

Further on, the respondents were asked to identify the limiting factors in increasing the utilization rate in their respective countries. They ranked the importance of the suggested limiting factors (processing costs, availability of recovered paper, lack of technology and price of recovered paper, and others) between 1 (the most important) and 5 (the least important). The average values of ranks indicate that the price of recovered paper (2.4), the processing costs (2.6) and the availability of recovered paper (2.8) are equally important for an increased recovered paper and board utilization in Europe. Lack of technology currently seems to be of minor importance (3.1). Processing costs and the availability of recovered paper were considered by 43 and 29% of the respondents, respectively, as the most limiting factors. Lack of technology and the price of recovered paper were considered by 20% of the respondents as the most important ones. Other aspects, not approached in the questionnaire, but mentioned by the respondents, included the management of rejects and energy costs, topics of growing interest at present in Europe. The results obtained to this question are presented in Figure 6.

From the above considerations, it can be concluded that price, processing costs and availability restrict the utilization of recovered paper. Potentials for a further increase of recovered paper utilization are present in the graphic paper sector, as already mentioned. This sector (other than newsprint) is reported to have the lowest utilization rate (around 10%) and, consequently, the largest potential for increase in terms of the overall utilization of recovered paper in Europe. The main prerequisite for exploiting this potential, however, is the quality of the recovered paper and the high recyclability level of its components.

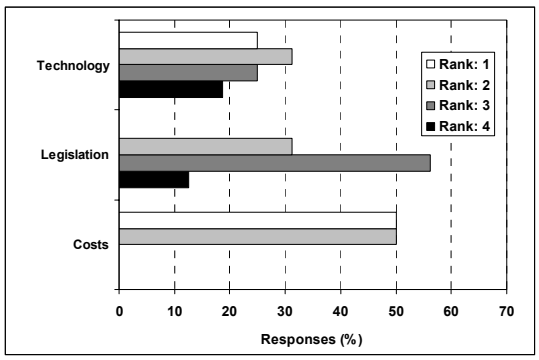

Figure 4: Most important obstacles to extending sorting activities in Europe. Ranks vary between 1 (the most important) and 4 (the least important)

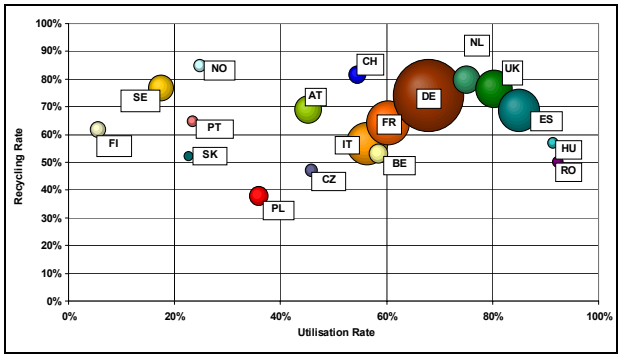

Figure 5: Recovered paper recycling rate, utilization rate and utilization in CEPI countries in 2008. Source: 2008 CEPI Statistics

Printing and converting in Europe

Eco-design of paper and board products, which directly translates into their recyclability, is a key issue for producing high-quality recycled pulp and, consequently, for increasing the use of recovered paper as a raw material for paper and board industry, especially if the general quality of the recovered paper goes down, as a result of higher collection rates. Adhesives and printing inks (particularly "flexo" inks) continue to be a major problem.[23-25]

First, respondents were asked if there is any awareness in the sector of printing and converting industries in their countries of the way in which converting and printing technologies affect the recyclability of the paper and board products. According to the

results of the questionnaire, this was the case in only 8 countries (44%), namely Denmark, Finland, Germany, Italy, etc. while, in the other 10 (56%), this awareness was anything but well-established (Bulgaria, Croatia, France, Poland, Romania or Spain).

Another question dealt with the means by which domestic printing and converting industries address the constraints of the paper and board industry by using recycling-friendly materials. 80% of the respondents considered the utilization of recycling-friendly printing inks as the main practice (which might be in contrast to some papermaker's experiences), 40% – recycling-friendly adhesives and 33% – other recycling-friendly materials or technologies. From a survey of the research projects in progress in Europe within the framework of COST E48 activities, it was concluded that adhesives and stickies still remain the key problems.[26]

To identify the reasons for which, in some countries, the constraints of paper industry are not taken sufficiently into account by the printing and converting industry, 4 alternatives were offered: costs, lack of technology, legislation and regulations, and others (to be specified). The respondents were asked to rank these alternatives between 1 (the most important) to 4 (the least important). Costs came first (10 of the 18 respondents, 56%), followed by legislation and regulations (6 responses, 33%) and lack of technology (2 responses, 11%). The comments of the respondents also indicated that environmental awareness was another important reason, "printers and converters are driven by profit, not by ecology". Figure 7 details such data.

Consequently, as anticipated, the dialogue between paper industry and their clients was viewed as insufficient. The respondents were also asked how printing and converting could be motivated (or urged) to improve the recyclability of the products. The respondents had to choose from the following alternatives: paying subsidies, reinforcing legislation and regulations, encouraging consumer's behaviour (towards environment-friendly products) or other means (to be specified). The results showed that a more severe legislation (considered by 7 of the respondents as the most important aspect, 43.7%) or paying subsidies (6 of the 16 countries, 37.5%) were regarded as the most effective strategies. Improving consumers' behaviour was considered the most important strategy only by the representative of Germany. Two respondents (12.5%) considered other issues as the most important ones. Figure 8 details the results obtained in the questionnaire.

Finally, the participants were asked if they believed that, if the printing and converting industry used more recycling-friendly materials and technologies, the recovered paper utilization rate in their countries could be significantly increased. In this case, 50% of the respondents answered "yes", while the other 50% answered "no". Negative answers were mainly given by representatives of countries where a high utilization rate had already been achieved. This means that there is still potential for increasing the use of recovered paper in the paper industry, on condition that a higher recyclability of the paper products is assured. This issue will be even more important as the quality of the paper products goes down with extended recovery of paper. Eco-design of the paper products could help to maintain the quality of recovered paper even at higher collection rates.

Considerable efforts have been carried out by the International Association of the Deinking Industry (INGEDE) and by some partners to the added value chain to enhance awareness of the recycling problems caused by the printing and converting processes. One example is standardization of a test to measure recyclability, an important achievement to be discussed further. The development of an effective communication basis between paper recycling industry and the printing and converting industries has been and still is a hot topic. Consequently, efforts have been made with little to no success at all. However, the paper industry should not stop undertaking any reasonable effort to intensify the dialogue with their clients – and *vice versa*.

In 2008, the European Recovered Paper Council adopted a new assessment scheme, the deinkability scorecard, to promote the eco-design of printed products, which will assure their recyclability and promote sustainable production processes. This scheme is designed to allow printers, publishers and other members of the paper value chain to identify which types of printed paper products are sufficiently "deinkable" with the currently available technologies. Five parameters – luminosity, colour,

cleanliness, ink elimination and filtrate darkening – are considered in a widely accepted standardised test, Method 11, developed by INGEDE.[25] According to laboratory tests, the results of the five scorecard parameters are weighed as to their importance, being displayed either numerically or graphically in a traffic light colour scheme. There are four categories of results – good, fair, poor and not suitable for deinking. To achieve the status of "fair" or "good", a printed product has to reach at least a score of 41 out of 100 points. A score below zero for any parameter leads to the overall assessment: "not suitable for deinking".

The European Recovered Paper Council – through the Declaration on Paper Recycling – is also promoting the importance of the eco-design of paper products along the whole paper and paper recycling value chain.

The paper chain

The study of the different stages of the recovered paper value added chain demonstrated that there is still potential for improving and achieving higher recycling rates in all areas, such as collection of recovered paper, sorting of recovered paper, recovered paper utilization (related to paper production structure and technology) and printing and converting.

Almost 60% of the respondents (11 of 19) considered collection systems as the most important area to consider for extending the limits of paper recycling. On the average, the relative importance of the collection systems was of 1.7 (the lower the number, the more efficient is considered the means), while the average ranks for paper production structure and technology and sorting systems were of 2.4 and 2.5, respectively.

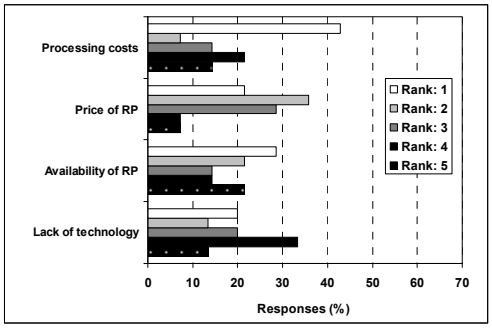

Figure 6: Most important obstacles to increasing the utilization rate of recovered paper in Europe. Ranks vary between 1 (the most important) and 5 (the least important)

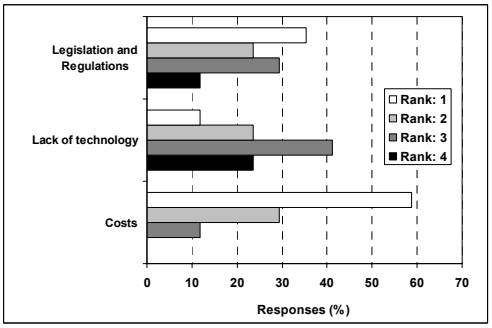

Figure 7: Reasons why printing and converting industries do not address constraints of the paper recycling industry. Ranks vary between 1 (the most important) and 4 (the least important)

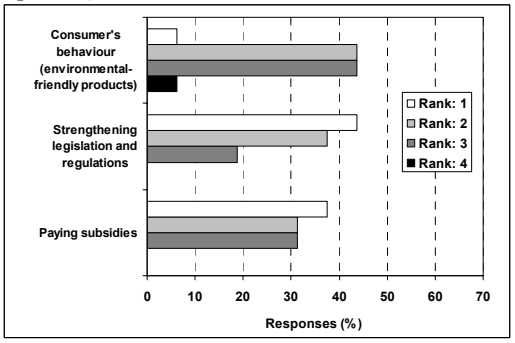

Figure 8: How to motivate (or urge) printing and converting industries to improve recyclability of their products in Europe. Ranks vary between 1 (the most important) and 4 (the least important)

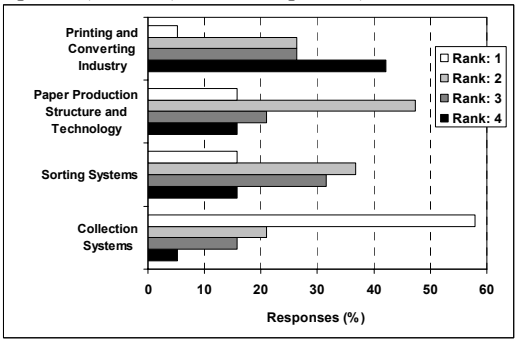

Figure 9: Importance of different areas from the paper recycling chain in extending the limits of paper recycling in Europe

These issues were considered as the most important by 3 representatives. The average importance of printing and converting industries in extending the limits of paper recycling was rated to 3.1 points, only one person considering that printing and converting industry was the most important limiting issue. Figure 9 lists the results obtained in detail.

CONCLUSIONS

Although the level of recycling in Europe is already one of the highest in the world, there is still some potential for improvement along the paper recycling chain, to extend the actual limits of paper recycling, especially in the area of recovered paper quality. The structure of the paper and board sector is able to use more recovered paper as a raw material, without any limitations in terms of technology.

There is still potential for an extended collection of recovered paper, especially in Eastern Europe. If all European countries collected used paper and board products as effectively as those that ranked in the top (80%), 11.3 million additional tons of recovered paper per year would become available – which is approximately the same amount as the one currently exported from CEPI countries.

Well-functioning collection systems are instrumental, however, the type of the system does not seem to be really important (municipal or public organizations, private companies or others). Still, the quality of recovered paper largely depends upon the collection system. Society's environmental awareness is the dominating prerequisite for an efficient recovery. Sustained efforts should be undertaken in this area in all countries, those with already high collection rates included, while the education of people should be viewed as a continuous necessity. The environmental awareness of people influences both the quantity and quality of the recovered paper to be collected. Paper and board collection from industry and administration is well-established across Europe, although improvements are still possible in a number of countries. In these cases, it has been considered that rewarding might be a promising approach.

The degree of sorting recovered paper is rather diverse and has a significant influence on paper quality. Sorting activities should be considered especially when lower quality sources are exploited for achieving higher collection rates. Sorting is still a mainly manual activity, although great efforts are being carried out for introducing automatization. This is an important aspect that can effectively contribute to reducing costs, demonstrated as being the main obstacle for an extended sorting of recovered paper in Europe.

The utilization of recovered paper in the European paper industry is medium (49% in 2008). However, there are great differences among countries, varying between 5% and 90%. The results have shown that there is still room for utilizing more recovered paper, in particular in the area of graphic papers (others than newsprint). The price of recovered paper, processing costs and availability have been determined as equally limiting factors in increasing the utilization of recovered paper in Europe, while the lack of modern technology seems to be of minor importance.

The impacts of printing and converting techniques on product recyclability have been also looked upon. All across Europe, the awareness of the problems and constraints of the paper recyclers, in the domain of printing and converting industries, is poor to non-existent. There have been and still are taken some efforts to improve communication among sectors. The main reason for not producing eco-designed products is the high costs, followed by legislation or regulations. The lack of technology has not been considered as an important obstacle. There seem to be two promising ways to increase motivation in the industry sector to produce better recyclable products, and namely by paying subsidies and reinforcing legislation and regulations. In this context, the development and adaptation of the deinkability scoreboard by the ERPC and the European Declaration on Paper Recycling can be regarded as the first promising initiatives.

Quality is the major prerequisite for extending the use of recovered paper as a raw material, the major threat being insufficient quality offered.

A considerable amount of research on the quality of the furnish is being carried on in Europe. Adhesives and stickies are still key quality factors.

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