

The Limits of Paper Recycling – an European Approach to Identify and Extend the Limits of Paper Recycling

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1. Recovered Paper: an indispensable raw material for the European Paper Industry

Paper recycling has now been practised for many decades in numerous countries across the world. The paper industry is counted among those branches who almost perfectly meet the expectations of society with respect to the sustainability of their raw material base, the environmental compatibility of their processes as well as the recyclability of their products and has done so for a long time. In particular the latter argument has dramatically improved the image of the paper industry throughout the last few years.

In 2004 more than 175 million tons of recovered paper and cardboard were used for the production of some 360 million tons of new paper and cardboard. Nowadays about 49% of the raw materials involved in papermaking in the US and Europe is recovered paper, with the rest being mainly wood virgin fibre, additives (12-15 %) and other non-wood fibres (1-2 %). It is estimated that in the very near future about half of the global amount of fibres used in papermaking will be recycled fibres.

In Europe, recovered paper has become a major raw material representing 51 % of the total volume of the raw materials used by the paper industry, and representing a recycling rate of more than 48 % in 2004, figures which were virtually inconceivable a couple of years ago.

CEPI, the Association of European Paper Industries has agreed on a target of 66 % by 2010. The driving force for this world-wide phenomenon was economics as well as the lack of other resources in some areas rather than ecological considerations, although rising problems with managing ever increasing amounts of private and municipal waste also made their contribution to this development.

There is no doubt that recovered paper as a raw material for the paper industry is here to stay. There should also be no reasonable doubt, that utilising used paper products of an acceptable quality as raw material for new paper and cardboard is by far the most economical and ecological strategy compared to alternatives like thermal utilisation or even burning. An efficient and robust long term strategy for recovery, reuse and recycling of materials is a cornerstone for improving the sustainability of the industry and the society.

2. Quality of Recovered Paper determines its future utilisation

One of the decisive criteria for the future utilisation of recovered paper is its quality. This is a rather complicated function of :

1. The amount of undesirable components in the recovered paper

This could either be inherent components of paper products like adhesives, plastic films, metal foil laminations and the like, or simply dirt or waste unintentionally collected together with the paper products. The paper industry does not have much influence on this factor – in contrast to those who recover the paper and even more to those who design paper products. In the past the paper industry has made pleas to develop consciousness of this crucial area – with limited success so far.

2. The state of the art of recovered paper treatment technologies

This is a very dynamic area. The suppliers are constantly, and successfully, undertaking huge efforts in order to increase the performance (and the profitability) of their products in

terms of selectivity, capacity, reliability and to develop new products – usually without considering the overall economics of the recycling process.

3. The accepted level of impurities in the finished pulp

This is not really an adjusting screw as the quality of the finished paper product isn't either. I.e. the quality of the finished pulp decides for which purpose it can be used, not the other way round. But of course, the lower the quality is, the more limited the use.

4. The accepted level of residues produced during recycling

This is an area largely dominated by laws, ordinances, regulations etc. but also by the means available to those who produce the residues. The regulations governing the disposal of waste will however undoubtedly become even more rigorous.

In the past the paper industry has always managed the problems associated with paper recycling very effectively. The menace of water based inks, the problems of sludge disposal, the increasing problems caused by stickies a.s.o. to name a few. But all this happened at recycling rates, at least in Europe, which were significantly lower than those we will possibly have to deal with in a couple of years.

The many lessons on recycling which the paper industry had the opportunity to learn throughout the last few decades may be summarised as follows:

- The quality of the individual fibre deteriorates in the course of time. There is no number of cycles by which the life span of a fibre could be characterised in a meaningful way – although such attempts have been made. This is due to the fact that the quality of a recycled fibre depends mainly on the wood species and the pulping process as well as its former individual history. On the other hand, an excessively recycled fibre might be of absolutely no use in a high quality kraft paper while it still could do a brilliant job as a natural filler in low grade graphic paper.
- Recovering and re-using paper as a raw material for the paper industry results in the establishment of a partially closed (new paper–old paper-) loop. Like in all such systems the consequence is the build-up of concentrations of all, possibly detrimental, matter which is part of the loop depending on the degree of closure. In order to avoid a collapse of the whole system, kidneys (purification processes) have to be installed in order to keep the concentrations on a manageable level. This function is assumed by the recovered paper treatment techniques. In spite of all achievements these techniques are still far from being perfect.
- Increasing the utilisation rates beyond certain limits also requires the exploitation of resources which had not been used hitherto. These are in many cases of low quality or highly contaminated papers and cardboards. Even with highly sophisticated cleaning techniques the quality of the recycled pulp produced from this raw material will be limited while yield will be low and the amount of residues produced during recycling, which have to be disposed of, will be high.

3. The balance between prices, availability, demand and supply of recovered paper

Quality of recovered paper is only one decisive aspect of its attractiveness for the paper industry. The most important other ones are **availability and prices**. Over the past few years, particularly in last century's mid 90ies, we have seen periods with insufficient recovered paper supply – at least in Germany and Austria. The reason at that time was an increased demand from East Asian countries which were ready to pay premium prices on international markets. The result was a shortage of recovered paper in Europe and a price level which motivated some manufacturers to restart their grinders. This however seemed to

be only a temporary phenomenon which eventually disappeared during the turbulent economic times in this part of the world in the late 90ies.

In the meantime the situation has changed again. The demand for recovered paper is getting stronger all over the world. The People's Republic of China is currently about to increase its recovered paper imports until 2010 by a factor of 6 within only 5 years. The same is probably true for Indonesia and a number of other Asian countries. The impressive number of new mills under construction or in the planning phase, many of which will be based on recovered paper, are a strong indication that unlike in the late 90ies, this time it will be the start of a permanent world-wide trend. This will undoubtedly have a strong influence on the world markets for recovered paper.

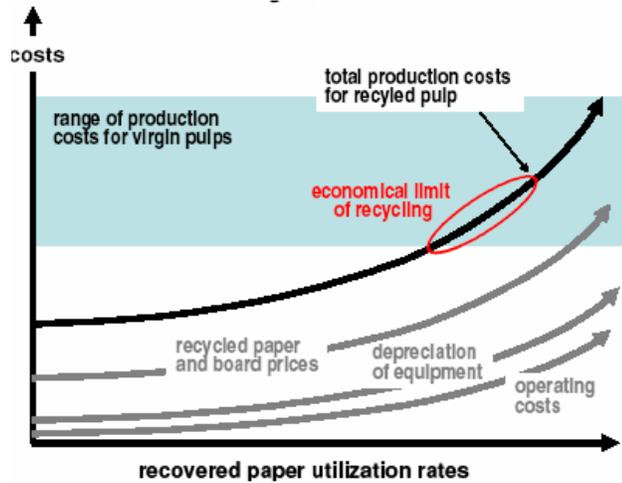
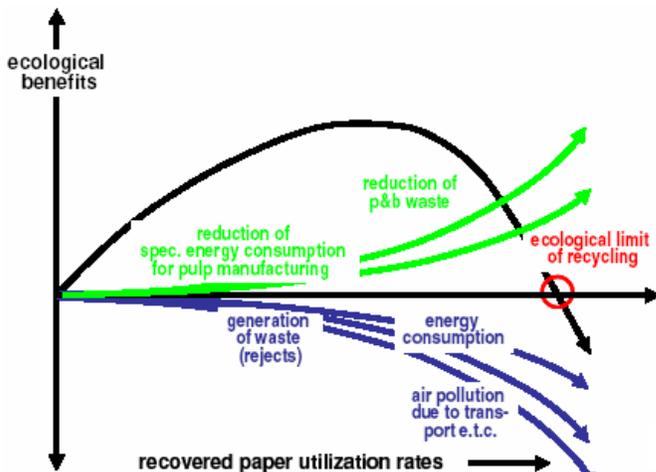


Fig. 1 : Economical limits of paper recycling



From all this it becomes evident, that there are limits of various kinds on the way and the intensity in which used paper and cardboard can be collected and recycled. Against this background a number of questions arise which remain unanswered for the moment but which might become extremely important in the future, maybe even in the very near future.

Fig. 2 : Ecological limits of paper recycling

4. Cross sectoral approach

As stated above the attractiveness of recovered paper as a raw material for the paper industry depends on many factors, the most important of which are:

- **The economy of using recycled pulp** instead of virgin fibres. This is certainly a question of the price for recovered paper which itself is a function of:
 - the availability (depending on collection and collection strategies),
 - the quality (depending on composition and collection strategies),
 - the ratio between demand and supply on international markets (depending, among others, on shipping costs and legislation),
 - the availability of effective and economically viable technologies for its preparation (depending upon R&D with the machinery suppliers),
 - the possibilities and regulations governing the management of waste generated during the production of recycled pulp.

- **The ecology of using recycled pulp** instead of virgin fibres. This strongly depends upon the energy necessary to turn recovered paper into a competitive fibrous raw material. Equally important however is the waste produced during recovered paper treatment which in many European countries must no longer be deposited off in landfills but has to be incinerated. There are also additional environmental impacts resulting e.g. from air pollution due to transport, which have to be taken into consideration.
- **The acceptance of new recycling-based products** within the society. This was no problem a few years ago. In the meantime however priorities have changed and environment is no longer on top of society's agenda. It must not be expected that the use of recovered paper will enjoy the same support from society which it enjoyed 10 years ago.
- **The contribution to the reduction of the waste problem.** This is neither an issue as it used to be a few years ago. In many countries landfilling of paper based products is no longer possible and incineration is regarded an environmentally compatible option. The pros and cons of this approach are still in discussion.

This short and incomplete list makes it obvious that predicting the future use of recovered paper and recycled pulp in the European paper industry requires a very comprehensive cross sectional approach including partners along the whole product chain as well as from other areas.

5. The European perspective

Europe currently enjoys a fairly good volume balance in paper production and consumption. It can safely be stated that for most grades the quality demands in the West European market are equivalent or superior to the products offered in any other market and are met by the European paper industry. The threat, in the graphic paper area, coming from electronic media seems to be far less than anticipated a few years ago.

The main industrial threat for the European paper industry are probably large production units in tropical countries based both on fast growing hardwood (mainly eucalyptus and acacia) and recovered paper which is typically not available in those countries but has to be purchased from outside. Their products will be highly competitive partly also due to far lower costs for labour and energy.

This results in a threat to the European paper industry which does not only apply to the potential development of international prices for virtually all paper grades but also to a much stronger competition in international raw material markets.

6. The COST Action Approach

Against this background a group of researchers in Europe felt that there was a necessity to find out what to do in order to better know where the limits to paper recycling are and what could possibly be done to extend those limits to an as large as possible extent. Eventually it was decided to do this in the form of a so-called COST Action. COST (Cooperation in Scientific and Technical Research) is one of the oldest pan-European research initiatives aiming at harmonizing and spreading scientific knowledge within Europe.

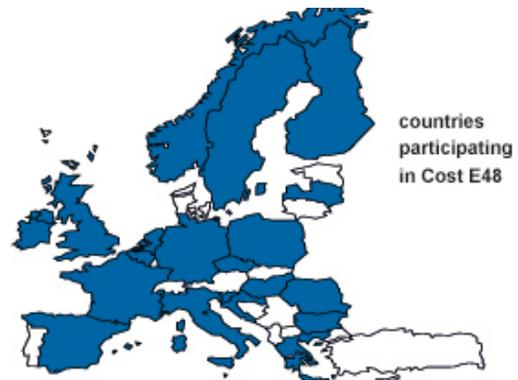


Fig. 3: The E48 member countries

6.1 Objectives and Benefits of COST E48

The main objective of the COST Action E48 "Limits of Paper Recycling" which was launched in early 2005 therefore is to collect facts, data and experiences and to develop on this basis scenarios which – in a meaningful way – help to develop a better idea how an ecologically and economically optimised utilisation of recovered paper within Europe could look like. In order to do this it is important to identify ecological and economical limits beyond which paper recycling would no longer be a reasonable option. Once these limits are identified the paper industry will be in the position to undertake targeted approaches aiming at extending these limits – or to make in-time decisions to prepare for a gradual re-substitution of recycled fibres by virgin fibres. The availability of such well and comprehensively investigated scenarios are an important prerequisite for the European paper industry to undertake means which enable it to maintain an as high as possible level of sustainability and at the same time remain competitive in world markets. Thus the way will be paved for targeted approaches in various fields, the aim of which is to safeguard the raw material base for the European paper industry for which recovered paper plays an important role and, at the same time help the industry on its way towards full sustainability,

The benefits of the results expected from this action will be:

- a sound base
 - for targeted research activities on recovered paper treatment technologies
 - providing arguments necessary for the discussion with governmental organisations and the government in order to avoid further obstacles reducing the attractiveness of recycling used paper products
- guidelines for the design of recycle-friendly paper products
- guidelines for more effective, tailor-made collection strategies for used paper products
- a background for investment decisions taking into account likely changes in raw material markets...

In order to achieve these benefits, it will be necessary to collect data and gain a better understanding of the following fields:

- mid-term development of the European paper industry's raw material markets
- expected improvements in existing process technologies as well as expected new technologies arising in:
 - machinery (particularly recycled pulp treatment techniques with improved selectivity as well as techniques by which fibre properties can be regenerated)
 - process technology (control techniques, quality management, sensors etc.)
 - process chemistry(not necessarily restricted to de-inking processes)
- mid-term development of quality standards for all major paper and cardboard grades, including upcoming new qualities
- pros and cons of established or planned collecting systems
- quality of recovered paper resources not yet exploited
- the future composition of recovered paper with respect to potentially detrimental substances
- feasible development in national and European legislation relevant to paper recycling.

6.2 Scientific Areas

The activities of E48 are focussed on 3 scientific areas (SA):

SA-1: Limits governed by the Characteristics of Recovered Paper & Cardboard

This implies the characterisation and evaluation of

- the potential quality of existing resources for recovered paper and cardboard as well as those which might additionally be exploited in the mid or long-term,
- the impact of foreseeable trends in paper converting and paper finishing on the quality (recyclability) of the product
- the various strategies for the recovery of used paper and cardboard products
- the impact of these recovery strategies on the quality of the paper recovered

SA-2: Limits governed by pulp preparation technologies

This implies the

- assessment of the state of the art and future potentials of recovered paper pulping techniques as well as those for cleaning and improving recycled pulps (this not only includes machinery but also the chemicals used for these process steps as well as process operation strategies (design of process chains including sensor technology and control systems),
- identification of changes in the composition of recovered paper in terms of non-paper components, their accumulation and the microbial activities in extremely narrowed or even closed water circuits and the potential impacts of all these effects on both processes and product quality.
- the recyclability of different raw materials

SA-3: Limits governed by market developments, legislation and sustainability aspects

This implies the identification of the mid-term development of supply and demand of recovered paper, particularly through

- monitoring world-wide, mid- and long-term investment projects for new production capacities for recycled fibre based paper and cardboard,
- identifying current and future trends in legislation with direct or indirect impacts on paper and cardboard recycling,
- predicting the consumers' attitude towards recycling based products and the future importance of environmentally sound processes and products,
- evaluating future product quality requirements to be met by major grades or at least those relevant for recycling and their implications,
- assessing the potential contribution to sustained paper recycling by the converting industries, i.e. by the recycling-oriented design of paper and cardboard products.

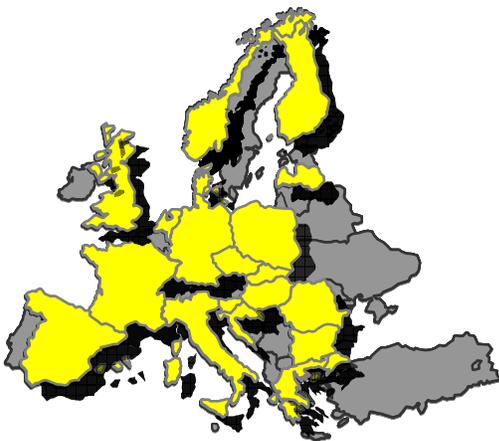


Fig 4: Countries responding to the questionnaire on collection strategies

7. Results obtained so far

Action E48 has now passed its mid-term and work is under progress in all areas. As an example of the results obtained so far, a brief description of the output of a survey based on a rather comprehensive questionnaire about paper collection strategies within Europe will be given.

This questionnaire was distributed to experts of all countries participating in E48 and a few more countries. In the meantime responds from 18 countries (s. fig. 4) covering the vast majority of the amount of paper and board recovered in Europe have been received which makes the results rather representative.

One of the main questions which arise once analysing the figures of the various European countries concern the reasons why some of them are so poor in collecting while others are poor in utilizing used p&b products. Only a few perform well under both aspects (s. fig. 5).

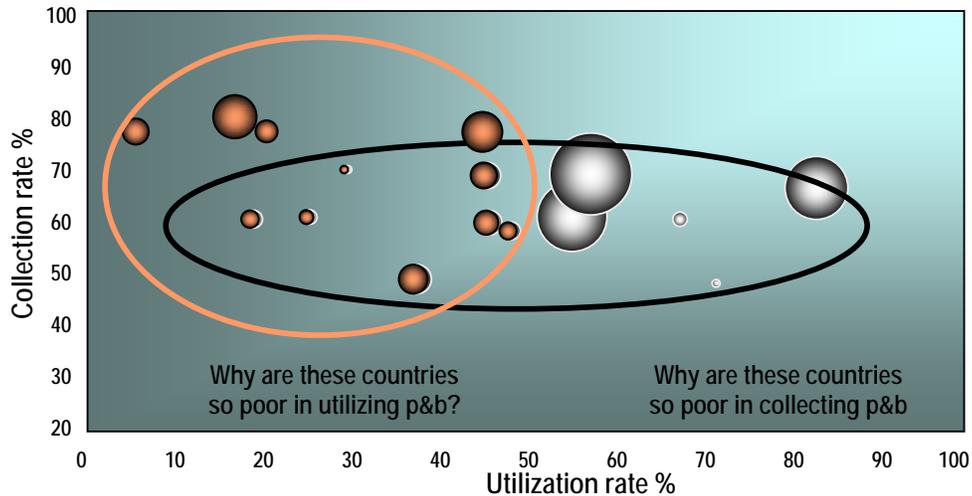


Fig. 5: Paper & Board recovery and utilization rates in Europe (2006)

From this chart it becomes obvious that the picture for both collection and utilization rates within Europe is rather scattered. There are countries in which further increases in collection rates are virtually impossible (like Germany, Finland, The Netherlands) and others with extremely low rates.

The finding on the basis of the questionnaires can be summarized as follows:

If all countries would reach the currently maximum collection rate (Germany: 74.5%), additional 18 % (8.785 Mt/y) of recovered p&b would become available in Europe.

However, there seems to be a long way to reach such a situation. With respect to potential reasons for this situation as far as poor collection rates are concerned the following influences were considered:

- the type of collecting system (and its acceptance by the consumer)
- the environmental awareness of the society
- the potential impact of strategies rewarding the consumers (the owners of the RP)

The next few figures (s. fig. 7) summarize corresponding results from the questionnaire.

From those it can be concluded that

- **neither type nor variety of collection systems have a significant influence on collection rates**
- **countries with low collection rates try to intensify p&b collection by rewarding the consumers.**
- **a high environmental awareness within a country is the most crucial prerequisite for increased p&b collection rates**

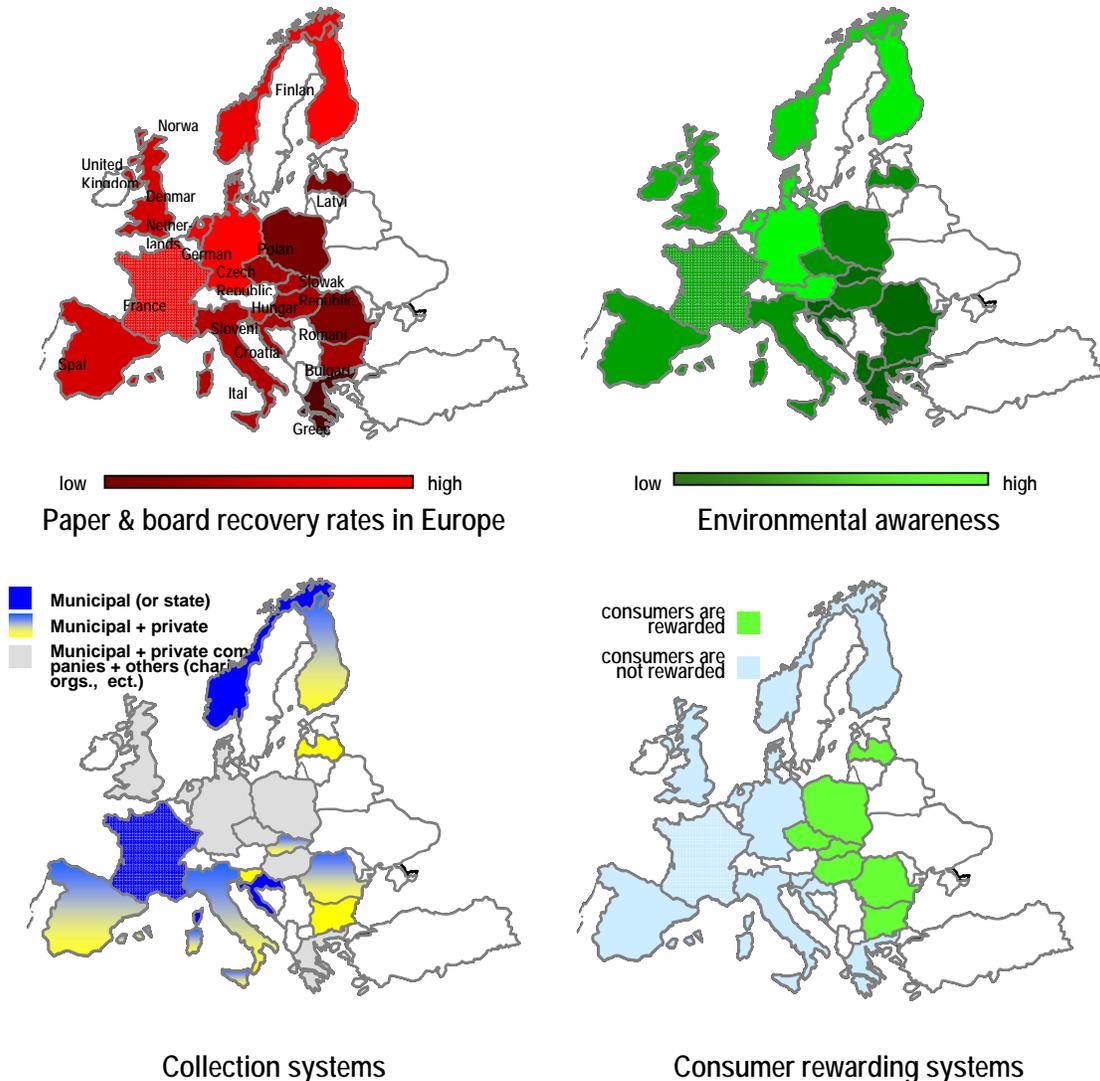


Fig. 7: Paper & board recovery rates and potential influences

8. Future activities in E48

Similar surveys like the one described above were carried out in a number of other areas, like on the competitiveness of paper recycling, the state of the art of recovered paper treatment technologies and on more reliable statistics on paper production, consumption, recovery and utilization. The major part of the work, however, still lies ahead of the almost 50 scientists from all across Europe who cooperate in E48: the development of scenarios how the future of paper and board recycling in Europe could look like in the next decade.