Eco Paper Loop

Enhancing Paper Recycling in Europe:

Optimising Paper Products, Packaging and Collection Systems

Outcome – Guidelines and Recommendations

CENTRAL EUROPE
COOPERATING FOR SUCCESS.

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

Enhancing the Quality of Paper for Recycling in Europe:

Optimising Paper Products, Packaging and Collection Systems

Outcome – Guidelines and Recommendations

This book gives you an overview about the results of the EcoPaperLoop Project

2012–2014

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EcoPaperLoop Project Partners

- Innovhub-Stazioni Sperimentali per l’industria, Paper Research Division, Italy (Lead Partner)
- Paper Technology Consulting GmbH, Germany
- Technical University of Darmstadt – Chair of Paper Technology, Germany
- Technical University of Dresden, Faculty of Mechanical Engineering, Institute of Wood and Paper Technologies, Chair of Paper Technology, Germany
- Pulp and Paper Institute Ljubljana, Slovenia
- University of Ljubljana, Slovenia
- University of West Hungary (Faculty of Wood Sciences) Paper Research Institute, Hungary
- Polish Packaging Research and Development Centre, Poland
- COMIECO, National Consortium for the Recovery and Recycling of Cellulose-based Packaging, Italy
- Lombardy Region, Italy

Supporting Organisations

- Ministry of Agriculture and the Environment, Slovenia
- Municipality of Dunaújváros, Hungary
- Milano Chamber of Commerce, Italy
- Confederation of the European Paper Industry
- Assocarta, Italy
- Intergraf
- Università di Milano Bicocca, Italy
- VDP, Germany
- Austria Papier Recycling, Austria
- INGEDE International Association of the Deinking Industry

Circular economy is a priority

The newly appointed European Commission has just announced it would withdraw the previous Commission's proposal on the circular economy including new waste legislation. As many Member States, industries and NGO's have criticized the withdrawal, European Commission reacted by announcing an even more ambitious package on the circular economy by the end of 2015. The case illustrates the circular economy is a priority for forward looking industries and the paper sector is a good example of what circular economy means in practice.

Policy choices and decisions need to be science-based to provide the right framework for a circular economy. The EcoPaperLoop project demonstrates how far the paper sector has gone down the road of circular economy, but it also identifies the potentials for even further improvement. The partners in the EcoPaperLoop advanced on tools to measure and benchmark these future potentials of closing the loop at its various stages from eco-design to end-of-life solutions. As an example, they developed a proposal to help the assessment of packaging recyclability and developed recommendations for paper collection schemes.

The paper sector will continue its efforts to unlock the potential of the circular economy by supporting projects like the EcoPaperLoop. Only with concrete demonstrations to closing the loops in the industry we provide policy makers with the evidence they will need to set a general circular economy framework supporting forward-looking industries further in these efforts.

Ulrich Leberle, CEPI

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GUIDELINE DOCUMENT:

RECYCLABILITY OF PAPER BASED PRODUCTS

DECEMBER 2014

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Guideline document: Recyclability of paper based products

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1. Introduction

Paper represents one of the best recycled material in Europe and a good example how the circular economy may work promoting proximity recycling thus creating new job opportunities at local level. Currently, the statistics[1] show that at European level 71,7% of this material goes back into new paper products. Nonetheless, the quality of this material is clearly affected by some present mega trends. The sharp decline of newspaper consumption in most of the European countries is reducing one of the best known recycled paper products; meanwhile the concomitant increase in the share of paper based packaging products poses new challenges due to the high diversification of these products. In order to retain the currently high paper recycling rate or even improve it in the future, a clearer definition of recycling oriented eco-design is necessary as well as a further development of the life cycle thinking in the whole paper value chain. The quality of the collected paper for recycling has to be considered equally important as the amount of collected paper by local decision makers. Besides, the extended producer responsibility for an effective material recycling shall become a key driver in the decision process of environmentally focused companies.

The collected paper for recycling in Central Europe (CE) accounts for approximately 16 million tonnes, representing about one third of the amount used by the European paper industry. However, the recycling rates are quite different among the CE countries. Some of them are approaching the theoretical limit in collection whereas others still show a significant potential that must be exploited. Learning lessons from best practices is a key point and communication through suitable expert based guidelines is very much relevant to spread correct information thus helping the paper value chain stakeholders to better contribute to the sustainability of the paper recycling loop.

This document gives a brief insight into paper recycling and quality requirements as well as a comprehensive collection of relevant guidelines, assessment schemes and laboratory test methods.

2. Glossary

Deinkability[2]: Removal of ink and/or toner from a printed product to a high extent by means of a deinking process. This shall restore as good as possible the optical properties of the unprinted product.

[1] CEPI – Confederation of European Paper Industries „Key Statistics European Pulp and Paper Industry 2013“
[2] European Recovered Paper Council, European Declaration on Paper Recycling 2011 - 2015

European Recovered Paper Council (ERPC): A committee of the paper value chain in Europe. Members of the ERPC are associations which are either Signatories or Supporters of the European Declaration on Paper Recycling.

Non-paper product materials: Any foreign matter in paper and board for recycling, which is a constituent part of the product and cannot be separated by dry sorting.

Paper and board for recycling[3] (often referred to as "paper for recycling"): Natural fibre based paper and board suitable for recycling and consisting of

- paper and board in any shape,
- products made predominately from paper and board, which may include other constituents that cannot be removed by dry sorting, such as coatings and laminates, spiral bindings, etc..

Paper product[2]: General term used to cover all paper- and board-based converted products.

Recyclability[2]: Design, manufacturing and converting of paper- and board-based products in such a way as to enable a high quality recycling of fibres and minerals in a manufacturing process in compliance – where appropriate – with current standards in the Community: as a minimum, recyclability requires that sufficient information is exchanged for appropriate risk management and safe re-use of fibres.

3. Quality of paper for recycling

Principally, paper for recycling can be divided in three groups. The two main ones are graphic and packaging grades, often referred to as white and brown grades. White grades are used predominantly for the production of graphic papers, some for hygiene papers and white top plies of packaging paper and board. The brown grades find their utilisation in the production of packaging paper and board. Also the mixed grades which mostly are used for corrugated papers or inner plies of boxboard belong to this group. The third group are special grades which usually require special treatment processes. These special grades are defined in group 5 of EN 643.

Quality of paper for recycling has several aspects. One is the composition and the content of unwanted substances expressed as unwanted papers, non-paper components and prohibited materials. This is mainly a function of the collection system and the subsequent handling of paper for recycling. The European standard EN 643 provides a detailed description and definition of the individual grades and their contents. Physical and optical properties of the paper for recycling and

[3] EN 643 – Paper and board – European list of standard grades of paper and board for recycling, January 2014

the level which can be achieved after treatment are a function of the composition and the recyclability. The form of delivery – loose or baled, original shape or shredded – is mainly relevant for handling but can also be a safety issue. Unnecessary shredding should be avoided since it creates dust and reduces fibre length and strength as well as deinking performance[4]. Moisture is mainly a commercial aspect but can become a quality issue if the paper for recycling is extremely wet. Last but not least the recyclability of individual products in paper for recycling is of particular importance.

The implementation of recyclability criteria in ecolabels, especially the latest EU-Ecolabel for printing products, demonstrates the importance of paper products to become a secondary raw material for papermaking.

4. The paper recycling processes

Depending on the kind of paper and board manufactured from paper for recycling, the processes are different. Common and basic process steps are slushing in a pulper and mechanical separation of impurities by screening through baskets or plates with holes or slots and by centrifugal forces in cleaners.

Brown processes often operate deflakers to separate fibre bundles ("flakes") into individual fibres and refiners to develop mechanical properties. These processes may be combined with a fractionation in order to treat only the long fibre fraction of the pulp. A slight dewatering is usually installed to provide the proper consistency for subsequent treatment, save volume for pulp storage and to separate the water circuits of stock preparation and paper or board machine. Some optional treatment like dispersing or kneading even require high consistency thickening of at least that portion of the pulp which is treated this way.

[4] Faul, A., Geistbeck, M., Klar, A.-K., Deinking Grades of Paper for Recycling – What determines the quality?, CTP-PTS Deinking Symposium, May 2014

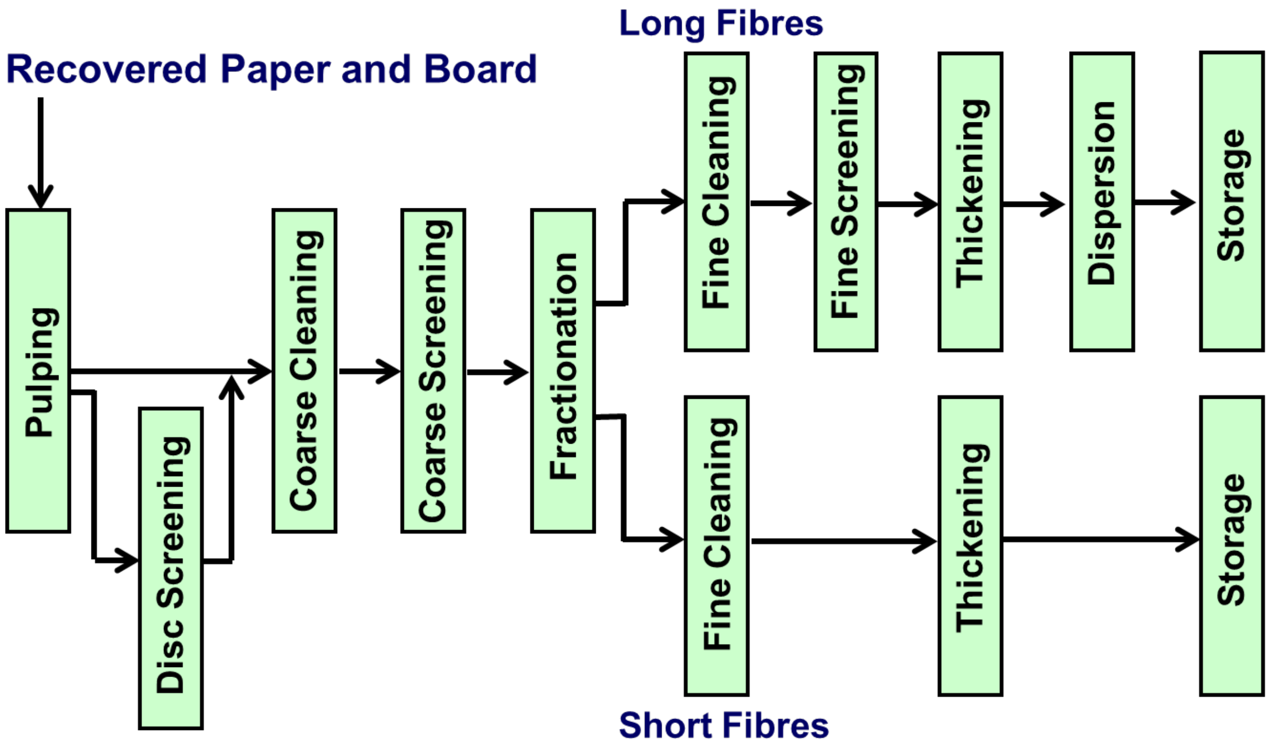

Figure 1: Typical layout for a recycling process to treat mixed and packaging paper for recycling[5]

White processes are typically equipped with a deinking step which is required to remove printing inks and to achieve a bright final pulp. Deinking consists of two stages:

- detachment of inks from the fibres in the pulper, usually with the help of chemical additives (sodium hydroxide, sodium silicate, hydrogen peroxide, soap) and
- separation of the detached ink particles by deinking (in flotation cells or in certain cases in washers).

By far the predominant ink separation process is flotation, mainly due to a significantly higher yield of the process. In the flotation deinking cells the pulp is mixed with air in form of small bubbles which "catch" the ink particles and transport them to the surface where they are skimmed or sucked off. A prerequisite for this flotation process is a hydrophobic character of the ink particles and a certain range of the ink particle size. In European deinking plants, the operation of a disperser for the entire pulp is state-of-the-art, also an internal treatment of the process water. A post-flotation has become common. Deinking plants have at least one high-consistency

[5] Putz, H.-J., Runte, S., Packaging Paper and Board: Raw Materials, Production, Converting and Recyclability, EcoPaperLoop seminar Warsaw, October 2013

thickening in order to separate the water systems of deinking plant and paper machine, which have different pH levels. For higher qualities, one or two bleaching stages are installed.

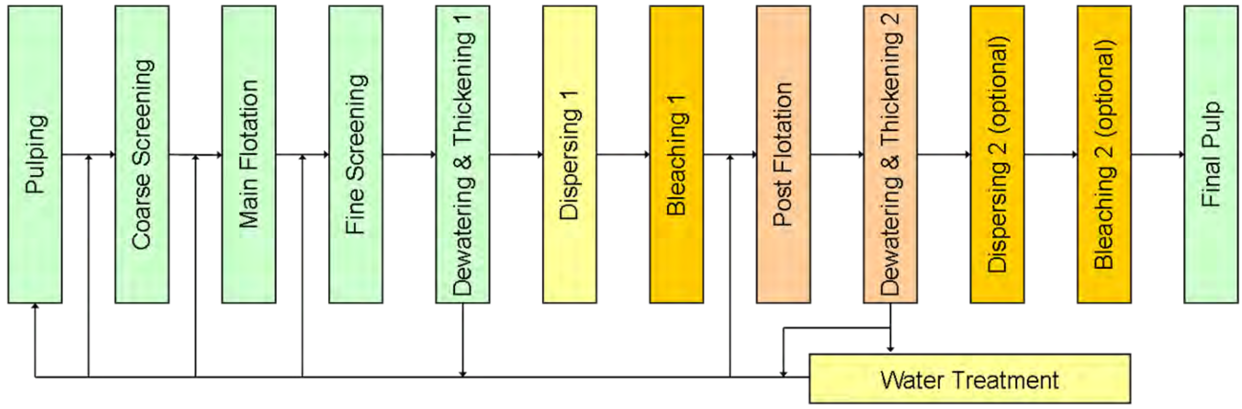

Figure 2: Typical layout for a deinking process (Green: Essential process steps in flotation deinking plants; Green and yellow: 1-loop deinking plant; Green, yellow and brown: Common 2-loop process design for standard grades; Orange: Additional options for higher qualities)[6]

There are some recycling plants utilising specific processes in order to treat special types of paper products which are regarded as detrimental to standard processes or to achieve a special quality of final product. Products which are known as detrimental to standard processes but utilised as raw material for the paper industry are defined as special grades of paper for recycling in group 5 of EN 643.

5. Aspects of recyclability

Recyclability in the context of this guideline document refers to features of individual paper products and should not be confused with the quality of a delivery of paper for recycling (as described in chapter 3).

A good recyclability enables paper and board mills to restore as good as possible the properties of the original paper and board before printing and converting by means of a reasonable process design. “Reasonable” refers to equipment, energy and additives needed as well as to the yield which can be achieved. In addition, the intended use of the recycled products should not be restricted for health & safety reasons.

[6] Faul, A., Oberndorfer, J., The challenge to deink inkjet prints together with recovered paper from households, 9th Research Forum on Recycling, Norfolk, VA (USA), October 2010

The scope of EcoPaperLoop deals with the first aspect, the restoration of the original properties. For all recycled pulps it means that the content of adhesive material ("stickies") should be low. Packaging paper mills are facing issues with high content of non-paper material and insufficient repulpability due to wet-strength additives and laminations. In graphic paper mills the main focus is on the removal of printing inks and varnishes.

6. What the producer can do

This chapter refers to several documents for guidance, assessment, and test procedures. All these documents are attached in full length to this guideline as annex.

6.1 Packaging products

It is obvious that the priority in producing packaging is on the functionality of the product. This objective is not always in line with requirements of a good recyclability. In cases of insufficient recyclability it should be checked whether and how the design can be amended to improve recyclability without affecting functionality. Also an "overdesign" of packaging should be avoided if it has a negative influence on recyclability.

Some paper companies operate plants which are designed to treat paper products which are regarded detrimental to recycling in standard processes. These processes can have a higher tolerance to coarse rejects and to flakes. Or they even utilise the non-paper product materials as valuable by-products.

Stickies, however, are unwanted in every paper recycling process because they can cause problems and downtime of the paper machine as well as quality defects in the manufactured product.

For some applications, a uniform optical appearance is desired. Therefore, this parameter should be considered in an assessment as well.

Chemical ingredients can also play an important role in the usability of the recycled product. A general requirement is to consider alternatives to the use of substances which can act detrimental in downstream recycling processes.

Within the framework of the EcoPaperLoop project, these statements have to remain at a general level. It is recommended that the packaging paper value chain intensifies its dialogue and extends it to recyclability issues in order to develop common guidelines which result to an enhanced recyclability of paper based packaging. The EcoPaperLoop project group drafted a scorecard assessing the parameters coarse rejects, flakes, macrostickies and optical homogeneity. This draft scorecard was discussed within the value chain and handed over to the European Recovered Paper Council, who will further develop it and possibly adopt a first version in spring 2015.

6.2 Graphic products

The graphic paper value chain started the discussion of recyclability issues in round tables in about 1996. These activities are ongoing in Germany at the Technical Committee Deinking and in Europe at the European Recovered Paper Council. Visible results of this cooperation are the "Guide to an Optimum Recyclability of Printed Graphic Paper" and the scorecards "Assessment of Printed Product Recyclability – Deinkability Score –"[7] and "Assessment of Printed Product Recyclability – Scorecard for the Removability of Adhesive Applications", both published by the ERPC.

The "Guide" describes the graphic recycling process in a more detailed form than this document and points out the obstacles to the process, thus guiding a producer to the materials and procedures which should be avoided. The two scorecards enable everybody in the value chain to assess the deinkability and the removability of adhesive applications of individual graphic paper products. They are based on laboratory tests simulating basic deinking and screening processes.

Producers of print products who apply for an ecolabel on printed products have to prove deinkability and removability of adhesive applications. All relevant ecolabels – the EU Ecolabel (2012/481/EU), the Nordic Swan (Nordic Ecolabelling of printing companies, printed matter, envelopes and other converted paper products), the Austrian Ecolabel (UZ 24 "Druckerzeugnisse") and the German Blue Angel (RAL-UZ 195 "Druckerzeugnisse") – contain criteria on these two characteristics.

7. Test methods on recyclability

The scorecards require test methods on which they are based. For the time being, there are three main methods delivering the results which can be assessed by means of the scorecards. EcoPaperLoop Method 1 is for the assessment of paper based packaging products, the INGEDE Methods 11 and 12 are for graphic products. These main methods need several auxiliary methods for some details of the laboratory procedures.

[7] The Deinking Scorecard was under revision in 2014 and was adopted in October 2014. The published version will describe good deinkable products in an annex which is in the process of being finalised. The layout work and the official publication of the revised scorecard are planned in March 2015. The enclosed "draft" version of the Deinking Scorecard dated on 02 Oct 2014 is – in its contents – identical to the adopted version.

7.1 Main methods

7.1.1 EcoPaperLoop Method 1

For packaging products, the main method is EcoPaperLoop Method 1 "Recyclability Test for Packaging Products". It requires a large sample size (480 g oven dried packaging product). This ensures that usually an entire product (independent of size) can be tested. The first step after disintegration is coarse screening (10 mm holes). The reject (non-paper product materials and not disintegrated materials) is weighed. The accept undergoes determinations of flake and macrosticky content, the latter according to INGEDE Method 4. The accept of the macrosticky analysis is similar to an industrial final pulp. It is used to form handsheets to assess the optical homogeneity.

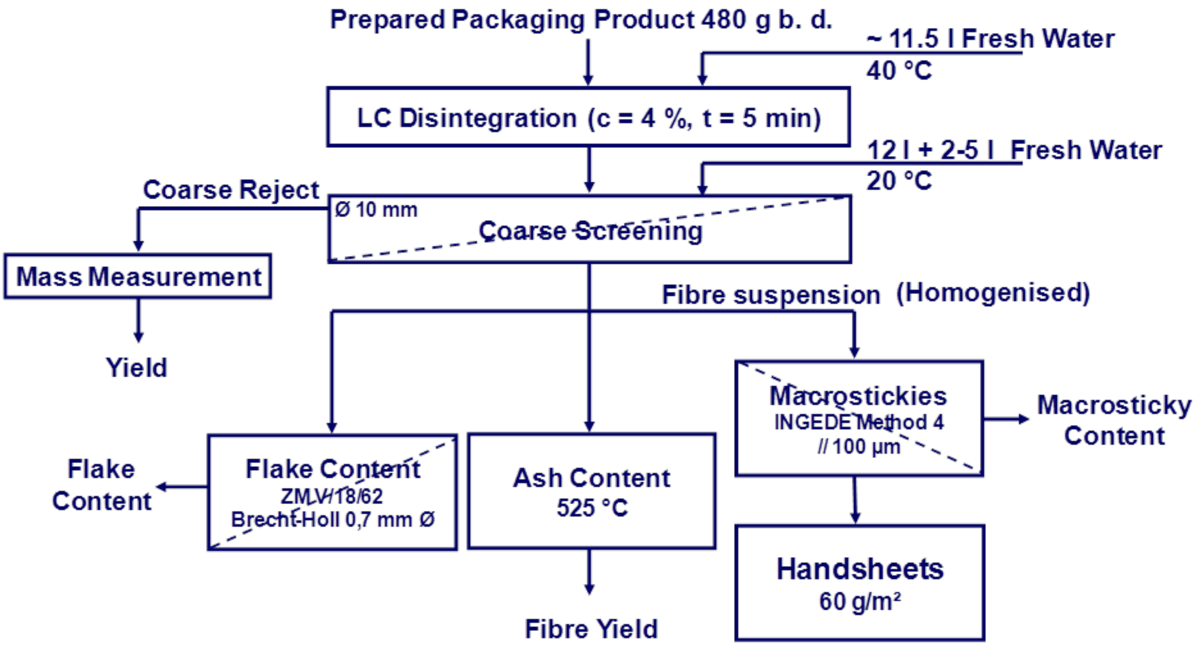

Figure 3: Procedure of the recyclability test for packaging products (EcoPaperLoop Method 1)

7.1.2 INGEDE Method 11

Flotation is the most widely used technology for ink removal in the paper recycling process. This INGEDE Method in a laboratory scale defines the essential steps of the flotation deinking process: pulping and flotation. In order to simulate the average age of paper recovered from households, an accelerated ageing step is part of the procedure. Special care was taken to define a procedure without the need to test unprinted paper. The whole laboratory procedure is shown in Figure 4.

The deinkability is assessed by three quality parameters of the deinked pulp and two process parameters.

Quality parameters	Process parameters
Luminosity	Ink Elimination
Colour shade	Filtrate darkening
Dirt specks (in two different size categories)	

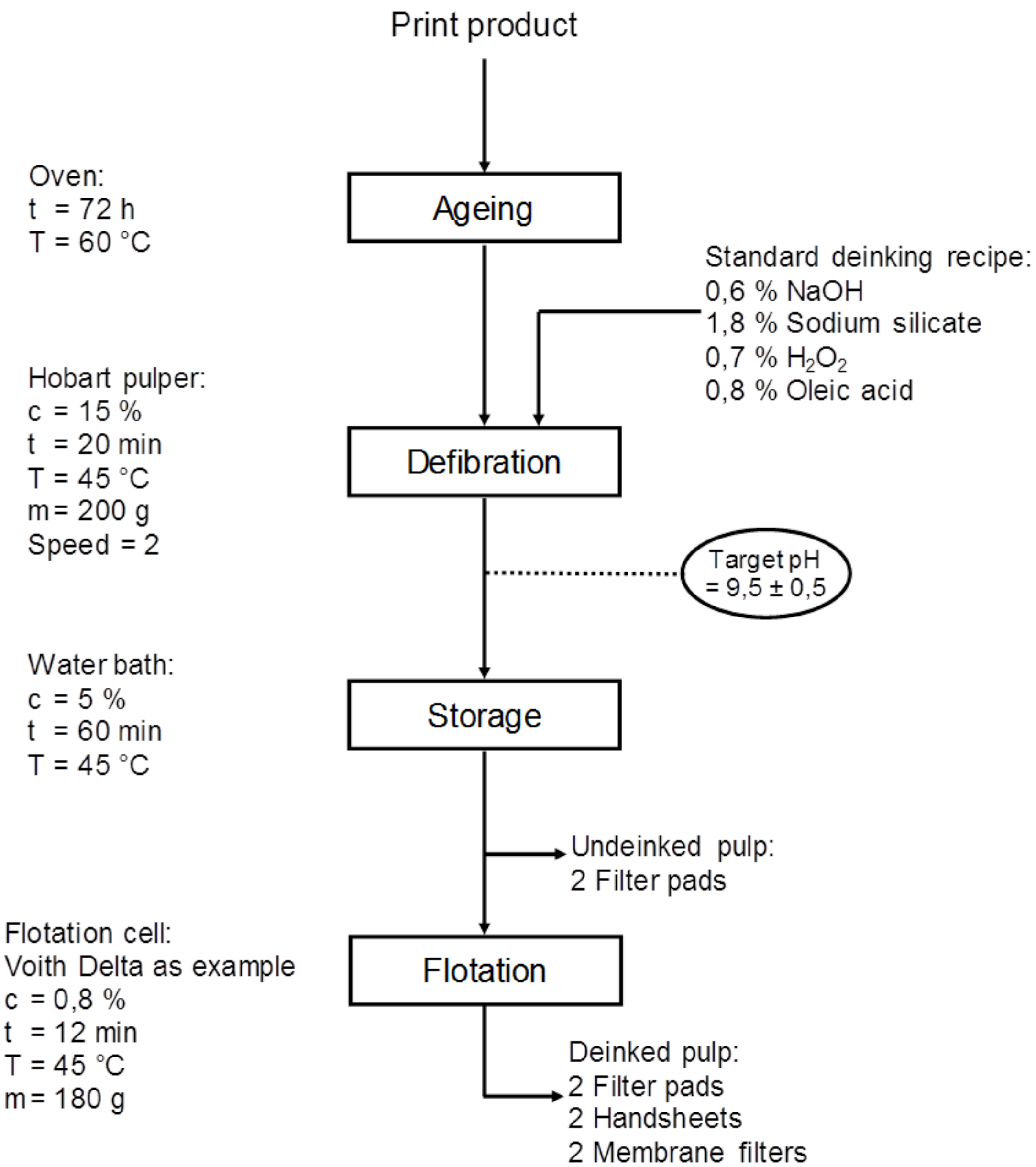

Figure 4: Procedure for testing deinkability with standard deinking recipe

7.1.3 INGEDE Method 12

This method is determined to simulate the screening ability of adhesive applications in a deinking process. The two essential process steps are pulping and screening.

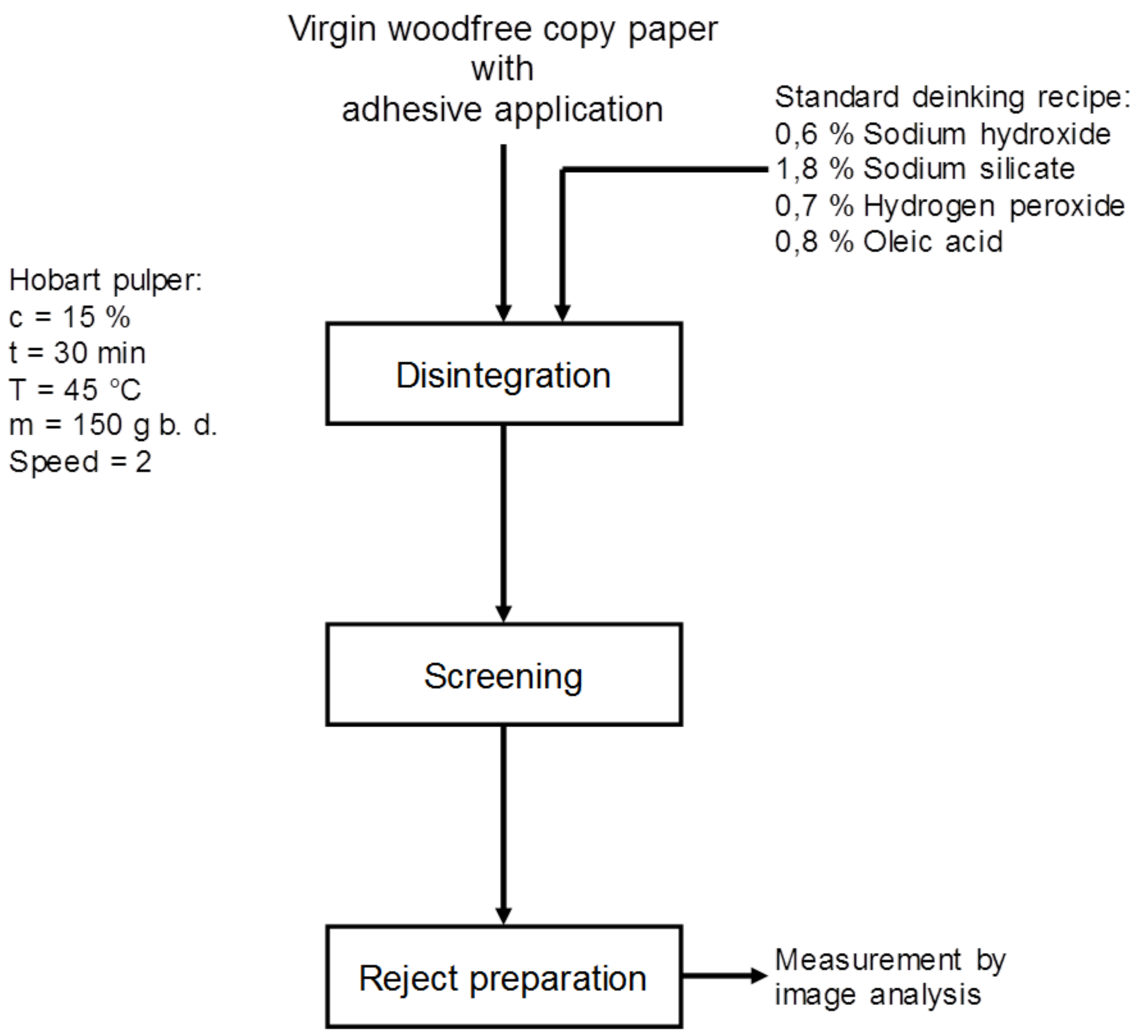

Figure 5: Testing fragmentation behaviour of adhesive applications

The separation of adhesive applications from the pulp is done by screening according to INGEDE Method 4.

The particle size distribution of the macrostickies is measured, thus allowing the assessment of the screening ability of the adhesive applications in an industrial process.

The setting of the screening ability limit of < 2 000 µm equivalent circle diameter was proven in semi-industrial pilot plant trials and confirmed by test results from industrial processes.

7.2 Auxiliary methods

7.2.1 INGEDE METHOD 1

For testing purposes, filter pads are prepared from industrial or laboratory pulp samples using a Büchner funnel and defined filter paper. Handsheets are prepared with the Rapid-Köthen method from industrial pulps under defined conditions. The filtrate samples are drained over a membrane filter and compared with a reference membrane filter made with tap water.

Optical measurements are conducted according to INGEDE Method 2.

7.2.2 INGEDE METHOD 2

Industrial or laboratory samples of pulp and filtrates in deinking processes are transformed to filter pads and handsheets by means of INGEDE Method 1. INGEDE Method 2 describes and defines the parameters and the settings of the measurement devices to obtain results for optical characterisation of the samples. The calculation of the ink elimination is also part of this method and allows an assessment of the deinking process.

7.2.3 INGEDE METHOD 4

The method describes a laboratory screening procedure for pulps of a paper recycling process. The reject of this screening procedure is prepared in such a way that macrostickies can be determined by means of an image analysis system.

8. Annex (with relevant documents):

EcoPaperLoop Method 1 (2014)

Guide to an Optimum Recyclability of Printed Graphic Paper (2008)

Deinking Scorecard (2014)

Removability Scorecard (May 2011)

INGEDE Method 11 (2012)

INGEDE Method 12 (2013)

INGEDE Method 1 (2014)

INGEDE Method 2 (2014)

INGEDE Method 4 (2013)

Recyclability Test for Packaging Products	**Leaflet**
	Issue: Nov. 2014

1 Introduction

In order to minimise the problems occurring during recovered paper processing, it is essential that packaging products are manufactured considering a good recyclability. In favour of this, the packaging products have to be manufactured for the most part from fibres and must be easy to disintegrate. This increases fibre yield and reduces energy demand as well as the amount of rejects to be disposed. Alike, adhesive applications used for packaging products have to be shear resistant to withstand shear forces during stock preparation processes, and to fragment mostly into particles of adequate size which can be removed during the process.

The following laboratory method defines a procedure to assess the processing of packaging material. For this purpose the content of non-paper product materials, the content of difficult to disintegrate material, the flake content, the macrosticky potential and also the ash content and fibre yield after a disintegration step are investigated. The determined data can be used to assess the packaging product's recyclability. Currently, such a general assessment scheme is not available.

2 Purpose and Application

The purpose of the method is to simulate the behaviour of packaging material during stock preparation in a paper mill. During the investigation, the packaging material is probed considering the content of non-paper product materials, content of difficult to disintegrate material, flake content, macrosticky potential, ash content and fibre yield.

The content of non-paper product materials as well as the content of difficult to disintegrate material and the flake content allow the evaluation of the disintegration behaviour of the packaging material. The non-paper product materials and the content of difficult to disintegrate material form coarse impurities which can stress the coarse screening process in a paper mill. The flake content detects impurities like small plastic parts and primarily fibre bundles which have to be removed during the fine screening steps of a paper mill. The flake content therefore gives information about the load of the industrial fine screening process.

The macrosticky potential is analysed by measuring the macrosticky area. The macrosticky area reflects the load of adhesive impurities within the industrial stock preparation.

The fibre yield is calculated with the yield and the ash content after coarse screening. It allows evaluation of the fibre content of the packaging material.

Handsheets are made from the accept of the macrosticky analysis. They give information about the optical properties of the stock.

3 Definitions

Non-paper product materials
Packaging materials are designed for different functions. For this reason, they are manufactured using a combination of paper and different other materials like plastics or metals. These non-paper product materials can disturb, hamper or avoid the material's recyclability.

Content of difficult to disintegrate material
As several packaging products show a certain water resistance and are more robust during disintegration in water, it is not possible to suspend certain fibre materials into single fibres, instead, fibre bundles remain. Such water resistant packaging materials disturb or hamper the preparation process and the material's recyclability.

Disintegration behaviour
The disintegration behaviour describes how the packaging material can be suspended into single fibres. The disintegration behaviour is analysed by considering the content of non-paper product materials, the content of difficult to disintegrate materials and the flake content.

Flake content
The flake content describes impurities like small plastic parts and primarily fibre bundles.

Yield
The yield describes the amount of usable solid stock material which passes the coarse screening step. By using the ash content a fibre yield could be calculated.

Ash Content
The ash content describes the inorganic content after incineration (525 °C) of the solid stock material which passes the coarse screening step.

Fibre Yield
The fibre yield describes the fibre content of the solid stock material which passes the coarse screening step. It is calculated by using the yield and the ash content.

Macrosticky potential
The macrosticky potential describes the macrosticky area after disintegration of the packaging material.

Handsheets
Handsheets from the accept of the macrosticky evaluation are prepared for visual inspection of the optical properties of the pulp.

4 Principle

This leaflet describes the preparation and investigation with its main steps of sample preparation, disintegration, coarse screening, ash content evaluation, flake content evaluation, macrosticky potential evaluation, yield and fibre yield calculation. For this purpose, a defined amount of the packaging material has to be prepared and then disintegrated at low consistency. The generated suspension has to be screened using a hole screen. The reject on the screen has to be evaluated gravimetrically and the yield has to be calculated. The screening accept has to be homogenised and analysed for flake content using Zellcheming Leaflet ZM V/18/62 [1] or alternatively by an adapted method suitable for the Haindl Classifier. For the macrosticky area the determination follows a macrosticky method based on INGEDE Method 4 [2]. From the accept of the macrosticky screening step handsheets have to be prepared according to ISO 5269-2 [3]. Furthermore from the accept of the coarse screening step the ash content has to be measured according to ISO 1762:2001 [4] and the fibre yield has to be calculated.

The flow chart of the procedure is given by **Figure 1**.

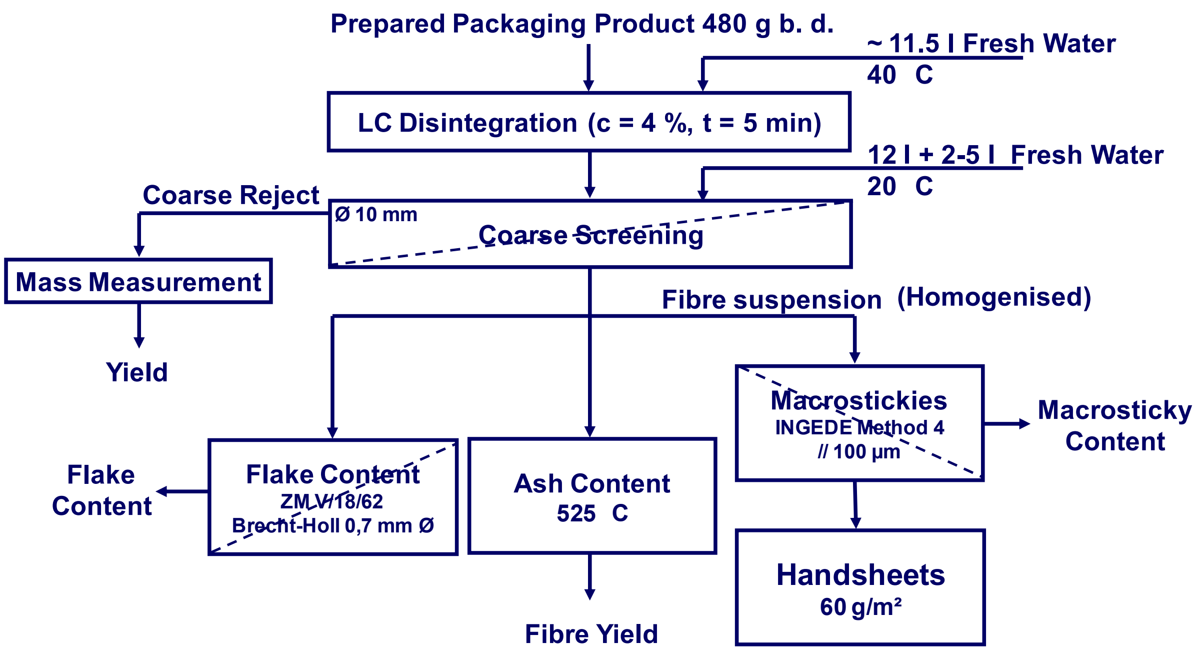

Figure 1: Flow chart of the procedure for the assessment of packaging material recyclability

5 Equipment and Tools

5.1 Disintegration equipment

The disintegration shall be carried out using a low consistency laboratory pulper that can handle a suspension volume of 12 l with a stock consistency of 4 %.

5.2 Coarse screening equipment

The coarse screening is performed utilising a screening device with a 10 mm hole screening plate at the bottom and a volume of 12 l in minimum has to be used. The accept stream of the screen has to be interruptible by an outlet valve. The screening holes have to be kept free during the screening process by using a stirrer. The stirrer blade has to be positioned 10–20 mm above the screen plate and has to run at 200 rpm. As the stirrer has to overcome high resistance forces if excessive coarse rejects are accumulated, the motor has to transmit high moment of torque to the stirrer. For this application the driving motor of a pillar drilling machine is suitable.

5.3 Screening equipment for flake content test

The flake content shall be measured with a Brecht-Holl screening device. The device is described in [5]. Alternatively, a Haindl Classifier can be used.

5.4 Ash determination

The ash content is determined according to ISO 1762:2001(E). - Paper, board and pulps – Determination of residue (ash) on ignition at 525 °C [4].

5.5 Screening equipment for macrosticky test

The macrosticky test must be performed using the screening equipment as described in INGEDE Method 4 [2]. A screening plate with 100 µm slot width is necessary. Using of a Haindl screening device according to ZELLCHEMING Leaflet V/1.4/86 [6] is recommended.

5.6. Equipment for handsheet preparation

Laboratory handsheets are prepared according to ISO 5269-2 [3] using a standard sheet former (model: Rapid-Köthen) with dryer (vacuum 95 kPa, 94 ºC).

5.7 Other Tools

- Distributor for suspension homogenisation
- Garden pump sprayer with atomised spray function
- Analytical balance
- Drying cabinet
- Büchner funnel 150 mm diameter
- Filter paper 150 mm diameter (e. g. Munktell Grade 12/N)
- Filter paper 240 mm diameter (medium to large pores, medium filtration speed, machine finished, good wet strength, white (e. g. Macherey-Nagel MN 617≡Nr.4))
- One sided, silicone-coated release paper (60 g/m²)
- Black water-based ink, e. g. Pelikan No. 4001
- Specially fused alumina powder: white, sharp-edged particles, grain size 220 according to FEPA Method.

6 Sampling and Sample Preparation

6.1 Determination of the adherend proportion

Before disintegration in the laboratory pulper, the dry content of the packaging sample has to be determined as well as the proportion of the adherend. To determine the mass ratio of the adherend, the mass of the air-dry packaging sample has to be measured. Afterwards the entire adherend is cut out tight with all adhesive material and weighed. The ratio between the mass of adherend (plus adhesive) and the mass of the total sample is defined as adherend ratio.

$$X_{Adherend}\ [\%] = \frac{m_{Adherend}\ [g]}{m_{Packaging\ Sample}\ [g]} * 100\ \%$$

$X_{Adherend}$:	Adherend ratio in %
$m_{Adherend}$:	Adherend mass (adhesive and glued packaging paper) in g
$m_{Packaging\ Sample}$:	Total packaging sample mass in g

6.2 Sample preparation

480 g oven-dry material is needed for one investigation. By using the dry content of the samples, the respective amount of packaging products is determined. If a packaging product has to be divided to reach sufficient amount of material, the correct ratio between adherend and non-adherend material has to be maintained. Therefore, parts of the adherend and non-adherend material should be added following the adherend ratio.

Afterwards the complete sample material has to be cut to palm size.

7 Procedure

7.1 Disintegration of the sample material

The palm size cut material has to be filled into the pulper completely adding water of 40 °C temperature. The amount of water has to be calculated in order to reach a disintegration stock consistency of 4 %. The disintegration time is 5 min. After disintegration, the complete sample is removed from the pulper. The sample with a volume of approx. 12 l will be processed further using the coarse screening device.

7.2 Coarse screening

The coarse screening is used to separate large and difficult to disintegrate paper parts as well as large non-paper product materials. The objective is to achieve a nearly fibre free reject. The device consists of a 10 mm hole screen and is defined in Chapter 5.2.

Before starting the process, a container with a capacity of 30 l in minimum is placed below the screening device to collect the screening accept. The outlet valve below the screen is closed. The stirrer is agitated with 200 rpm and has to be operated during the complete screening process. The suspension with the volume of 12 l is filled in the screening device completely and agitated for 3 more seconds. Then the outlet is opened to start the screening process.

When the suspension is drained completely, the outlet valve is closed, then 12 l tap water are filled into the device. After agitating for 3 more seconds the outlet is opened and the device is drained again.

Then, free fibres still attached to the screening plate or the surface of the device, are drained through the screen using 2–5 l tap water, sprayed using the garden pump sprayer. The water-jet is arranged like spray. The objective is a nearly fibre free reject. Otherwise excessive spraying might dilute the suspension after the coarse screening too much; a very low stock consistency might be problematic for the following tests. Here a good compromise must be found. Therefore it is recommended to use 2–5 l tap water for this step. In exceptional cases up to 10 l tap water can be used for the benefit of a fibre free coarse screening reject.

Then the stirrer is stopped, and the reject on the screening plate is transferred to a weighted and heat resistant case in order to dry the reject until constant weight. The temperature during the drying should be 105 °C. Afterwards the reject mass is determined gravimetrically.

7.3 Yield calculation

The yield can be calculated using the coarse reject as following:

$$Yield\ [\%] = \frac{Packaging\ Product\ used\ [g\ oven-dry] -\ Coarse\ Reject\ [g\ oven-dry]}{Packaging\ Product\ used\ [g\ oven-dry]} * 100\ \%$$

7.4 Homogenisation of screening accept

The accept of the coarse screening must be mixed gently by hand to guarantee a well mixed suspension in order to ensure a homogenous sampling for flake content evaluation, macrosticky determination and ash content measurement. A minimum of 70 g oven-dry pulp sample should be filled directly into a distributor to have a sufficient amount of material for all trials. The pulp is then diluted to a stock consistency of approximately 1 %. After gentle mixing of two minutes minimum, samples for the respective trials can be taken. The distributor stirs until all samples are taken.

7.5 Determination of flake content

The homogenised accept of the coarse screening has to be tested for flake content acc. to ZELLCHEMING Leaflet V/18/62 [1]. In contrast to this method, non-paper product materials like small plastic parts are not removed from the reject on the screen plate but examined as part of the flake content. As screening plate a metal plate with a hole diameter of 0,7 mm has to be used, complying with the requirements of the method. 5 samples with 2 g oven-dry sample material each have to be classified for 5 min using 100 double strokes per minute.

Alternatively to the Brecht-Holl screening device a Haindl Classifier could be used. If a Haindl Classifier is used, a water volume flow of 3,33 l/min or 0,2 m³/h has to be applied.

In the case of a high filter mass and low flake content, negative results for the flake content can occur due to scales accuracy. In such cases, the use of filters with lower mass (e. g. with smaller filter diameter) is recommended.

7.6 Ash content determination

From the homogenised accept of the coarse screening, filters for stock consistency measurement should be prepared and incinerated (525 °C) for ash content determination, following the conditions of ISO 1762:2001(E) [4].

7.7 Fibre Yield calculation

By a combination of yield and ash content the fibre yield could be calculated as following:

$$Fibre\ Yield\ [\%] = \frac{(100\ \% - \ Ash\ Content\ [\%]) \cdot Yield\ [\%]}{100\ \%}$$

7.8 Determination of macrosticky area

The homogenised accept of the coarse screening has to be tested for macrosticky area according to INGEDE Method 4 and to be determined as macrosticky area per kg of packaging material [2]. Therefore, four suspension samples of 10 g oven-dry material are screened over a 100 µm slotted plate.

The screening period per sample is 5 min. The screening is performed in a Haindl device with 480 double strokes per minute. Prior to screening, the suspension samples have to be diluted to a stock consistency of max. 1 %. The complete sample is filled into the Haindl device continuously within the first 5 seconds of the screening.

The reject on the screening plate is then transferred to a paper filter following INGEDE Method 4, stained and visualised. If an overlapping of the residue occurs on the filter, the test has to be repeated, and the residue has to be divided and transferred to several filters. Alternatively the suspension mass can be reduced. In that case more than four samples have to be prepared to maintain sufficient sampling mass. After that the filters have to be finished and evaluated using image analysis, as described in INGEDE Method 4. Also a microscopic inspection of the samples prior to the measurement is necessary. White particles or plastics which are definitively no stickies must be detected and removed or painted over in black so they are not visible any more for the macrosticky image analysis system.

The accept of the macrosticky screening step is used to prepare handsheets.

7.9 Handsheet preparation

An appropriate volume of material for a preparation of handsheets with 60 g/m² should be taken from the accept of the macrosticky screening. As the screening is done with 10 l/min water flow and using 10 g oven-dry pulp, it can be enough to collect the first 15 l accept for the consistency measurement and the two handsheets. After standard laboratory handsheet formation according to ISO 5269-2 [3], drying takes place in the Rapid-Köthen dryer between carrier board and a cover sheet. The drying time should be 7 minutes. In total, a minimum of two handsheets has to be produced.

Afterwards the handsheets are inspected visually for optical inhomogeneities. The observations should be noted.

8 Report

The results for the reject of the coarse screening step, the calculated yield, the flake content, the macrosticky area, the sticky area size distribution, the ash content and the fibre yield as well as the handsheet observations are summarised in a report. The report must consist of the single results as well as the arithmetical means. All results have to be scaled per kg packaging material. Additionally, the mass of the packaging material, the adherend ratio report and the observations of the handsheets have to be mentioned in the report. Photographs from the used packaging material and the coarse screening reject should be made with a scale for documentation always. If deviations from the above mentioned procedure are conducted, reasons and type have to be noted.

9 References

1. Prüfmethode: ZELLCHEMING Merkblatt V/18/62. (Fachausschuss für Physikalische Halbstoff- und Papierprüfung). Prüfung von Holzstoffen für Papier, Karton und Pappe: Gravimetrische Bestimmung des Stippengehaltes von Stoffsuspensionen.
2. Prüfmethode: INGEDE Method 4. (INGEDE e.V.). Analysis of Macro Stickies in Deinked Pulp (DIP).
3. Norm: ISO 5269/2: Pulp - Preparation of laboratory sheets for physical testing, Part 2: Rapid-Köthen Method.
4. Norm: ISO 1762:2001(E): Paper, board and pulps – Determination of residue (ash) on ignition at 525 °C.
5. Brecht, W.; Holl, M.: Stippengehaltsbestimmung und Faserfraktionierung in einem Gerät. In: Das Papier, 2(1948) Nr. 5-6, S. 85-91
6. Prüfmethode: ZELLCHEMING Merkblatt V/1.4/86. (Fachausschuss für Physikalische Halbstoff- und Papierprüfung). Prüfung von Holzstoffen für Papier, Karton und Pappe: Gleichzeitige Bestimmung des Gehaltes an Splittern und Faserfraktionen.

10. Source of Supply

Pulper, coarse screening device and alumina powder:
Chair of Paper technology and Mechanical Process Engineering (PMV)
Technische Universität Darmstadt
Alexanderstr. 8
64283 Darmstadt
Germany
pmv@papier.tu-darmstadt.de

11. Annexe

Annex 1: Description of the equipment used in this method
Annex 2: Remark to labels with integrated electronic

Annex 1: Recyclability Test for Packaging Products	Leaflet
	Issue: Nov. 2014

1 Introduction

Subsequently, the equipments to perform the experiments are described in detail, which are used to assess the recyclability of packaging products within the method.

2 Disintegration equipment

As disintegration equipment a low-consistency pulper (LC pulper) has to be used, that can handle a suspension volume of 12 l in minimum with a stock consistency of 4 %. Suitable for this purpose is the disintegration equipment shown in **Figure 1**, which originally belonged to the Escher-Wyss laboratory refiner. The sideways arranged rotor is driven by a 1.5 kW motor with 3,000 min^{-1}. **Figure 2** and **Figure 3** show the pulper and the rotor as dimensioned drawings. Other disintegration equipment must enable comparable fibre separation behaviour.

Figure 1: Picture of LC pulper

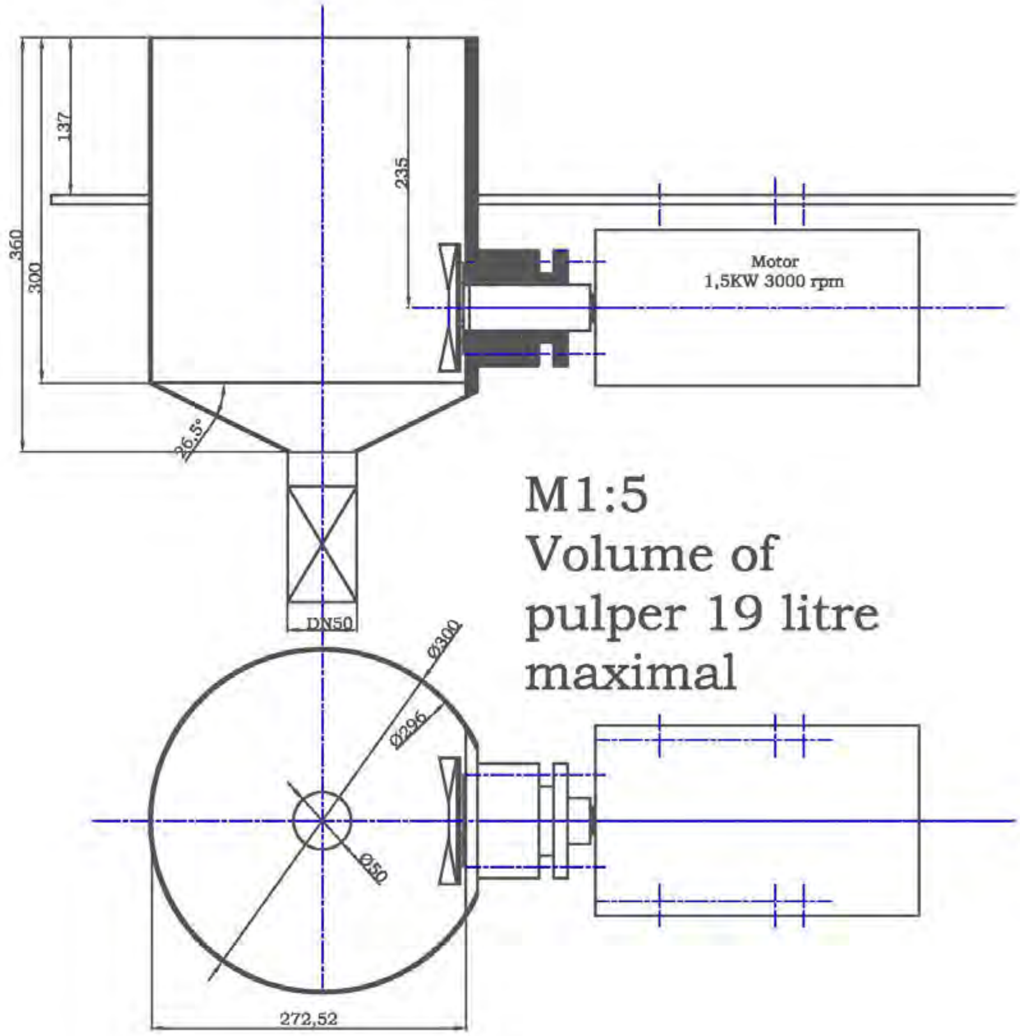

Figure 2: Dimensioned drawing of LC pulper

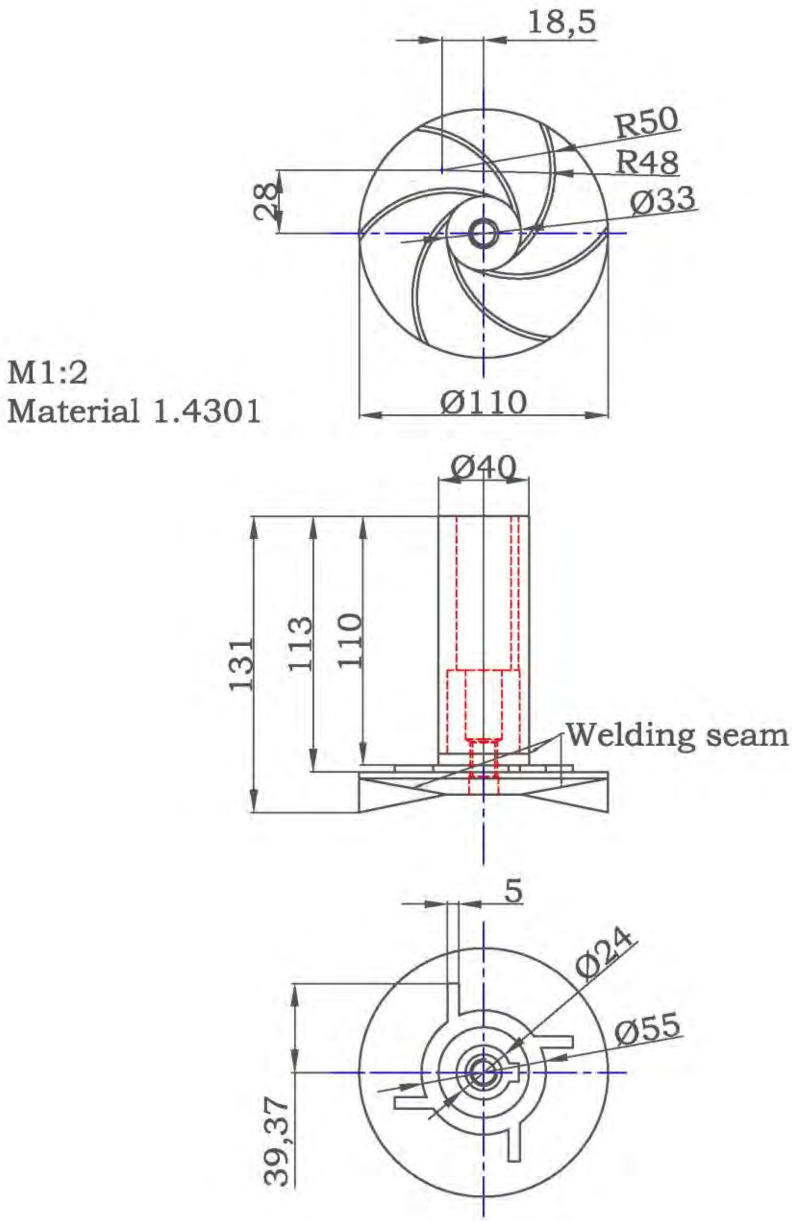

Figure 3: Dimensioned drawing of rotor from LC pulper

3 Coarse screening equipment

For coarse screening a cylinder with a 10 mm hole screening plate at the bottom and a minimum volume of 12 l has to be used (**Figure 4**). The flow through the hole plate must be interruptible by a ball valve. The screening holes have to be kept free during the screening process by using a stirrer. The dimensions of the blade stirrer are shown in **Figure 5**. The stirrer blade has to be positioned 10 – 20 mm above the screen plate and has to run at 200 rpm. As the stirrer has to overcome high resistance forces if excessive coarse rejects are accumulated, the motor has to transmit high moment of torque to the shaft of the stirrer. Therefore the driving motor has to have power of 1.5 kW in minimum. For this application the driving motor of a pillar drilling machine is suitable for example. The basically experimental setup is shown in **Figure 6**.

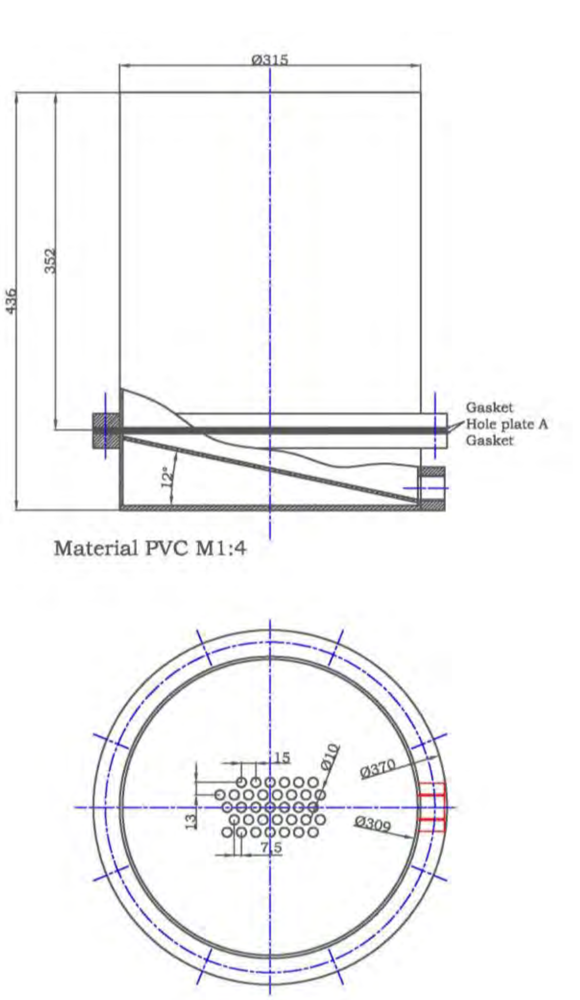

Figure 4: Dimensioned drawing of coarse screening equipment

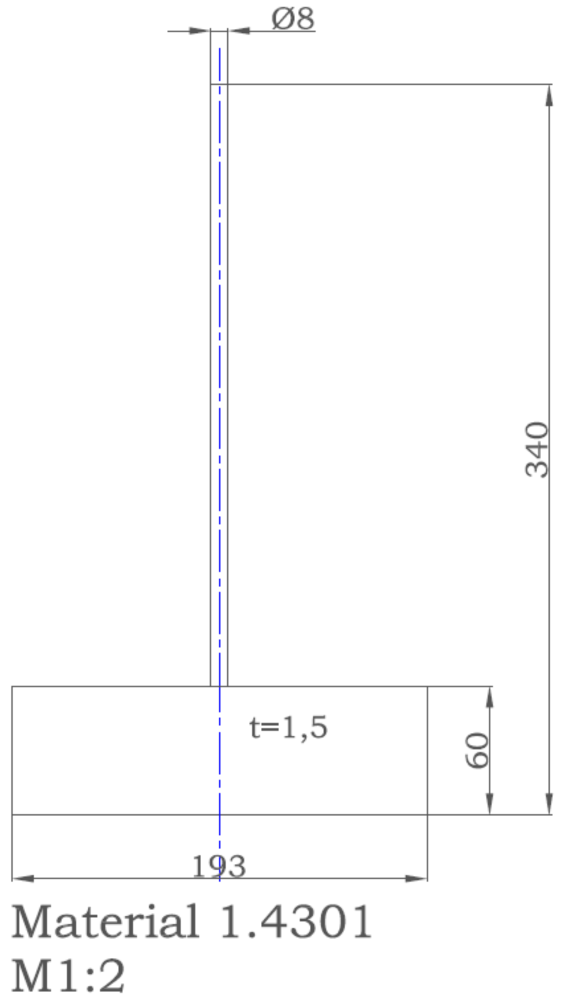

Figure 5: Dimensioned drawing of blade stirrer for coarse screening

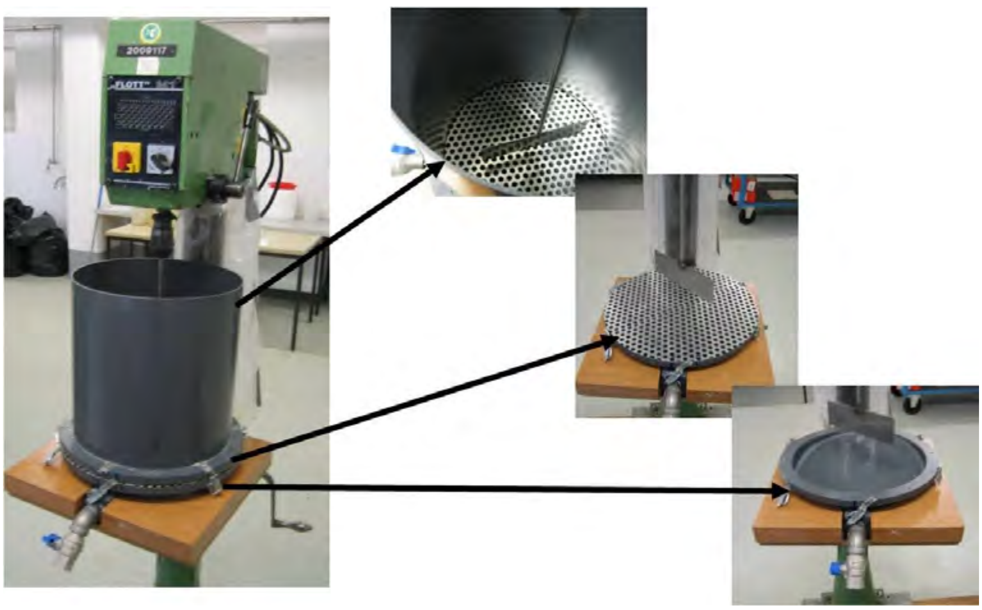

Figure 6: Basic experimental setup in pictures

4 Screening equipment for macrosticky determination

The macrosticky test must be performed using the screening device according to ZELLCHEMING Leaflet V/1.4/86. Using of a Haindl Sorter is recommended. For the intended maximum membrane stroke of 480 double strokes per minute, the device has to be equipped with an extension to operate as a splash guard (**Figure 7**). As screening plate a 100 µm metal slot plate has to be used because plastic slotted plates are not able to hold the mechanical stresses permanently due to the high stroke frequency.

Figure 7: Haindl screening device

5 Screening equipment for flake content determination

The flake content has to be measured with a Brecht-Holl screening device, which is shown in **Figure 8**. A plate with holes of of 0.7 mm diameter has to be used. Alternatively, a Haindl classifier with appropriate hole plate and operating conditions can be used.

Figure 8: Brecht-Holl screening device

Annex 2: Recyclability Test for Packaging Products	Leaflet
	Issue: Nov. 2014

1 Remark on labels with integrated electronic

Labels with integrated electronics may contain harmful substances, which particularly can be discharged in the disintegration step. Especially with regard to the production of food packaging products, unknown or toxicologically harmful substances should not attain into the paper loop in principle. However, the determination of such substances is not the subject of this leaflet.

Applications, such as labels, shall be examined generally as a whole, insofar their mass fraction has to be rounded up proportionately. The testing of label material has to be done according to INGEDE Method 12 [1]. The labels are applied to 480 g oven-dry packing material. Selection of the packaging material, the amount of applied labels and the application form are based on the real ratio for the concrete purpose.

Subsequently, the packaging material has to be cut into palm size. Labels, especially those with electronic components may not be cut, bent or otherwise damaged prior to the disintegration. Deviations have to be documented in the test report.

Applications, such as labels, affect the recyclability of packaging products in different ways. As a non-paper product material component they can lead to increasing rejects after coarse screening or they can affect the flake content. Adherend parts may cause macrostickies. Applications with harmful substances can disturb sustainable the recyclability of packaging products. Preferably, for the protection of the paper recycling loop this non-paper product material components with harmful substances have to be discharged completely after the first disintegrating step. With regard to a recycling-oriented design of paper and cardboard packaging products, it has to be mentioned in the test report to which extent the applied applications are not damaged after disintegration and are separated as reject after coarse screening. It must also be mentioned in the report, which applications or parts of it attain into the screened pulp suspension.

2 Literature

1. INGEDE Method 12. - Assessment of the Recyclability of Printed Paper Products - Testing of the Fragmentation Behaviour of Adhesive Applications.

Guide to an Optimum Recyclability of Printed Graphic Paper

European Recovered Paper Council

www.paperrecovery.eu

I. Introduction

This paper deals with the recycling of recovered graphic paper, for the production of graphic paper and other white papers. For brown packaging, other recycling techniques apply.

In recent years the recycling of recovered paper in the production of graphic papers and other white papers has increased considerably.

Today recovered paper is, in terms of quantity, the most important raw material for the European paper industry. Now, in particular newsprint consists increasingly of recycled graphic paper. The treatment of recovered paper starts with the separation of non-paper components, and is followed by the removal of the printing ink in the flotation deinking process. The share of printing ink in average recovered paper mixtures amounts to about 2% by weight. However yields of de-inked pulp (DIP) are only between 75% and 85%, because besides the printing ink and adhesives, fragments of paper fibres and parts of the mineral fillers and coating pigments are also removed.

The result of the recovered paper treatment depends on many factors (e.g. quality of the paper, type of printing process, properties of the printing ink, etc). Moreover the ageing process and climatic conditions during the life cycle of the print products can influence the result.

In many countries it has recently become increasingly difficult in deinking pulp mills to maintain the customary standards of yield and brightness of DIP. The reasons for this are manifold:

- **The increasing collecting rates throughout Europe and the systems used for the collection of used paper destinated to be deinked are a challenge for the deinking industry. There is a danger that the requirements of recovered paper quality are not met; e.g. due to higher shares of board or aged products.**

- **The increase in the recycling of recovered paper leads to lower shares of virgin fibres in recovered paper.**

- **The trend in newspaper printing to apply growing quantities of ink onto ever thinner paper brings an unfavourable quantitative ratio of ink / paper.**

To make up for these unfavourable developments, equipment used in deinking plants is constantly being extended. However to maintain the achieved standard, it is also necessary that everyone involved in the paper chain - including parties placing the order and designers of print products - give due consideration to the requirements of recycling. In the European Declaration on Paper Recycling 2006 – 2010 all major stakeholders in the paper value chain committed themselves to act accordingly.

II. Processes

Various process steps must be evaluated in the technical process of graphic recovered paper treatment.

1. Separation of non-paper components

As a matter of principle, operators of deinking plants see non-paper components in an unfavourable light, because they increase waste quantities. However, quite often, such components cannot be avoided. To impede the de-inking process as little as possible, the following requirements are important:

- Non-paper components should be dimensioned and mechanically stable in such a way that they survive as large particles, without being comminuted, in the conditions of pulping and allow mechanical separation by means of punched screens, slot screens and centrifugal purifiers. Relevant examples are cover foils, staples, thick adhesive layers, various product samples.

- Materials applied in very small dimensions or disintegrating into very small parts are unfavourable because they cannot be removed using today's conventional sorting methods.

2. Detachment of the printing ink film

The next step is to remove the printing ink film from the paper fibres. In the case of prints on coated paper there is, of course, no contact between printing ink and paper fibres. Here in general no problems arise, because the paper coating disintegrates as the recovered paper is pulped and fragments of the ink film are released. On uncoated paper the adhesion of printing ink to paper depends, firstly, on paper properties such as surface structure, fibre type, ash contents, etc and, secondly, the drying mechanism of the chosen printing process.

Printing inks, which form firmly sticking, tenacious printing ink films are more difficult to remove from the fibre. Examples are inks drying by polymerisation (oxidative drying, radiation curing). The ageing of offset inks based upon oxidative drying materials can also significantly reduce the deinkability.

3. Soluble and redispersable components

Components in the recovered paper, which dissolve in the process under standard conditions of deinking (pH 8 - 10) and reach the process water, pose a risk of unintended spreading to all parts of the paper machine. Problems occur when sticky residues - stickies - form upon redrying. In principle, these stickies have to be removed by tedious manual work, causing downtime, or by additional cleaning equipment, reducing the lifetime of equipment and paper machine clothing. A typical way in which stickies form is the agglomeration of dispersed or dissolved auxiliary materials, e.g. water-soluble or redispersable adhesives, paper-coating binders, coatings, varnishes and printing ink constituents. A similar – albeit very rare – problem arises when dyes from paper or printing ink dissolve initially in water and subsequently move onto clean paper fibres.

The requirement therefore is that recovered paper should contain as few components as possible, which dissolve or disperse in weakly alkaline medium and form sticky residues or cause discolourations.

4. Flotation

Flotation, which is the most common process currently used in Europe, is the essential step to remove printing inks. Supported by surface-active substances, printing ink particles gather on the surface of air bubbles. This process works at an optimum with printing ink particles sized between 20 - 100 µm. Thus, the loaded air-bubbles streams upward through the paper pulp. On the surface of the flotation cell, a dark foam segregates, which contains printing ink, fragments of paper fibre, fillers and paper-coating pigments. Particles smaller or bigger than the optimum particle size are floated with less efficiency.

In some cases water-based printing inks are used for flexo-newspaper printing. These inks may contain binders soluble in the alkaline range. Consequently in deinking, such inks do not break up into fragments of printing ink film but into pigment particles, smaller than 1 µm in size. These particles are much too small for flotation.

Printing ink particles too large for the flotation process occur in cases of tenacious, crosslinked ink films in thick layers on coated paper. For example, this problem can arise in connection with coated papers and UV inks or conventional sheet-fed offset inks coated with UV varnishes. When such coarse printing ink particles are obtained, the paper mill still has the option of comminuting them in a disperser and floating them once again. However, this 2nd deinking loop makes the process more complex and increases the rejects.

Likewise, paper mills whose furnish contains a proportion of water-borne flexo newsprint and therefore particles too small to float, often utilise an optional washing cycle. However this is usually only necessary when the proportion of water-borne flexo newsprint exceeds 5% of the total recovered paper, but washing is not reasonable for recovered papers with high mineral content, e. g. magazines.

III. Recyclability assessment

Development and design of printed products are dynamic. Materials and processes, too, are subject to technical innovations. Therefore it is necessary that all parties involved evaluate their products as to good recyclability if major changes are made to materials and processes.

Solutions are available to the various problems highlighted in this guide. These solutions must be examined in each individual case. In this examination, additional criteria, e.g. production quality, economic efficiency, environmental protection, occupational safety, etc have to be included in the assessment.

Institutes and paper mills throughout Europe have developed assessment methods. With the help of these methods it can be estimated whether printed products meet the criteria of recyclability. ERPC recommends using its assessment scheme “Deinkability Scores”. Harmonisation of schemes to assess the removal ability of adhesive applications is recommended.

When assessing whether the criteria of recyclability have been fulfilled, the relevance of the quantity of the examined print product must be taken into account with regard to its deinking performance and the final properties of the recovered substrate.

IV. Recovery of residues from the deinking process

The paper industry is eager to reuse residues generated in recovered paper treatment or to find external possibilities of reuse. Technical and economically feasible options are available. Here it is important that individual constituents do not impair the reuse of residues.

V. Updating

Statements made in this guide will be reviewed and revised if necessary.

Addendum

Non Impact Printing Inks

The quantity of printed office paper in collected paper for recycling is growing at a rate of 20% per annum. Most of this paper is printed by non-impact printing methods such as photocopiers, laser printers and inkjet printers.

Inks used in photocopiers and laser printers are often referred to as ‘toners’ and are often in a dry fine powder form.

Toners are coloured thermoplastic polymers that are usually based on pigments (not dyes). They contain low levels of additives used to help confer electrostatic properties, but essentially their fusing/fixing properties are of greatest interest in the recycling process, and are dominated by the thermoplastic polymer.

In normal use, particles of the dry toner are developed onto a photoreceptor and transferred to paper. At this stage the toner is still in the form of discrete particles, ~10µm in size. The paper then passes through some form of high temperature fusing system and this is where the problem arises, in terms of eventual recycling. During the fusing process the toner polymer melts, wetting and adhering to the paper fibres. At the same time the discrete particles merge forming much larger solidified ‘lumps’ depending on the size of the image. The toner is then well bonded to the paper fibres.

Some toners bond large numbers of paper fibres together which do not float in the flotation process and consequently are retained in the DIP causing a ‘speckling’ problem much like in the case of UV inks. Likewise, paper-mills whose furnish contains a proportion of recovered paper from offices have the option to break them down in a disperser and repeating the flotation process again.

Ink jet inks, commonly used on paper and found in office waste are usually water based dye types. The inks contain little or no resin component and the dye is completely water-soluble. In the flotation cell the dye redissolves and cannot be separated and subsequently moves onto the paper fibres as described in section 2.3. The recommendation is therefore the same, that recovered paper should contain as few components as possible that may cause discolouration.

[September 2008]

4

SIGNATORIES

June 2009

www.cepi.org
www.paperrecovery.org

www.citpa-europe.org

www.erpa.info

www.europeantissue.com

www.ingede.org

www.intergraf.org

www.fepe.org

SUPPORTERS

www.eadp.org

www.eupia.org

www.enpa.be

www.feica.org

www.faep.org

www.radtech-europe.com

www.finat.com

European Recovered Paper Council
c/o CEPI aisbl
Confederation of European Paper Industries
250 Avenue Louise, Box 80
B-1050 Brussels
Tel: +32 2 627 49 11   Fax: +32 2 646 81 37
mail@cepi.org
www.cepi.org   www.paperonline.org
www.paperrecovery.org

If you want to help us develop paper recycling in Europe, why not include the following email tagline in your own email signature:

"When you print this email, please recycle it. Paper is renewable, recyclable and the natural support of ideas. www.paperonline.org"

Design by Ben Timmers (CEPI)

European Recovered Paper Council Draft 2 October 2014	**Assessment of Printed Product Recyclability – Deinkability Score –**	**ERPC Logo**

1 Introduction

Deinking, the removal of printing inks, is a major step in the recycling process of printed graphic products to produce a bright pulp suitable for a wide range of recycled papers and board.

For an efficient functioning of the circular economy it is valuable that products can be recycled to similar quality levels as the original products. It is therefore desirable that printed products are deinkable. If they are not deinkable, printed products can be recycled to lower grade paper and board.

The deinkability of a printed product as a whole can be assessed by only looking at its Deinkability Score, which can range from -100 to +100. For individual products this is done by using the rating of the results given in this specification or by comparing the Deinkability Scores of several printed products.

If a more thorough technical / scientific evaluation has to be made, the individual scores or the measured values of the deinkability parameters can be used.

Ecolabels for printed matter on European and National levels require a positive deinkability result. In many cases, this can be achieved by choosing the proper printing technology and material combination. For these cases, exemptions for deinkability tests are defined in an annex to this Scorecard. This annex is subject to review and revision according to new knowledge gained.

2 Scope

This document of the European Recovered Paper Council provides an assessment of the deinkability of a printed product by evaluating results of a laboratory deinking test procedure. It is applicable to all kinds of printed graphic products on white paper.

3 Principle

Results of deinkability tests achieved by means of INGEDE Method 11 are converted into Deinkability Scores. For each of the five parameters – luminosity, colour, cleanliness, ink elimination and filtrate darkening – threshold and target values are defined. Cleanliness is measured as dirt speck area in two particle size classes. The threshold and target values are depending on the category of the printed product. If the result meets the target value or is better, it scores the maximum points allocated to this parameter. The maximum points achievable for each parameter are different thus indicating the importance of each individual parameter. A score below 0 in one or more parameters leads to the overall assessment “not suitable for deinking”.

4 Determination of the Deinkability Score

In this chapter, particularly in the tables, abbreviations for the assessment parameters are used:

Y:	Luminosity
a*:	Colour a* (green – red) of the CIELAB system
A:	Dirt particle area
A_{50}:	Dirt particle area for particles larger than 50 µm (circle equivalent diameter)
A_{250}:	Dirt particle area for particles larger than 250 µm (circle equivalent diameter)
IE:	Ink elimination
ΔY:	Filtrate darkening

Rounding of the parameters: Y, IE and ΔY to whole numbers, a* to one decimal and A to one decade. The individual scores of each parameter are rounded to whole numbers as well. Method: financial rounding.

4.1 Source of the deinkability results

The results of deinkability tests have to be obtained according to INGEDE Method 11. The fibre yield of the laboratory flotation, determined as yield of organic components, should be at least 65%. . If that value is not reached, the test has to be repeated with reduced flotation time.

For the determination of IE the parameter R_{700} has to be used with the term $\left(\frac{(1-R_{\infty,unpr})^2}{R_{\infty,unpr}}\right)$ set to 0.

For the image analysis, DOMAS or Simpatic are allowed.

4.2 Weighting of the parameters

The assessment of deinkability consists of five parameters. Three of those – luminosity, colour and cleanliness – refer to the quality of the deinked pulp, the other two – ink elimination and filtrate darkening – are process parameters. The quality parameters have a higher maximum score than the process parameters, which serve as a kind of backup for the assessment. The split of the evaluation of cleanliness in two size classes of the dirt speck area gives a total of six single scores.

Table 1: Maximum score for each parameter

Parameter	Y	a*	A_{50}	A_{250}	IE	ΔY	Total
Maximum Score	35	20	15	10	10	10	100

4.3 Threshold values

For a good deinkability, the values for Y and IE have to be high, the values for A and ΔY have to be low. The parameters with a desired high value have a lower threshold, the parameters with a desired low value an upper threshold. The a* value has both thresholds because the result should be within a target corridor. Falling below a lower threshold, exceeding an upper threshold, as well as falling out of a threshold corridor, results in a negative score for this parameter.

The thresholds are not comparable to the actual industrial quality requirements; they are by far less challenging due to a wide safety margin. This is because INGEDE Method 11 is not a complete simulation of the industrial deinking process; the assessment is to determine the relative challenge a printed product means for a flotation deinking plant. This margin also takes variations in the test procedure into account.

Printed products in the category “Low ink coverage products (Brightness of base paper > 75)” typically are produced using woodfree uncoated or coated papers. They usually end in grades of paper for recycling of groups 2 and 3 – medium and higher grades according to EN 643. These grades are used by mills producing deinked pulp with high optical quality requirements. Products in the categories “Newspapers”, “Magazines, uncoated”, “Magazines, coated” and “Low ink coverage products (Brightness of base paper ≤ 75)” typically are produced using mechanical pulp based or recycled papers. After use, these products predominantly end in grades of paper for recycling which are used in deinking plants with lower optical quality requirements. Therefore it is possible to have the same threshold in these four categories but necessary to increase the thresholds for the high quality requirements.

Table 2: Threshold values for “Newspapers”, “Magazines, uncoated”, “Magazines, coated” and “Low ink coverage products (Brightness of base paper ≤ 75)”

Parameter	Y [Points]	a* [-]	A_{50} [mm²/m²]	A_{250} [mm²/m²]	IE [%]	ΔY [Points]
Lower Threshold	**47**	**-3.0**			**40**	
Upper Threshold		**2.0**	**2.000**	**600**		**18**

Table 3: Threshold values for “Low ink coverage products (Brightness of base paper > 75)”

Parameter	Y [Points]	a* [-]	A_{50} [mm²/m²]	A_{250} [mm²/m²]	IE [%]	ΔY [Points]
Lower Threshold	**67**	**-3.0**			**40**	
Upper Threshold		**2.0**	**2000**	**600**		**18**

4.4 Target values

Each parameter has a target value depending on the product category.

Table 4: Target values

<table>
<tr><th>Category of printed product</th><th>Y
[Points]</th><th>a*
[-]</th><th>A_{50}
[mm²/m²]</th><th>A_{250}
[mm²/m²]</th><th>IE
[%]</th><th>ΔY
[Points]</th></tr>
<tr><td>Newspapers</td><td>≥ 60</td><td rowspan="5">≥ -2.0
to
≤ +1.0</td><td rowspan="5">≤ 600</td><td rowspan="5">≤ 180</td><td>≥ 70</td><td rowspan="5">≤ 6</td></tr>
<tr><td>Magazines, uncoated</td><td>≥ 65</td><td>≥ 70</td></tr>
<tr><td>Magazines, coated</td><td>≥ 75</td><td>≥ 75</td></tr>
<tr><td>Low ink coverage products (Brightness of base paper ≤ 75)</td><td>≥ 70</td><td>≥ 70</td></tr>
<tr><td>Low ink coverage products (Brightness of base paper > 75)</td><td>≥ 80</td><td>≥ 75</td></tr>
</table>

Note: Brightness measurement is done according to ISO – R457 (without UV).

Definitions and examples for the product categories:

Newspapers:

Written publication containing news, information and advertising, usually printed on low-cost paper called newsprint

Inserts, flyers & brochures – with an ash content of less than 22%: Leaflets for advertising.

Directories: Telephone books and similar types of printed products.

Magazines:

This category comprises a variety of printed products. They are distinguished in two sub-categories, depending whether the base paper is uncoated or coated.

Magazines: Publications which are generally published on a regular schedule, containing a variety of articles, generally financed by advertising, by a purchase price, by pre-paid magazine subscriptions, or all three.

Inserts, flyers & brochures – all coated ones; if uncoated, with an ash content of 22% or higher: Leaflets for advertising.

Catalogue: Publication containing a list of merchandise from a company, often in a similar fashion as any magazine.

Books with high ink coverage

Low ink coverage products:

Products, which are typically printed on high grade paper and/or with significantly lower ink coverage than magazines.

In this category belong text only prints, transactional and transpromotional prints, formal or personal correspondence, one side printed products, low ink coverage books and the like.

In case of doubts whether a printed product is a Low ink coverage product, the determination can be made by measuring the grey scale value, if necessary as average of several pages which should be representative for the printed product. If the grey scale value is above 200 (on a scale of 0 to 255), the product is regarded as Low ink coverage product. Procedure: A print sample is scanned by the scanner used for DOMAS with the equipment's scan software. For the scan 24 bit and 600 dpi (all other settings: standard settings) will be used and the file is saved in jpeg format. The median grey value of the complete scan (sample with paper margin but no scanner header) is measured (e.g. with the freeware “imagej”). Calculation of the grey scale value is done by arithmetic average of the RGB values.

4.5 Determination of the Deinkability Score

It is recommended to use spreadsheet software to calculate the score. The INGEDE Office can provide the formulae in Microsoft Excel® format.

4.5.1 Calculation of the score per parameter

Results of the individual parameters which meet or exceed the target values receive the maximum scores for these parameters (according to Table 1). “Exceeding the target values” means:

- In case of Y and IE: higher than the target value
- In case of A and ΔY: lower than the target value
- In case of a*: between higher and lower target value

If this is not the case, the score has to be calculated. For each individual parameter, the ratio of units better than the threshold value, divided by the range between threshold and target values, multiplied by the maximum score for this parameter, gives the Deinkability Score for this parameter. All individual scores are rounded to whole numbers by financial rounding.

Calculation for one individual parameter:

$$DS_P = \frac{(R_P - TH_P)}{(T_P - TH_P)} \cdot MS_P$$

Where

The index letter P stands for one of the six results Y, a*-value, A_{50}, A_{250}, IE and ΔY

DS_P is the Deinkability Score of the parameter P

RP is the result of the parameter P

TH_P is the threshold value of the parameter P (according to Table 2 or Table 3)

TP is the target value of the parameter P (according to Table 4)

MS_P is the maximum score of the parameter P (according to Table 1)

Example: Deinkability Score DS_Y for the luminosity of DP from newspapers

Luminosity Y of DP:	55
Threshold TH_Y:	47
Target T_Y:	60
Maximum score MS_Y:	35

$$DS_Y = \frac{(55-47)}{(60-47)} \cdot 35 = 22$$

The DS is limited to the maximum score MS for each individual parameter, even if the calculation gives a higher result. In that case it is not possible to compensate a weak deinkability in one parameter with a very good deinkability in another parameter.

If the result is worse than the threshold, the score is negative for this parameter. In that case the absolute number is limited to the same value as the maximum score for this parameter.

If the value a* is above the higher target value, the upper thresholds and targets have to be used in the formula – and vice versa if it is below the lower target value.

4.5.2 Calculation of the Deinkability Score

For a complete evaluation of the deinkability, the six individual scores are added. If one or more individual scores are negative, the assessment of the printed product is “not suitable for deinking”. However, the product may be well recyclable for a process without deinking.

If a product is assessed as “not suitable for deinking” due to negative scores of one or more parameters, the scores of the parameters with positive results are not displayed.

Note (Ink Elimination):

In case of Low ink coverage products the determination of the Ink Elimination IE can become inaccurate. If IE is the only parameter which causes a printed product to fail, the ink coverage should be artificially increased and the test repeated. Increased ink coverage with analogue prints can be achieved by cutting unprinted portions off from the test samples In case of digital printers a print pattern with higher ink coverage should be chosen. In seldom cases in which the ink coverage cannot be increased, e. g. at note pads with ruling only, the assessment should be done with the help of the other parameters. In these cases the Score for IE will be set to 10 points.

Table 5: Examples (Newspapers)

Parameter	Y	a*	A_{50} (DOMAS)	A_{250} (DOMAS)	IE	ΔY	Deinkability Score / Assessment
Threshold	47	-3 / +2	2.000	600	40	18	
Target	60	-2 / +1	600	180	70	6	
Maximum score	35	20	15	10	10	10	
Sample A							
Result	55	-2.5	450	220	60	8	good
Score	**22**	**10**	**15**	**9**	**7**	**8**	**71**
Sample B							
Result	45	-2.0	200	120	32	12	**not suitable for deinking**
Score	**-5**	**20**	**15**	**10**	**-3**	**5**	**-8**
Sample C							
Result	60	-1.6	150	90	75	5	good
Score	**35**	**20**	**15**	**10**	**10**	**10**	**100**

5 Rating of the results

In order to give the user an idea of the relevance of the Deinkability Scores, they should be assessed according to the following table:

Table 6: Rating of the Deinkability Scores

Score	Evaluation of deinkability
71 to 100 Points	Good
51 to 70 Points	Fair
0 to 50 Points	Tolerable
negative (failed to meet at least one threshold)	Not suitable for deinking (may be recyclable without deinking)

Experience has shown that in cases of poor deinkability not all results of the individual parameters are bad. If the most critical parameter is just slightly better than the threshold, the scores of the other parameters usually give already a sum of about 50 points. Therefore a Deinkability Score of up to 50 points is regarded as “tolerable”.

In charts, coloured backgrounds as in the table above should be used whenever possible. In order to reflect the assessment above, the colours should be set as follows:

- Below 0 points: red
- 0 to 40 points: orange
- 40 to 50 points: transition orange to yellow
- 50 to 70 points: yellow
- 70 to 80 points: transition yellow to green
- 80 to 100 points: green

6 Generic testing

Typically for the assessment of print product recyclability in the case of the EU Ecolabel licencing and similar (including R&D purposes), it is not always possible or appropriate to provide a genuine print product for testing. A generic testing can therefore be performed on dummies, i.e. a reference product case[1]. Results of the assessment for the reference product case will be valid for all related print products bearing the same features as the tested dummy, i.e. the same technical data and material

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[1] *European Commission’s Ecolabel User’s Manual for the application for printed paper of March 2013 refers to a “reference case, which will allow to submit further orders under the limit set by the reference case”.*

combination with the same or lower ink coverage (for each ink). The related printed products will therefore not require further laboratory deinking test procedures.

For the use of the tested printed product as a dummy, all certificates will state the following:

"These test scores are also valid for printed products with the same or lower ink and varnish coverage."

Generic tests can be performed on combinations of inks and types of paper, allowing printers to select pre-tested combinations suitable for deinking according to the ERPC scorecard.

7 Exemptions to the deinkability test

Many printed products are deinkable and will pass the deinkability test. The criteria for which printed products can be exempted from testing are defined in an annex of this document. This annex is subject to review and revision according to new knowledge gained.

8 Report

The report should contain detailed data of the printed product, the printing process and the deinking test:

- Identification of printed product as to name, publishing company, date of issue, product category, print process and paper quality.
- Printing parameters and press settings.
- Name and exact identification of inks or toner.
- Results of the deinking test according to INGEDE Method 11.
- The laboratory equipment used for the deinking test and deviations from INGEDE Method 11, if any.
- Deinkability Scores for every parameter and total (total only if all six individual scores are 0 or higher). The results can be provided either numerical or as graphics. For a graphic presentation column stacked charts are recommended. If at least one element of the stacked columns points to the negative side, this product is rated "not suitable for deinking", even if the other elements are positive. In order to avoid confusion, in case of "not suitable for deinking", only the negative columns are displayed in charts.
- Assessment of the deinkability according to Table 6.
- Optional but desired: Any interpretation of the result which is possible with the help of the technical data.

9 References

- EN 643 – European list of standard grades of paper and board for recycling
- INGEDE Method 11 – Assessment of Print Product Recyclability – Deinkability Test –

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Assessment of Printed Product Recyclability

Scorecard for the Removability of Adhesive Applications

European Recovered Paper Council
www.paperrecovery.eu

1 Introduction

The assessment of recyclability of printed paper products has several aspects. Two major ones are removability of adhesive applications and deinkability. The removability of adhesive applications of a printed product can be assessed by looking at its Removal Score, which can range from -20 to +100.

The sufficient removal of adhesive applications is one of the challenges for the paper manufacturers using recovered paper. In the recovered paper treatment process, adhesive applications disintegrate during pulping to “stickies”. Stickies is a broad term for all tacky components in recovered paper pulp. Depending on their size and their behaviour they are called macrostickies, microstickies or potential secondary stickies. Mechanical screening with slotted screens is the most efficient tool for sticky removal. High removal efficiency can only be achieved if adhesive applications disintegrate into particles of large size. The smaller the particles are, the lower their removal efficiency is. In addition, they can re-agglomerate later in the papermaking process and thus form secondary stickies which lead to major problems in paper production and/or converting processes.

In this regard, the removability depends not only on the composition of the adhesive but also on the type of application, such as the shape of the application and the thickness of the layer. The larger and thicker the layer of a given adhesive, the less disintegration into small particles occurs. In any case, the particle size of stickies has a certain distribution. The applied method for testing – INGEDE Method 12 – can detect particles of 100 µm size and larger.

Investigations have proven that macrostickies above a particle size of 2 000 µm are completely removed in state-of-the-art paper recycling processes. It is the objective to have a low total area of macrostickies which has to be expected after industrial screening. This area therefore can achieve up to 80 points in this assessment scheme. The higher the share of macrostickies below 2 000 µm, the higher the danger is of having many stickies below the detection limit of the method. Therefore the share of macrostickies below 2000µm has a threshold at 50%. Lower shares are rewarded with up to 20 points.

Literature: see concluding remarks.

2 Scope

This ERPC document provides an assessment of the removability of adhesive applications of a printed paper product as one aspect of its recyclability. The assessment is done by evaluating results of a laboratory test procedure. It is applicable to all kinds of printed paper products containing any adhesive applications.

3 Principle

This assessment scheme deals with the fragmentation of adhesive applications and their removability by a laboratory screening process. It serves as an evaluation for potential sticky problems at the paper machine and quality defects in the produced paper or board.

The assessment refers to complete printed products, disregarding which number and type of adhesive applications it contains. INGEDE Method 12 defines the details of the test procedure.

Results of macrosticky measurements achieved by means of INGEDE Method 12 are converted into Removal Scores. There is a threshold defined for the share of the macrostickies below 2 000 μm (equivalent circle diameter). A share above this threshold results in a negative score and is assessed as "insufficiently removable". The area below 2 000 μm particle size has a scoring limit. By allocating removal efficiencies to the different sticky size classes in industrial screening the theoretical macrosticky content of the pulp after screening is calculated. If this value exceeds the scoring limit, the parameter macrosticky area receives 0 points. This happens also if the share of the macrosticky area fails to meet the threshold.

For both parameters – share and area – target values are defined. If the result meets the target value or is better, it scores the maximum points allocated to this parameter.

4 Determination of the Removal Score

In this chapter, particularly in the tables, abbreviations for the assessment parameters are used:

A_t	**Theoretical macrosticky area in the pulp after industrial screening**
S_{2000}	**Share of macrosticky area below a particle size of 2 000 μm (equivalent circle diameter)**
T_A	**Target value for the theoretical macrosticky area A_t**
T_S	**Target value for the share of macrosticky area S_{2000}**

Rounding of the parameters: A_t to one decade, S_{2000} to whole numbers. The individual scores of both parameters are rounded to whole numbers as well. Method: financial rounding.

4.1 Source of the removability results

The test results have to be obtained according to INGEDE Method 12. For the image analysis, DOMAS or Simpatic are allowed.

4.2 Removal efficiency of the different size classes

One of the factors which defines the efficiency of industrial screening processes is the particle size distribution of macrostickies. The larger the macrostickies, the better their removal efficiency by screening is. Based on results of research projects and evaluation of industrial samples the screening efficiency can be determined as in Table 1.

Size class of macrostickies (equivalent circle diameter)	Removal efficiency
< 600 µm	0 %
600 µm to 1 000 µm	20 %
1 000 to 2 000 µm	80 %

Table 1: Removal efficiency as function of the macrosticky particle size

4.3 Weighting of the parameters

The assessment of removability consists of two parameters. It is beneficial for the paper recycling industry that the total amount of macrostickies is low. Therefore the amount receives a significantly higher score than the share.

Parameter	S_{2000}	A_t	Total
Maximum Score	20	80	100
Minimum Score	-20	0	-20

Table 2: Maximum score for each parameter

2

If printed products contain adhesive applications but no macrostickies can be detected, the reject of the laboratory screening has to be assessed. There are two extreme cases thinkable – either the adhesive is still attached to a medium (label, tape, etc.) or it is not detectable. In the first case the product will receive the full score for both parameters. In the second case it has to be assumed that all stickies are of low particle size. These products receive scores of -20 for S_{2000} and 0 for A_t.

4.4 Threshold value and scoring limit

Exceeding the upper threshold of S_{2000} results in a negative score for this parameter. Exceeding the scoring limit of A_t results in the score of 0 for this parameter.

Parameter	S_{2000} [%]	A_t [mm²/kg product]
Scoring limit	n/a	5 000
Upper Threshold	50	n/a

Table 3: Threshold value and scoring limit

4.5 Target values

Both parameters have target values.

Parameter	T_S [%]	T_A [mm²/kg product]
Target values	≤ 10	≤ 500

Table 4: Target values

Special case: Labels

Normally, adhesive applications can only be assessed properly after their application on a printed product. Exceptions are labels which do not represent a final product but their application can be easily simulated. See INGEDE Method 12 for details. Since a label is usually not recycled as a pure material, this assessment defines a projection of the macrostickies content originating from label applications. In cases of sticker covers of magazines and of address labels on envelopes, the share of the complete labels (paper plus adhesive) is about 2,5 % of the complete product. Based on this, the amount of macrostickies in mm^2/kg determined by the test according to INGEDE Method 12 has to be divided by 40.

This calculation tool should only be used if no real finished product is available.

3

4.6 Determination of the Removal Score

It is recommended to use spreadsheet software to calculate the score. The INGEDE Office can provide the formulae in Microsoft Excel® format.

4.6.1 Calculation of the score per parameter

Results of the individual parameters which meet or exceed the target values receive the maximum scores for these parameters (according to Table 2). “Exceeding the target values” means that the result has to be lower than the target value.

If this is not the case, the score has to be calculated by linear interpolation. For both parameters individually, the ratio of units better than the scoring limit respective threshold value, divided by the range between scoring limit respective threshold and target values, multiplied by the maximum score for this parameter, gives the Removal Score for this parameter. The individual scores are rounded to whole numbers by financial rounding.

Calculation of the Removal Score for the share of macrostickies below 2 000 µm:

$$RS_S = \frac{(50 - S_{2000})}{(50 - T_S)} \times 20 \qquad \textit{(Formula 1)}$$

Where

RS_S is the Removal Score for the macrosticky share

50 is the threshold value of the share of macrostickies below 2 000 µm (equivalent circle diameter; according to Table 3)

S_{2000} is the share of the macrosticky area below 2 000 µm (equivalent circle diameter)

T_S is the target value of the share of macrostickies below 2 000 µm (equivalent circle diameter; according to Table 4)

+20 and *-20* are the maximum and minimums score of the share of macrostickies below 2 000 µm (according to Table 2)

Calculation of the theoretical macrosticky area in pulp after screening:

Note: The following calculations are only necessary if the score RS_S for the share of macrostickies is 0 or higher. If the score RS_S for the share of macrostickies is below 0, the score RS_A for the macrosticky area is set to 0.

$$A_t = A_{600} + A_{1000} \times 0{,}8 + A_{2000} \times 0{,}2 \qquad \textit{(Formula 2)}$$

4

Where

A_t is the theoretical macrosticky area after industrial screening in mm²/kg printed product

A_{600} is the macrosticky content in the size classes below 600 µm (equivalent circle diameter)

A_{1000} is the macrosticky content in the size classes between 600 µm and 1 000 µm (equivalent circle diameter; 0,8 corresponds to a screening efficiency of 20 %)

A_{2000} is the macrosticky content in the size classes between 1 000 µm and 2 000 µm (equivalent circle diameter; 0,2 corresponds to a screening efficiency of 80 %)

Calculation of the Removal Score for the macrosticky area:

$$RS_A = \frac{(5000 - A_t)}{(5000 - T_A)} \times 80 \qquad \textit{(Formula 3)}$$

Where

RS_A is the Removal Score for the macrosticky area

5000 is the scoring limit of the macrosticky area (according to Table 3)

A_t is the theoretical macrosticky area after screening in mm²/kg printed product

T_A is the target value of the macrosticky area in mm²/kg printed product (according to Table 4)

+80 and *0* are the maximum and minimum scores for the macrosticky area (according to Table 2)

If the value A_t is higher than the scoring limit (5 000 mm²/kg), the score RS_A is set to 0.

The Removal Score is limited to the maximum score for each individual parameter, even if the calculation gives a higher result. In that case it is not possible to compensate a weak recyclability in one parameter with a very good recyclability in another parameter.

If the result is worse than the threshold, the score is negative for this parameter. In that case the absolute number is limited to the same value as the maximum score for this parameter.

4.6.2 Calculation of the Removal Score

If the score RS_S for the macrosticky share is negative, the score RS_A for the macrosticky area is set to 0 and the assessment of the printed product is “insufficiently removable”. If the score RS_S for the macrosticky share is 0 or higher, both individual scores RS_S and RS_A are added.

5 Rating of the Results

In order to give the user an idea of the relevance of the Removal Scores, they should be assessed according to the following table:

Score	Evaluation of removability
71 to 100 Points	**Good**
51 to 70 Points	**Fair**
0 to 50 Points	**Tolerable**
Negative (failed to meet the threshold)	**Insufficient**

Table 5: Rating of the Removal Scores

In charts, coloured backgrounds as in the table above should be used whenever possible. In order to reflect the assessment above, the colours should be set as follows:

- Below 0 points: red
- 0 to 40 points: orange
- 40 to 50 points: transition orange to yellow
- 50 to 70 points: yellow
- 70 to 80 points: transition yellow to green
- 80 to 100 points: green

5

6 Report

The report should contain detailed data of the printed product, the process for applying the adhesives and the laboratory screening test:

- Identification of printed product as to name, publishing company, date of issue, product category, type of adhesive applications and paper quality.
- Technical data and settings of the adhesive application device.
- Name and exact identification of adhesives.
- Results of the recyclability test according to INGEDE Method 12.
- The laboratory equipment used for the recyclability test and deviations from INGEDE Method 12, if any.
- Removal Scores for both parameters and total (total only if both scores are 0 or higher). The results can be provided either numerical or as graphics. For a graphic presentation column stacked charts are recommended. If the score of the share of macrosticky points is negative, this product is rated as “insufficiently removable”, even if the score for the macrosticky area is positive.
- Assessment of the recyclability according to Table 5.
- Optional but desired: Any interpretation of the result which is possible with the help of the technical data.

6

7 Concluding remarks

This assessment was developed with results from INGEDE Project 129 09 PMV which was also supported by bvdm, FEICA and FINAT. The data collected was from books, brochures, catalogues and labels.

There are numerous literatures on stickies, their origin, their behaviour in the paper recycling process and their impact on runnability and quality. One example is: Putz, H.-J., Stickies in recycled fiber pulp, chapter 11 of: Göttsching, L. and Pakarinen, H. (editors), Recycled Fiber and Deinking, Fapet Oy 2000, ISBN 952-5216-07-1.

8 References

- INGEDE Method 12 – Assessment of the Recyclability of Printed Paper Products – Testing of the Fragmentation Behaviour of Adhesive Applications
- Terminology of Stickies, ZELLCHEMING Technical Leaflet RECO 1, 1/2006

Annex: Examples

Characterisation of the examples:

A. Book with protein, EVA and PVAc adhesives
B. Telephone directory with EVA hotmelt adhesives
C. PSA paper label with UV acrylic, non tackified adhesive
D. Book with PVAc dispersion adhesive

Parameter / Sample	Example A	Example B	Example C*	Example D	Remarks
Macrosticky area by size class [µm]	mm²/kg	mm²/kg	mm²/kg	mm²/kg	
100 - 200	143	33	35	10	
200 - 400	340	59	23	11	
400 - 600	442	68	459	15	
600 – 1 000	1 000	208	4 315	16	
1 000 – 2 000	836	599	33 058	30	
2 000 – 3 000	127	388	30 162	0	
3 000 – 10 000	3 402	1423	15 419	0	
10 000 – 20 000	0	19 043	0	0	
20 000 – 200 000	0	13 244	0	0	

Table 6: Macrosticky size distribution (determined by INGEDE Method 12)

* Example C: Results obtained by means of INGEDE Method 12 are already divided by 40 (see chapter 4.5)

7

Size distribution of macrostickies (according to INGEDE Method 12)

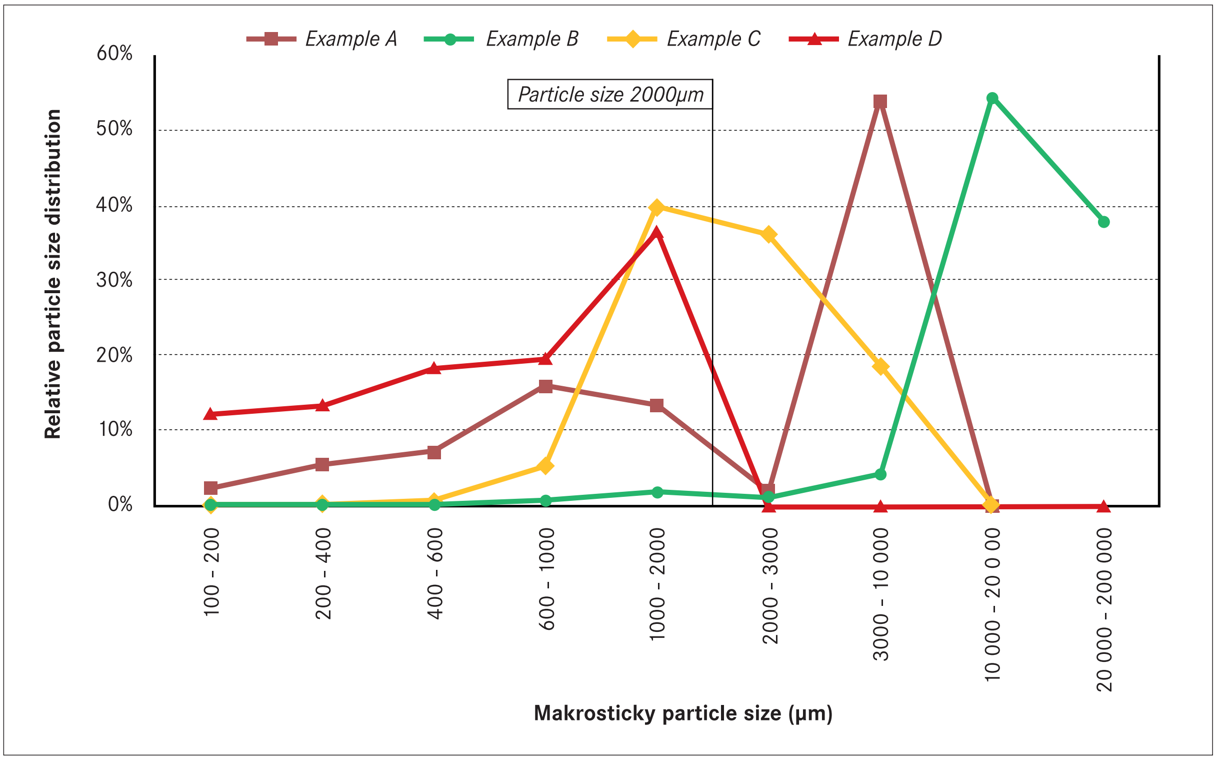

Figure 1: Macrosticky size distribution

Parameter / Sample	Example A	Example B	Example C	Example D	Remarks
Macrosticky area by size class [µm]	mm²/kg	mm²/kg	mm²/kg	mm²/kg	
100 - 600	925	160	517	36	A_{600}
600 - 1 000	1 000	208	4 315	16	A_{1000}
1 000 - 2 000	836	599	33 058	30	A_{2000}
100 - 2 000	2 761	967	37 890	82	*Subtotal 2000*
100 - 200 000	6 290	35 065	83 471	82	*Total*

Table 7: Subtotals and totals of Table 6

Parameter / Sample	Example A	Example B	Example C	Example D	Remarks
Share of macrosticky area below 2 000 µm S_{2000}	44%	3%	45%	100%	Calculation: ***Subtotal 2000*** divided by ***Total*** (Table 7)
Theoretical macro-sticky area after screening A_t [mm²/kg]	1 892	446	10 581	55	See Formula 2

Table 8: Calculation of auxiliary parameters

Parameter / Sample	Example A	Example B	Example C	Example D	Remarks
Share					
Threshold for the share	50%	50%	50%	50%	
Target for the share T_s	10%	10%	10%	10%	
Maximum score for the share	20	20	20	20	According to Table 2
Score for the share RS_S	3	20	2	-20	See Formula 1
Area					
Scoring limit for the area	5000	5000	5000	5000	
Target for the area T_A	500	500	500	500	
Maximum score for the area	80	80	80	80	According to Table 2
Score for the area RS_A	55	80	0	0	
Total Score					
Removal Score	58	100	2	-20	$RS_S + RS_A$

Table 9: Score calculation

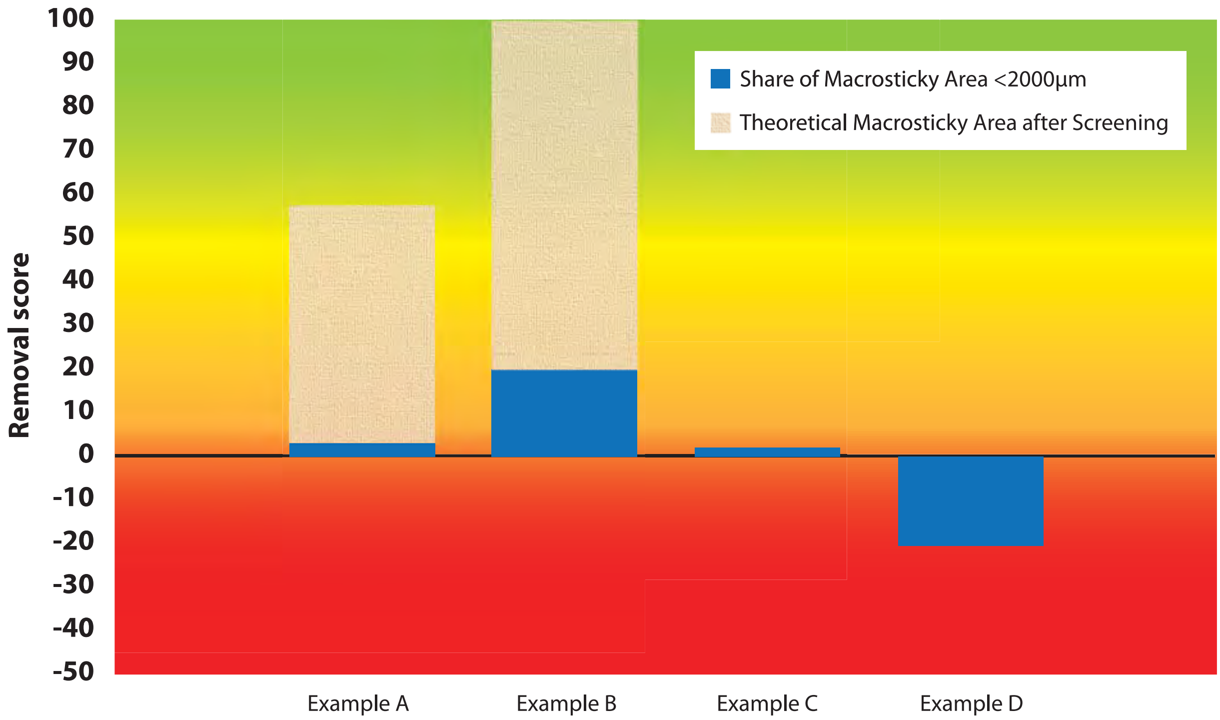

Figure 2: Removal Scores for Examples A to D

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Interpretation of the results of Examples A to D:

A. Share S_{2000} close to threshold and area A_t on average level results in an average Removal Score.

B. Low share S_{2000} and low area A_t results in the maximum Removal Score.

C. Share S_{2000} close to threshold and very high area A_t results in a low Removal Score.

D. The very high share S_{2000} leads to the assessment “insufficiently removable” despite the very low area A_t.

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SUPPORTERS

www.eadp.org

www.eupia.org

www.enpa.be

www.feica.org

www.faep.org

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If you want to help us develop paper recycling in Europe, why not include the following email tagline in your own email signature:

"When you print this email, please recycle it. Paper is renewable, recyclable and the natural support of ideas. www.paperonline.org"

Design by Ben Timmers (CEPI)

INGEDE Method 11

July 2012

Assessment of print product recyclability – Deinkability test

This document was originally developed and launched by INGEDE, its members and its research partners. In the frame of the EcoPaperLoop Project INGEDE Method 11 was translated into several languages. However, in case of any discrepancies the only valid version is the one in English language.

INGEDE Method 11 **July 2012** 13 Pages	**Assessment of print product recyclability** **– Deinkability test –**	INGEDE International Association of the Deinking Industry

Introduction

A good recyclability of printed products is a crucial feature for the sustainability of the graphic paper loop. It belongs to the focal work of INGEDE to safeguard and improve recyclability.

One of the measures is to provide tools for the assessment of the recyclability in the two aspects:

- Deinkability
- Screenability of adhesive applications.

Therefore a set of methods has been developed to simulate the common operating conditions of relevant process steps in an industrial deinking plant under standard conditions in a laboratory scale. This allows to estimate the relative challenge a printed product means to a deinking plant. Deinking plants producing deinked pulp for newsprint, publication and other printing & writing papers predominantly use paper for recycling with a significant content of mechanical pulp based grades. These papers usually are deinked in an alkaline environment. This is meant by the term “common operating conditions”. Printed paper products recovered by household collection together with newspapers and magazines are also treated under these common operating conditions.

This method has been developed for the assessment of the deinkability of individual printed products.

1 Scope

This INGEDE Method describes a procedure to evaluate the deinkability of printed paper products by means of alkaline flotation deinking. It can be used for any kind of printed paper product.

2 Terms and definitions

Deinked Pulp (DP):

- Pulp consisting of printed products deinked according to this method.

Undeinked Pulp (UP):

- Pulp consisting of printed products disintegrated mechanically with added deinking chemicals, prior to flotation.

3 Principle

Flotation is the most widely used technology for ink removal in the paper recycling process. This INGEDE Method in a laboratory scale defines the essential steps of the flotation deinking process: pulping and flotation. In order to simulate the average age of paper recovered from households, an accelerated aging step is part of the procedure. Special care was taken to define a procedure without the need to test unprinted paper. The whole laboratory procedure is shown in Figure 3.

The deinkability is assessed by three quality parameters of the deinked pulp and two process parameters.

Quality parameters:

- Luminosity
- Colour shade
- Dirt specks (in two different size categories).

Process parameters:

- Ink Elimination
- Filtrate darkening.

4 Equipment and auxiliaries

4.1 Equipment

- Warming cabinet with free or forced ventilation or with air turbulence according to ISO 287.
- Analytical balance up to 1 000 g with an accuracy of at least 0,001 g
- Analytical balance up to 3 000 g with an accuracy of at least 0,1 g
- Hobart pulper N 50, available from Hobart GmbH. Use the type of stirrer and a comparable cover, shown in the following figures. Additionally, it is possible to install a revolution counter, which stops the device automatically.

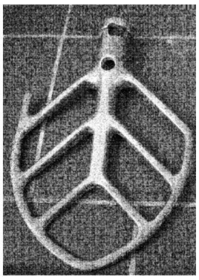

Figure 1: Stirrer for the Hobart pulper

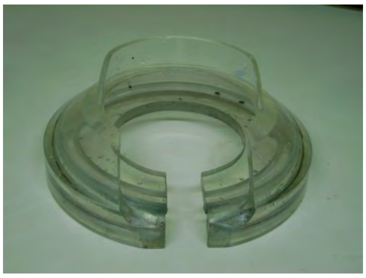

Figure 2: Cover for the Hobart pulper

- Temperature-controlled water bath
- Heating plate equipped with magnetic stirrer, or commercial-grade hot-water heater
- Laboratory flotation cell (references: PTS cell, Voith Delta 25™)
- Plastic scraper (in case of PTS cell)
- Beakers
- Muffle furnace which can be adjusted to an incineration temperature of 525 °C
- pH measuring system with an accuracy of 0,1 points.

If different equipment is used, this has to be mentioned in the test report.

4.2 Chemicals

- Sodium hydroxide (NaOH), pro analysis, CAS # 1310-73-2
- Sodium silicate 1,3–1,4 g/cm³ (38–40 °Bé)
- Hydrogen peroxide (H_2O_2), e.g. 35 %
- Oleic acid ($C_{18}H_{34}O_2$), extra pure, CAS # 112-80-1, e.g. Merck Article No. 1.00471
- Calcium chloride dihydrate ($CaCl_2 \cdot 2 H_2O$), CAS # 10035-04-8

5 Procedure

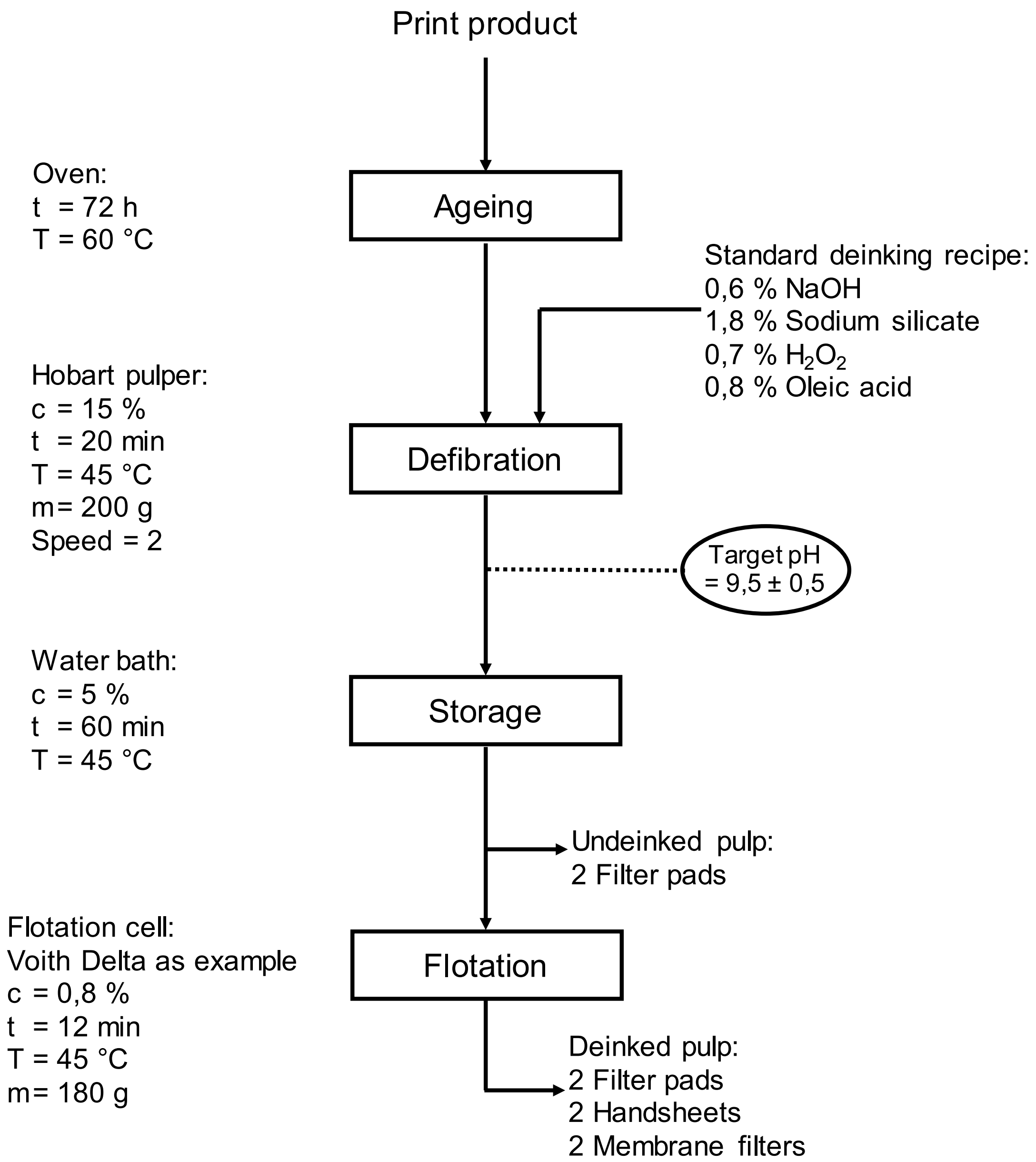

Figure 3: Procedure for testing deinkability with standard deinking recipe

5.1 Sampling

The printed samples used in the tests must not be split up. The minimum amount of each printed sample is 250 g oven-dry.

5.2 Identification

Each print product is designated by its title, publishing house, issue date, product category, printing method and paper grade, if available. Determine the ash content of the paper sample.

Weigh the complete printed product. After weighing, remove any inserts and non-paper components from the printed product to determine their share in the total mass of the product.

5.3 Separation of adhesive applications

To allow the sticky-forming potential of the printed product to be assessed independently, separate all evident adhesive applications from the paper, mark them according to their use, and store them separately.

Glued backs of magazines or catalogues shall be separated according to INGEDE Method 12.

5.4 Accelerated ageing

Place the samples in a warming cabinet for accelerated ageing at 60±3 °C for 72 hours

Accelerated ageing of the samples is necessary because the storage of the papers for recycling can influence their deinkability. These accelerated ageing conditions correspond to 3–6 months of natural ageing.

5.5 Breaking up of samples

Accelerated aged samples are torn into pieces of about 2x2 cm² and acclimatised. A part of the acclimatised samples is used to determine the moisture content according to ISO 287 with at least one sample of about 50 g minimum. Based on the obtained results, calculate the appropriate air-dry weight of the samples which corresponds to the oven-dry weight prescribed.

5.6 Weighing the samples

After homogenising the samples by hand, weigh out samples of 200 g oven-dry.

5.7 Preparation of dilution water

During laboratory treatment of the printed products (5.9 to 5.13), use only water which has been treated to obtain the prescribed hardness values.

To obtain the desired water hardness, add calcium chloride dihydrate ($CaCl_2 \cdot 2\ H_2O$) in deionised water until the concentration of calcium ions reaches 3,21 mmol/l, equivalent to 472 mg/l. This is equivalent to 128 mg Ca^{2+}/l.

If tap water is used, this shall be mentioned in the test report indicating the respective hardness.

During sample preparation, a constant temperature of 45 °C should be maintained. The dilution water should therefore be stored in a water bath whose temperature can be controlled accordingly. It is also possible to heat part of the dilution water to a considerably higher temperature by means of a hot-water heater, and successively add cold dilution water until the desired temperature has been reached. It is not advisable to separately heat the individual stock solutions (dilution water, chemical stock solution, peroxide solution).

5.8 Preparation and dosing of chemicals

The standard formulation is as follows:

Table 1: Standard deinking recipe

Chemical	Dosage (related to oven-dry paper)
Sodium hydroxide	0,6 % (100 %)*
Sodium silicate	1,8 % (1,3–1,4 g/cm^3)*
Hydrogen peroxide	0,7 % (100 %)
Oleic acid	0,8 % (extra pure)

* Only if the pH is either too low or too high after pulping or if it is too low before flotation, the dosages of sodium hydroxide and of sodium silicate have to be adapted (see 5.10).

Make sure that the chemicals are dosed with a relative tolerance not exceeding ±1 %.

It is useful to prepare a total amount of 2 l stock solution which will be sufficient for 5 tests. Dissolve 6 g sodium hydroxide in deionised water, heat slightly to approx. 60 °C and proceed by adding 8 g oleic acid. Stir until the solution is clear, then add 18 g sodium silicate and fill up with deionised water to 2 litres. The formation of soap reduces the alkalinity. 0,114 % sodium hydroxide is needed to neutralise the oleic acid.

In addition, prepare 100 ml hydrogen peroxide solution for each test, using deionised cold water.

5.9 Defibration

Fill the Hobart pulper with the prescribed sample quantity (200 g oven-dry). Take 400 ml of chemicals solution and fill up to a total volume of 1233 ml with appropriately heated dilution water. Add this deinking liquor into the vessel and run the Hobart pulper for some seconds. Then stop it, brush down any scrap of paper from the vessel wall. Repeat this step as often as necessary.

After the first stop, add the peroxide solution (100 ml). The stock consistency is now 15 %. Immediately after, disintegrate the stock for 20 min at approx. 45 °C, using rotor speed 2.

To maintain a constant temperature and avoid splashing losses, cover the vessel during disintegration, for example with a suitably sized, tight-fitting plastic lid (see Figure 2).

5.10 pH value after defibration

At the end of pulping, measure the pH. For a precise measurement of the pH after pulping it is necessary to create a small amount of filtrate by pressing out a pulp sample.

The target pH value is 9,5.

Using the standard formulation from chapter 5.8 the permitted range of pH is 9,5 ± 0,5. If the pH is beyond this range, the sample has to be discarded and the test repeated with an adapted dosage of chemicals. In case of too low pH after pulping the dosage of sodium hydroxide has to be increased. In case of too high pH, both sodium hydroxide and sodium silicate have to be reduced by the same ratio. The minimum dosage of sodium hydroxide is 0,2 %.

Beginning with a non standard chemical formulation, while not proving to be in the range with the standard formulation, the accepted pH is 9,5 ± 0,2.

Figure 4 describes the procedure when starting with standard or non standard chemical formulation.

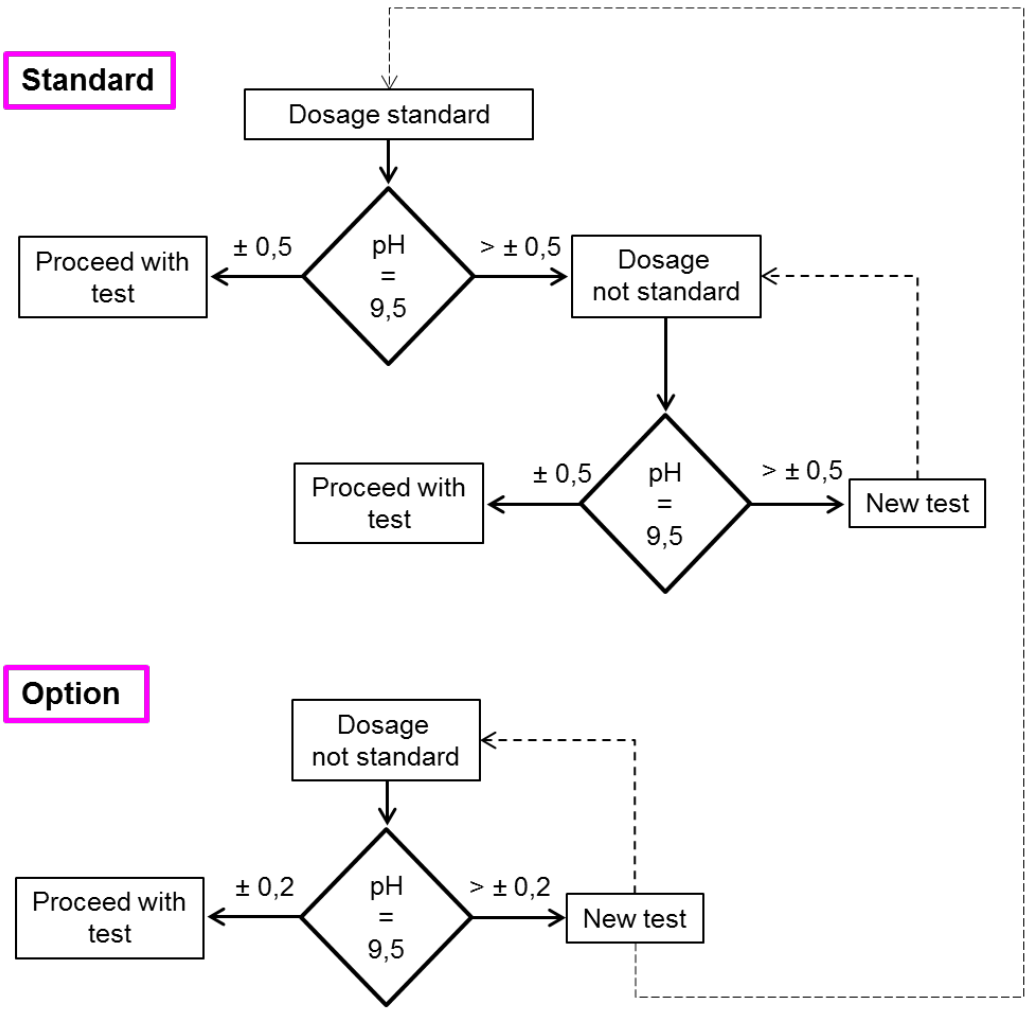

Figure 4: pH value tolerances

ANNEX A describes a method to pre-test the pH after storage with a smaller sample amount. It gives an idea whether a too low or too high pH has to be expected. This principle of pre-testing is applicable also with other chemical dosages, but does not compensate the original defibration with 200 g oven-dry pulp. The requirements of pH tolerances must be fulfilled regardless the pre-test result.

5.11 Storage

The amount of pulp needed for the subsequent treatment steps depends on the quantities required for the final handsheet and filter pad formation (see 5.14). Stock quantities of 12 g oven-dry undeinked (UP) and approx. 15 g oven-dry deinked pulp (DP) are needed in minimum. Stock losses will vary depending on the print products used and can amount up to 50 % during flotation.

Store the amount of stock required for subsequent treatment for 60 min in a water bath at 45 °C and 5 % consistency. The dilution water has been brought to a temperature of 45 °C and to the desired level of hardness.

Measure the pH before and after the storage time. The pH can be measured with reasonable accuracy in the pulp at storage consistency. However, it is recommended to measure the pH before and after the storage in a filtrate without fibres in order to increase the accuracy of the measurement. This filtrate can be generated by pressing a small cullender onto the surface of the pulp. The pH electrode can then be dipped into the filtrate which forms inside the cullender.

5.12 Dilution

After storage the stock samples must be diluted with 45 °C warm water to terminate any chemical reaction before the treatment continues. Use tap water for the UP sample. For the pulp sample to be deinked, use water that has been brought to a temperature of 45 °C and to the desired level of hardness. The consistency after this dilution should be around 1 %; it can be the consistency required for flotation.

Measure the pH. At flotation consistency it should be equal or higher than 7,5, provided that the defined range of the pH after pulping is met. If the pH before flotation is below 7,5, discard the sample and repeat the test with a higher dosage of sodium hydroxide.

Start the flotation before preparing the UP specimens.

5.13 Flotation

Heat up the cell with hot water if the cell has big metal parts. After some minutes pour out the heating water and fill in first some of the prepared dilution water of 45 °C to prevent the “concentrated” pulp from staying in dead corners later. Add the diluted sample into the flotation cell. Fill up with dilution water, and proceed as the instructions of the flotation cell describes. The starting point for the flotation time is when the air supply is started. The process time is set in the following instructions for the recommended flotation cells. For other cells, the process should run until the status of hyper-flotation is reached.

5.13.1 PTS flotation cell

Use the following settings for flotation: air supply rate 60 l/h, stirrer speed in suspension 1200 min^{-1}, flotation period 10 min, suspension temperature approx. 45 °C, consistency approx. 0,8 % at the beginning with 12 g oven dry pulp.

During the entire flotation process, use the scraper to remove the froth without stock, if possible. Collect the skimmed-off flotation rejects in a tank. Continually add dilution water to compensate for the drainage, keeping the suspension level constantly up at the edge of the overflow for the duration of the flotation.

After a flotation period of 10 min switch off the air supply and the stirrer. Use dilution water to bring down any rejects from the overflow into the collecting tank and then dewater the froth. Determine the amount of the overflow oven-dry according to ISO 4119 and use this amount to calculate the flotation yield.

5.13.2 Voith Delta 25TM

The air supply has to be set to approx. 7 l/min. Use the supplier’s calibration sheet to find the corresponding point on the scale. The other parameters are: flotation period 12 min, suspension temperature approx. 45 °C, consistency approx. 0,8 % at the beginning with 180 g oven-dry pulp.

During the flotation process add the necessary amount of 45 °C warm water several times in order to maintain the level of the aerated suspension in the cell. In case of low foaming tendency, increase the level in order to guarantee the overflow of foam.

After the flotation period switch off the air supply. Use dilution water to bring down any rejects from the overflow into the collecting tank, and then dewater the froth. Determine the amount of the overflow oven-dry according to ISO 4119, and use this amount to calculate the flotation yield.

5.13.3 Other laboratory flotation cells

Use flotation parameters and conditions similar to the standard conditions applied during the laboratory treatment of deinked recycled pulps.

The flotation should run until the status of hyper-flotation is reached. Set the flotation time in order to get maximum luminosity and ink elimination.

5.14 Specimen preparation

For undeinked pulp two filter pads and for deinked pulp two filter pads and two laboratory handsheets are required to permit an optical evaluation. In addition, two membrane filter specimens are prepared from the filter pad filtrate of the deinked pulp so as to be able to assess filtrate quality. INGEDE Method 1 is used to prepare the specimens.

5.15 Analysis

The following optical characteristics of air conditioned filter pads, laboratory sheets and filtrate filters are determined using INGEDE Method 2.

- Luminosity Y of deinked pulp
- L*, a*, b* colour coefficients of deinked pulp
- Ink elimination IE_{700} and/or IE_{ERIC}
- Filtrate Darkening ΔY of deinked pulp
- Dirt particle area A of deinked pulp

Measure the stock consistency to maintain required conditions, e.g. for storage and flotation. Use the filter pads of stock consistency measurements to determine the ash content of undeinked and deinked pulp in accordance with ISO 1762.

In order to calculate yield values (overall yield and fibre yield) make sure to measure the feed and the overflow of the flotation. Maintain the correct amount of oven dry pulp for the flotation process.

The flotation yield is calculated as follows:

Yield (Overall yield):

$$Yield = \frac{(c_{UP} \cdot m_{UP}) - (c_{froth} \cdot m_{froth})}{(c_{UP} \cdot m_{UP})} \cdot 100\,\%$$

Where:

c_{UP} in g/kg	stock consistency of undeinked pulp
m_{UP} in kg	feed amount flotation, undeinked pulp
c_{froth} in g/kg	stock consistency of overflow
m_{froth} in kg	overflow mass

Fibre Yield:

$$Fibre\,Yield = Yield \cdot \frac{(1 - Ash_{DP})}{(1 - Ash_{UP})}$$

Where:

Ash_{DP}	Ash content of deinked pulp in decimal
Ash_{UP}	Ash content of undeinked pulp in decimal (e.g. 0.03)

6 Report

The following should be recorded in the test report:

- Identification of print product as to name, publishing company, date of issue, product category, print process and paper quality, ash content.
- Mass-related proportion of supplements and non-paper material in %.
- Number and type of adhesive applications.
- pH after pulping, before and after storage and before flotation.
- Chemical dosage for pulping.
- Ash content of undeinked and deinked pulp.
- Flotation yield in %.
- Fibre yield in %.
- Overflow mass m_{froth} .
- Overflow stock consistency c_{froth} .
- Luminosity Y of deinked pulp.
- L*, a* and b* of deinked pulp.
- Ink elimination IE_{700} in %, $R_{\infty,UP}$, $R_{\infty,DP}$ at 700 nm.
- Alternatively to IE_{700}, the ink elimination using ERIC values (IE_{ERIC}) may be determined.
- Filtrate darkening ΔY of the deinked pulp sample filtrate.
- Dirt particle area of deinked pulp in mm²/m² in two categories with the dirt particle area > 50 µm and the dirt particle area > 250 µm.

Deviations from the conditions stipulated for this test method, if applicable (e.g. pulping device, specification of the laboratory flotation cell, conditions of flotation).

Any further optical characteristics of undeinked and deinked pulp yielded as well as their respective filtrate quality may also be noted in the test report.

7 References

7.1 Cited Standards and methods

- INGEDE Method 1 – Test sheet preparation of pulps and filtrates from deinking processes
- INGEDE Method 2 – Measurement of optical characteristics of pulps and filtrates from deinking processes
- INGEDE Method 12 – Assessment of the recyclability of printed paper products – Testing of the fragmentation behaviour of adhesive applications
- ISO 287 – Paper and board - Determination of moisture content of a lot - Oven-drying method

- ISO 1762 – Paper, board and pulps — Determination of residue (ash) on ignition at 525 °C
- ISO 4119 – Pulps – Determination of stock concentration
- ISO 5263-1 – Pulps – Laboratory wet disintegration
- ISO 5269-2 – Pulp – Preparation of laboratory sheets for physical testing. Part 2: Rapid-Köthen method

7.2 Literature and other related documents

- European Recovered Paper Council, Assessment of Print Product Recyclability – Deinkability Score – User's Manual, March 2009, www.paperforrecycling.eu/

7.3 Sources

This method has been published for the first time in 2001. A major revision was done in 2007 according to the definitions made in INGEDE Project 85 02 CTP/PMV/PTS – European Deinkability Method. In 2009 criteria for the pH after pulping and before flotation were added. After gaining some experiences, procedures related to the pH criteria were added to this version.

Annex A:

Testing the pH of a smaller sample amount

In case of not having a sufficient amount of sample paper for repeating the disintegration, test a small amount of your sample beforehand. Use 20 g oven dry sample, pour in 40 ml of the preheated standard chemical formulation and fill up to 123 ml with preheated dilution water. Prepare 10 ml of the peroxide solution. Disintegrate the sample with a dispersing device (e.g. hand blender, laboratory dispersing machine), stop after some seconds and add the prepared peroxide solution. Then disintegrate until the sample is pulped. Store the pulp at 45 °C for 20 minutes and determine the pH.

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INGEDE Method 12

January 2013

Assessment of the Recyclability of Printed Paper Products – Testing of the fragmentation behaviour of adhesive applications

This document was originally developed and launched by INGEDE, its members and its research partners. In the frame of the EcoPaperLoop Project INGEDE Method 12 was translated into several languages. However, in case of any discrepancies the only valid version is the one in English language.

INGEDE Method 12 **January 2013** 11 Pages	**Assessment of the Recyclability of Printed Paper Products** **Testing of the fragmentation behaviour of adhesive applications**	INGEDE International Association of the Deinking Industry

Introduction

A good recyclability of printed products is a crucial feature for the sustainability of the graphic paper loop. It belongs to the focus of INGEDE activities to safeguard and improve recyclability.

One of the measures is to provide tools for the assessment of the recyclability in the two aspects:

- Deinkability
- Screenability of adhesive applications

Therefore a set of methods was developed which simulate unit operations of a deinking plant and allow conclusions about the behaviour of a printed product and the adhesive applications in a deinking plant.

This procedure deals with the fragmentation behaviour of adhesive applications after pulping as one aspect of recyclability assessment. The method is based on the general requirement that it should be possible to separate adhesive applications mechanically. The fragmentation behaviour determines the screenability (see ERPC Scorecard “Assessment of Print Product Recyclability – Scorecard for the Removability of Adhesive Applications”).

1 Scope

This INGEDE method describes a procedure for testing the fragmentation behaviour and screenability of adhesive applications on paper products. It is suitable for known and for unknown amounts of adhesives in the recycled paper sample.

2 Terms and definitions

Macrostickies:

ZELLCHEMING Technical Leaflet RECO 1, 1/2006 “Terminology of Stickies”, determined by means of INGEDE Method 4.

Stickies is the term for adhesive (tacky) particles that occur when recycled fibres are utilised. Macrostickies is commonly the term for the tacky residues on the screening plate after a fractionation.

Adhesive Applications:

Adhesive spine

Are the adhesive back binding of printed books, magazines, journals and catalogues.

Side glue

One or two pages at the front and one or two pages at the back side of a printed product are part of the binding. The adhesive spine and the side glue form together the adhesive binding.

Glued-in inserts

These are adhesive applications to glue samples or leaflets mostly for commercial purposes into or at printed products.

PSA

Is the abbreviation for pressure sensitive adhesives, typically used for labels and stickers.

3 Principle

This method is determined to simulate the screening ability of adhesive applications in a deinking process. The two essential process steps are pulping and screening.

This method describes the laboratory pulping process by defining the physical conditions and the addition of deinking chemicals (Figure 1).

The separation of adhesive applications from the pulp is done by screening according to INGEDE Method 4.

The particle size distribution of the macrostickies is measured, thus allowing the assessment of the screening ability of the adhesives application in an industrial process.

The setting of the screening ability limit of < 2 000 µm equivalent circle diameter was proven in semi-industrial pilot plant trials and confirmed by test results from industrial processes.

One driving force to develop this assessment method is the fact that normally the amount of adhesives in a printed product is unknown. If it is known, the test can be combined with INGEDE Method 13.

4 Equipment and auxiliaries

4.1 Equipment

- Analytical balance up to 1 000 g with an accuracy of ± 0,001 g
- Analytical balance up to 3 000 g with an accuracy of ± 0,1 g
- Hobart pulper model N 50, supplied by HOBART GmbH, equipped with a blade type stirrer (see INGEDE Method 11)
- Haindl classifier in accordance with ZM V/1.4/86 or Somerville tester according to TAPPI T 275 sp-07 or Pulmac Master Screen-type instrument according to TAPPI T 274 sp-08
- Slotted plate with a slot width of 100 µm
- Rapid-Köthen sheet former in accordance with ISO 5269/2 respectively
- Drying cabinet in accordance with ISO 287

- Scanner-based image analysis system with a minimum resolution of 600 × 600 dpi, e. g. DOMAS, SIMPALAB

4.2 Test material

- Woodfree, virgin fibre based copy paper with an ash content of 20 ± 3 % ash determined at 525 °C
- Test material for sticky visualisation according to INGEDE Method 4

4.3 Chemicals

The required standard deinking chemicals are listed in INGEDE Method 11:

- Sodium hydroxide p. A.
- Sodium silicate, density 1,3–1,4 g/cm³
- Hydrogen peroxide, e. g. 35 %
- Oleic acid, extra pure

5 Procedure

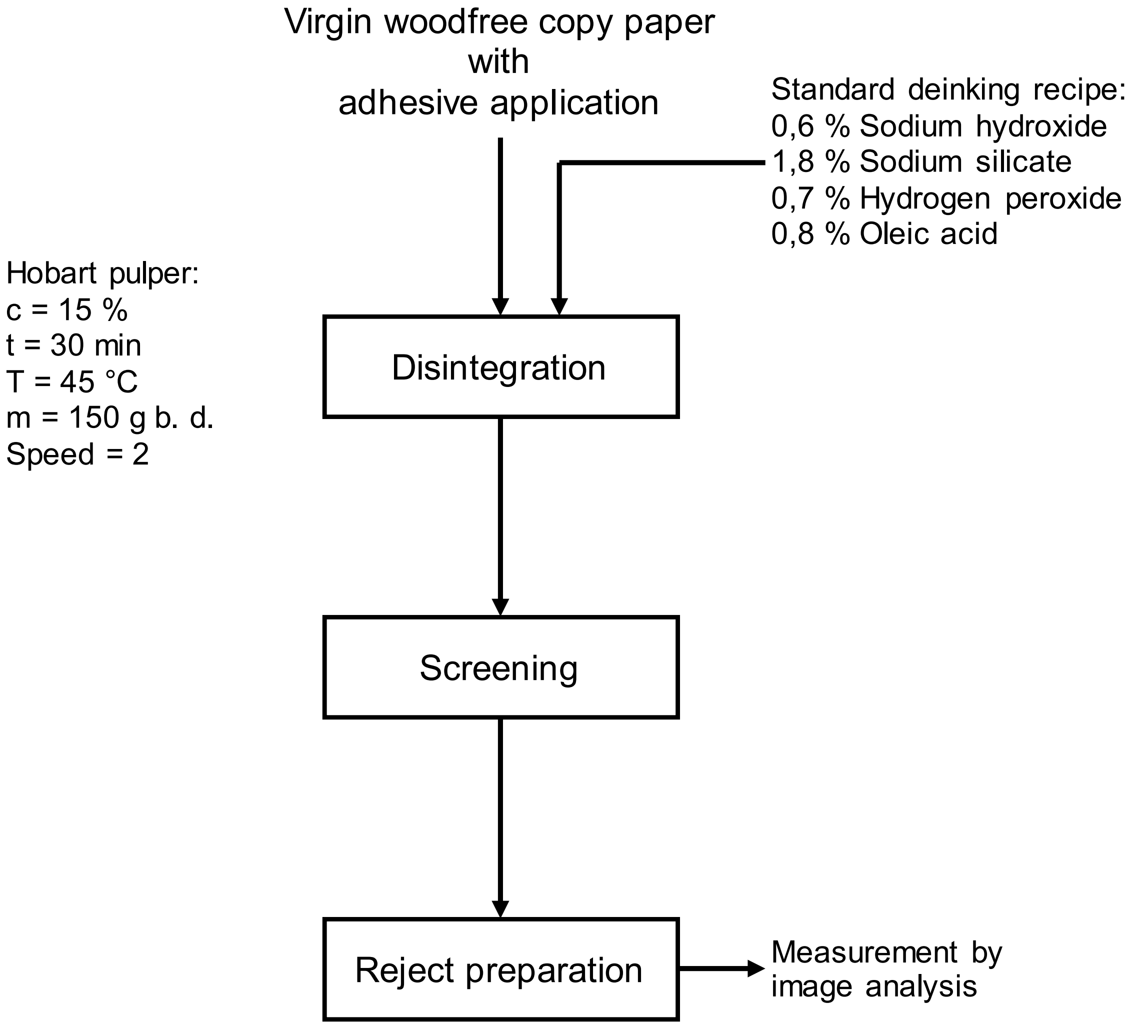

Figure 1: Testing fragmentation behaviour of adhesive applications

5.1 Preparation of adhesive applications

It is recommended to store the samples under climate conditions according to ISO 187 for 24 hours. Use the recommended amount of adhesive applications as it is described below otherwise state the utilized amount or area in the report. Vary the amount of adhesive applications only for the case not reaching representative results or reduce the amount of adhesive applications if stickies heavily overlap on the reject filter.

<u>Adhesive spine</u>

The evaluation of a printed product includes the testing of all adhesive applications. The different adhesive applications of one printed product are tested separately and the results are added weight-proportional (mm^2/ kg). Bookbinding backs which may consist of different adhesive types are tested as one compound as far as no further information is required. The spine and side binding is normally tested together in one test. The both pages at the front and at the end of the printed product should not be separated from the adhesive back unless they contain adhesive applications which should be evaluated independently.

Adhesive magazine and catalogue backs should be separated by means of a saw, leaving approximately 4 cm of the page width attached to the adhesive back. The following use of individual pieces is recommended for the test.

Table 1: Recommendation for the use of magazine/ catalogue back

Width of magazine or catalogue back	Length of each piece	Number of pieces
< 4,5 mm	2,5 cm	5
4,5–6,9 mm	2,5 cm	4
7,0–9,9 mm	2,5 cm	3
10,0–19,9 mm	2,5 cm	2
20,0–30,0 mm	1,0 cm	4
> 30,0 mm	1,0 cm	3

<u>Side glue</u>

If the side glue is of special interest, it is tested separately. The glued sides of the spine of a printed product are prepared similar to the adhesive backs: After separating the first two pages at the front and at the back from the spine, cut a stripe from these pages of 4 cm width including the glued area. Then cut the stripe into pieces of the recommended length in the table.

Glued-in inserts

Glued-in inserts have to be tested separately from spine and side glue.

Inserts made of fibrous material (paper) should not be separated from the printed product page to avoid adhesive losses. The adhesive stays covered with paper on the bottom and on the top side. Cut out the adhesive leaving a frame of paper of approximately 2 cm around the adhesive. Then cut pieces with maximal 2 cm length (which might possibly mean to cut the adhesive).

It might be necessary to use several samples of glued-in inserts to generate a sufficient amount of stickies, e.g. 5 applications. Record the amount for subsequent calculation and report.

Inserts made of plastic materials are detached from the sample without removing the adhesive or with transferring the adhesive carefully back to the printed product page. Cover the adhesive with a clean part of the printed product page and then cut out the adhesive while leaving a frame of paper of 2 cm around it. Then cut pieces with maximal 2 cm length (which might possibly mean to cut the adhesive).

PSA application in printed products

Finished paper label products, e.g. in special editions, journals or magazines may contain huge flat PSA applications. Use 100 cm^2 of the PSA application and stick them on woodfree copy paper. Then cut them into 1–2 cm^2 pieces. If one printed product contains less than 100 cm^2 PSA application use those of several issues of the printed product. Record the number of products for subsequent calculation and report. After performing the test, express the test result in mm^2/kg printed product.

PSA applications – not a final product

Not finally applied PSAs, stickers or labels, are stuck on woodfree copy paper and pressed one time with a press roll (2 kg). It is recommended to use 100 cm^2. This area has to be cut after attaching to the woodfree copy paper into 1–2 cm² small pieces before pulping. Record the grammage of the PSA in g/m^2.

If possible, the area and mass of all tested individual adhesive applications should be recorded. That will allow calculating the test result in relation to these figures.

5.2 Sample preparation

For pulping purposes, virgin fibre based copy paper (20 ± 3 % ash) is used. The total mass of copy paper and adhesive application to be tested is 150 g oven-dry. The paper should be provided in 1–2 cm² sized pieces.

5.3 Disintegration

On order to simulate an industrial sticky fragmentation, it is necessary to use a Hobart pulper under the following conditions. The total mass of copy paper and adhesive application tested is 150 g oven-dry. The total suspension volume in the vessel is 1000 ml.

In the beginning, the vessel of the Hobart pulper is filled with hot water of about 50 °C. After removing the water from the vessel, the copy paper is added as well as 300 ml of the basic chemical solution prepared in accordance with INGEDE Method 11 and tempered dilution water to a total of 925 ml. The dilution water should be heated to such a level that, after the addition of all pulp components, the temperature in the pulper is 45 °C. Directly after the start of the pulping process, set in motion by switching on the rotor at speed 2, the peroxide solution (75 ml), also prepared in accordance with INGEDE Method 11, is added. The prepared adhesive application to be tested is then stirred in immediately afterwards.

Especially during the first five minutes of the disintegration process, any solid particles that attach to the wall of the vessel should be pushed back in to ensure a complete treatment of all solid material. The pulper can be stopped briefly for this purpose.

The pulping time is 30 minutes in total. In order to keep the temperature constant during pulping and to prevent stock losses, the pulper should be fitted with a tightly closing lid.

5.4 Screening

In order to ensure that all generated sticky fragments are taken into account in the evaluation, the entire prepared stock (150 g oven-dry) is screened in portions. For this purpose, the pulped stock is filled up with water to a total volume of 3 000 ml, and the dilution water is used at the same time for rinsing out the pulper vessel. After its homogenisation, the pulp suspension is divided into three equal parts of 50 g oven-dry each. Depending on the contaminant concentration the operator can also decide to screen in portions of 25 g oven dry pulp. For this, divide the pulp suspensions into six equal parts of 25 g oven-dry (500 ml) each and dilute them to 1 liter.

The screening procedure follows INGEDE Method 4.

5.5 Specimen preparation

After each individual screening, the residue is treated according to INGEDE Method 4. It is recommended to prepare one filter sample from each individual screening. Pay attention that no overlapping of stickies occurs on the filters. In the case of presence of larger sticky fragments which can occur especially when testing adhesive backs, check visually if smaller stickies are overlaid before drying the dewatered residue. Try to separate them carefully on the filter or transfer the larger sticky fragments on an additional filter. Big, cubic sticky particles must be transferred on an additional filter (in a later step smaller and flat particles are better covered by the alumina powder).

Besides dewatering, the preparation of the residue includes the part steps of drying and sticky visualisation. The visual check of the contrasted filter preparations is omitted, as there are no other hydrophobic particles than those to be tested contained in the residue. All hydrophobic particles that occur as a result of the adhesive application are taken into account in the following measurement by image analysis.

5.6 Measurement by image analysis

The treated filter preparations are then evaluated with the aid of a scanner-based image analysis system at a resolution of 600 dpi. The area to be measured should be selected in such a way as to ensure that all macro stickies are recorded.

Ensure that one class limit is fixed at the identical equivalent circle diameter of 2 000 µm when defining the class limits. The lowest measuring limit, in view of the method concerned, is 100 µm. When defining the upper limit, it must be ensured that no large sticky fragments are excluded.

DOMAS or SIMPALAB systems can be used. The following defined class limits have to be set:

100 µm, 200 µm, 400 µm, 600 µm, 1 000 µm, 2 000 µm, 3 000 µm, 5 000 µm, 10 000 µm and larger than 10 000 µm.

5.7 Evaluation

Add up the results of single measurements which were obtained due to the screening of individual portions. The final test results are expressed in mm^2/kg printed product air dry, for this, calculate as follows.

<u>Adhesive spine</u>

After the image analysis, the results for adhesive backs are obtained in mm^2/analysed filter area. Calculate the sticky area for the overall back length and divide it by the mass of the printed product (catalogue, magazine...) in kg. The result is mm^2 stickies per kg printed product.

<u>Side glue</u>

Proceed similar to the adhesive spines.

<u>Glued-in inserts</u>

The result of the glued-in insert is divided by the number of used inserts for one test. Divide then by the mass of printed product mass. The result is mm^2 stickies per kg printed product.

<u>PSA application in printed products</u>

The results of PSA application are obtained in mm^2 stickies per 100 cm^2 which have been tested. Based on that, calculate the sticky area for the effective PSA area present in the printed product. Divide then by the mass of printed product and get the result in mm^2 stickies per kg printed product.

PSA applications – not a final product

Calculate the theoretical mass of the tested 100 cm^2 ($m_{100\,cm^2}$):

$$m_{100cm^2} = w_{PSA} \cdot 0{,}01 m^2$$

w_{PSA} grammage of the label, g/m^2

- "Scorecard for the Removability of Adhesive Applications" (ERPC):

Calculate the amount of macrostickies per kg label product. This value is expressed in mm^2/kg label and is transferred to the Scorecard.

- Macrostickies per kg printed product:

It is assumed that the share of the complete label (paper plus adhesive) is about 2,5 % of the complete printed product. Based on this calculate the factor

$$Factor = \frac{25g}{m_{100cm^2}}$$

Multiply the sticky area in mm^2/100 cm^2 with this factor. The result is the macrosticky area per kg printed product under the approval.

The following characteristic quantities from the accumulative result of the measurement of the three individual preparations are used for evaluation purposes:

A_{total} in mm^2 /kg printed product: Total area of macrostickies

A_{MS} in mm²/kg printed product: Total area of macrostickies < 2000 µm identical equivalent circle diameter

S_{2000} in %: Share of macrosticky area below a particle size of 2000 µm identical equivalent circle diameter

A_{600} in mm^2/ kg printed product: The macrosticky content in the size classes below 600 µm identical equivalent circle diameter

A_{1000} in mm^2/kg printed product: The macrosticky content in the size classes between 600 µm and 1 000 µm identical equivalent circle diameter

A_{2000} in mm^2/kg printed product: The macrosticky content in the size classes between 1000 µm and 2 000 µm identical equivalent circle diameter

Presupposing knowledge of the adhesive mass or its application area respectively, it is possible to put the measured area of macrostickies in relation to these figures as mm²/g adhesive or mm²/cm² application respectively.

6 Report

The following should be recorded in the test report:

- Number and type of adhesive applications, amount used in the test if different
- A_{total} in mm^2/kg per single tested adhesive application and overall result for the printed product
- A_{MS} and S_{2000} per single tested adhesive application and overall result for the printed product
- Deviations from the conditions of this test method

7 References

7.1 Cited Standards and methods

Reference was made to the following standards in this method:

- ZELLCHEMING Technical leaflet RECO 1, 1/2006 “Terminology of Stickies”
- ZM V/1.4/86: Gleichzeitige Bestimmung des Gehaltes an Splittern und Faserfraktionen . http://www.zellcheming.de/download/merkblaetter/merkblatt_5_1_4_86.zip
- ISO 1762 – Paper, board and pulps – Determination of residue (ash) on ignition at 525 °C
- TAPPI T 275 sp-07: Screening of Pulp (Somerville-Type Equipment)
- TAPPI T 274 sp-08: Laboratory screening of pulp (Master Screen-type instrument)
- INGEDE Method 4: Analysis of macrostickies in deinked pulp
- INGEDE Method 11: Assessment of Print Product Recyclability - Deinkability Test
- ERPC: Assessment of Printed Product Recyclability – Scorecard for the Removability of Adhesive Applications www.paperforrecycling.eu
- ISO 5269/2: Pulp – Preparation of laboratory sheets for physical testing – Part 2: Rapid-Köthen method
- ISO 287 (2009): Paper and Board – Determination of moisture content – Oven drying method

7.2 Sources

This INGEDE Method was developed and tested within the scope of INGEDE project 66 99 PMV “Evaluation of recyclability of print products with particular consideration of adhesive pulp components” in 2001. In the course of the INGEDE project 129 09 “Preparation of an adhesive application database and development of a recyclability scoring system” the INGEDE Method 12 was revised in 2010.

Assessment of the Recyclability of Printed Paper Products

Testing of the fragmentation behaviour of adhesive applications

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INGEDE Method 1

December 2014

Test sheet preparation of pulps and filtrates from deinking processes

This document was originally developed and launched by INGEDE, its members and its research partners. In the frame of the EcoPaperLoop Project INGEDE Method 1 was translated into several languages. However, in case of any discrepancies the only valid version is the one in English language.

INGEDE Method 1 **September 2014** 6 Pages	**Test sheet preparation of pulps and filtrates from deinking processes**	INGEDE International Association of the Deinking Industry

Introduction

Pulp made of paper for recycling contains typically printing inks influencing its optical properties. Cleaning and flotation remove small sized impurities and printing inks whereby the removal efficiency depends also on applied printing process. The determination of residual ink content uses reflectance measurements of light in the near infrared region. The reflectivity of light gives indication for the content of fine and filler materials which influence the light scattering coefficient and for ink content that alters the light absorption coefficient. The calculation for scattering coefficients requires paper specimens with an opacity less than 95 % (ISO 9416) that is mostly fulfilled with machine papers. Pulp samples taken along the deinking process or pulp samples from deinkability tests (INGEDE Method 11) have to be treated. This INGEDE Method describes the preparation of filter pads where fine and ink losses during preparation are negligible. Filter pads are opaque that hinders the calculation of light scattering coefficient s. Assuming a constant light scattering coefficient is not a recommended approach due to the fact that light scattering varies from pulp to pulp for example when the ash content changes. INGEDE Method 1 describes therefore the preparation of handsheets with the use of recirculated water. The method can be used for industrial as well as for laboratory pulp samples.

1 Scope

This INGEDE method is used to prepare test sheets and filter pads from pulps of the deinking process and laboratory samples.

2 Principle

For testing purpose filter pads are prepared from industrial or laboratory pulp samples using a Büchner funnel and defined filter paper. Handsheets are prepared with the Rapid-Köthen method from industrial pulps under defined conditions. The filtrate samples are drained over a membrane filter and compared with a reference membrane filter made with tap water.

Optical measurements are conducted according to INGEDE Method 2.

3 Equipment and auxiliaries

3.1 Equipment

- Distribution device (volume: 10 l)
- Büchner funnel with appropriate vacuum device that allows a pressure difference ≥ 60 kPa
- Filter paper: Munktell type 1289
- Analytical balance up to 3000 g having an accuracy of at least ± 0,1 g
- Standard sheet former (model: Rapid-Köthen) with dryer (vacuum 95 kPa, 94 ºC), according to ISO 5269-2

- Paper cover sheets and carrier boards according to ISO 5269-2

Filtrate darkening:

- Cellulose nitrate membrane filter: Sartorius type 11306-050N, ø 50 mm, pores ø 0,45 µm
- Vacuum filtration unit with 39 mm bottom inside diameter of the funnel
- Water jet pump or vacuum pump
- Desiccator

3.2 Chemicals

- Cationic Polyacrylamide (CPAM) – high molecular weight, low cationic charge – a polymer for example used for sludge dewatering. Use the CPAM as solution of 1 g/l concentration (powder diluted in tap water).
- Alum

4 Samples

4.1 Pulp samples

A sample should be analysed in the laboratory after sampling a representative quantity of material at the relevant recovered paper processing stage or taking a sample from laboratory deinking test. The consistency of the material should be measured according to ISO 4119.

After the consistency of the material has been measured, the sample is diluted and homogenised to a consistency of 8 g/l in a distribution device. After the consistency has been measured again, a sample can be taken for preparing the test sheet. No pH adjustment is required.

Pulp suspensions up to a consistency of 10 % can be used immediately for sheet preparation without further preparation. However, deinked pulp with higher consistency must be disintegrated before sheet forming. Disintegration takes place in accordance with ISO 5263-2, whereby the disintegration process is restricted to five minutes. At a consistency of 2 % periods of mechanical stress should be held short in order to avoid changes in size distribution of unwanted particles, e. g. ink and stickies.

4.2 Filtrate samples

The preparation of filter pads for measuring the optical properties generates filtrates which are used to prepare the membrane filter samples afterwards. The preparation of the two filter pads produces two filtrate samples from each pulp sample.

5 Procedure

5.1 Filter pads

At least two filter pads are prepared of the pulp samples respectively.

The filter pad is formed using a Büchner funnel which has been covered by a moistened filter paper. The prepared filter pads have a basis weight of 225 g/m². A filter paper diameter of 150 mm and a maximum Büchner funnel diameter of 160 mm are recommendable. For this case 4,0 g oven-dry pulp material is used and the suspension is topped up with tap water to a volume of 1 litre.

Other filter diameters may be used referring to table 1. The diameter of the Büchner funnel corresponds to the filter diameter and should not exceed the maximum value in table 1. Usually, Büchner funnels are purchased by their nominal diameter that is identical with the filter diameter.

If a differing size of Büchner funnel and filter paper are used the sample volume has to be adapted according to table 1. The consistency of the pulp sample remains 0,4 %.

Table 1: Pulp volume for Büchner funnel filtration

Diameter max Büchner funnel in mm	Diameter filter paper (Munktell 1289) in mm	Oven dry material in g	Sample volume at 0,4 % consistency in ml
120	110	2,15	538
135	125	2,75	688
160	150	4,00	1000
195	185	6,10	1525

After filtering and carefully removing the filter paper, the wet filter pad is laid between two new sheets of filter paper before drying. The drying time in the Rapid-Köthen dryer is 10 minutes. The dried filter paper should not be removed from the filter pad until immediately prior to measuring the optical properties.

Experiences have shown that the support of a thin wire made of nylon helps to avoid marks. For this purpose use a nylon wire with a mesh width of about 140 µm and a mesh diagonal of about 190 µm and place it under the filter paper. This option is allowed when preparing the filter pads, but not if the filtrate is analysed for filtrate darkening measurements. For optical assessment of filtrate quality according to chapter 5.5 collect the filtrate obtained from filter pads prepared with one filter paper.

5.2 Laboratory handsheet formation – General procedure

An appropriate volume of material should be taken from the distribution device for each handsheet. After standard laboratory handsheet formation, dry the sheet in the Rapid-Köthen dryer between carrier board and a cover sheet. The drying time should be 7 minutes. The carrier board and the cover sheet should not be removed from the handsheet until immediately prior to measuring the optical characteristics.

5.3 Handsheets for determination of the dirt particle area A

At least two handsheets for the determination of the dirt particle area (A) are prepared with fresh water in order to reach better contrast for the optical analyses. Grammage m_A should amount to 42,6 g/m^2 ± 1,6 g/m^2, related to oven-dry substance.

5.4 Handsheets for the determination of Kubelka Munk parameters

Handsheets for the determination of Kubelka Munk parameters specific light absorption coefficient (k) and specific light scattering coefficient (s) are prepared with recirculated water. Their opacity should not exceed 95 % in the near infrared area.

A homogeneous suspension quantity corresponding to 1,35 g of oven-dry substance is being taken from the distribution container to prepare a laboratory sheet in compliance with ISO 5269-2. After dewatering it is removed from the wire section and either disposed of or used as laboratory sheet for piling to determine reflectance factor R_∞. The filtrate obtained in the process (white water) is being retained and used to dilute the next sheet. To increase the concentration of the white water, this procedure is repeated for four times without changing oven-dry substance. The 5th sheet is removed from the wire section and dried between carrier board and cover sheet in the Rapid-Köthen drier for a minimum of seven minutes. Determine the grammage of the sheet.

The suspension quantity required for sheet formation is modified for the first time so as to obtain a laboratory sheet of a grammage m_A of 42,6 g/m^2 ± 1,6 g/m^2, related to oven-dry substance.

Note: The above grammage corresponds to a laboratory sheet weight of 1,35 ± 0,05 g after RK-drying.

The adapted suspension quantity is then used to prepare two more laboratory sheets (sheets 6 and 7) with the concentrated filtrate, which are also dried between carrier board and cover sheet in the Rapid-Köthen drier for a minimum of seven minutes. To facilitate the following optical measurement, it is recommended to mark top side and wire side.

Prior to optical assessment, the two laboratory sheets have to be conditioned in compliance with ISO 187. The sample grammage after conditioning in a standard reference atmosphere ought to be 45 g/m^2. The value is rounded to 0,1 g/m^2.

5.5 Filtrate samples

The complete filtrate obtained by dewatering the pulp for one filter pad is homogenised. 100 ml filtrate is completely drained using a cellulose nitrate membrane filter in a vacuum filtration unit. Any fibrous material found on the membrane filter may indicate that some pulp bypassed the filter paper when preparing the filter pad. In such a case the membrane filter and filtrate have to be discarded. Prepare a new filter pad and filtrate as described in chapter 5.1.

The filtrate of two filter pads (chapter 5.1) is filtered respectively. Generally, the filtration is done without any retention aids. The result of this filtration must be a discoloured, clear liquid.

Exception:

In case of still having a colourised filtrate after membrane filtration, repeat the procedure with a new sample (100 ml). Add retention aid solution (start with 5 ml) before membrane filtration, possibly alum or cationic polyacrylamide (CPAM) with high molecular weight and low cationic charge. State in the report whether the membrane filtrate was coloured and a retention aid was used, if yes, how much.

The membrane filters are removed from the filtration unit and dried in a desiccator.

Reference membrane filters are made in the same way, but using exclusively 100 ml of tap water without pulp. Prepare a membrane filter for each test series or on a daily basis at least.

6 Report

- The type of handsheets prepared
- Büchner funnel diameter
- Photography of handsheets and filter pads, membrane filtrate and membrane filter
- Filtrate sample preparation with or without retention aid, dosage
- All deviations from the method

7 References

7.1 Cited Standards and methods

- INGEDE Method 2: Measurement of optical characteristics of pulps and filtrates from deinking processes.
- ISO 187: Paper, board and pulps – Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples (1990).
- ISO 4119: Pulps – Determination of stock concentration (1995).
- ISO 5263-2: Pulps – Laboratory wet disintegration - Part 2: Disintegration of mechanical pulps at 20 °C (2004)
- ISO 5269/2: Pulp – Preparation of laboratory sheets for physical testing, Part 2: Rapid-Köthen method.
- ISO 9416: Paper – Determination of light scattering and absorption coefficients (using Kubelka-Munk theory) (2009)

7.2 Sources

This method has been published for the first time in 1997. A major revision was done according to the definitions made in INGEDE Project 85 02 CTP/PMV/PTS – European Deinkability Test Method. In 2006, also parts of the INGEDE Methods 3 and 10 were transferred to this method. In 2014 a filter paper was defined based on the results of INGEDE Project 140 13.

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INGEDE Method 2

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Measurement of optical characteristics of pulps and filtrates from deinking processes

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INGEDE Method 2 **24 November 2014** 11 Pages	**Measurement of optical characteristics of pulps and filtrates from deinking processes**	INGEDE International Association of the Deinking Industry

Introduction

Optical properties are key parameters for the quality of deinked pulp as well as for determining the efficiency of deinking operations. Parameters and details of the measurement procedures defined and described in this method are reflectance factors, light absorption and scattering coefficients, ERIC, colour values and dirt specks.

The method contains the determination of the Ink Elimination IE based either on the light absorption coefficients or on ERIC of undeinked and deinked pulps.

Particularly when dealing with extremely fine dispersed printing ink particles (e. g. water based printing ink) in the deinked pulp, the filtrate analysis method allows assessing possible pollution levels which may occur in the water systems of deinking plants.

1 Scope

This INGEDE method describes procedures for measuring and calculating various optical characteristics of pulps and filtrates from deinking processes by means of filter pads and handsheets. The method is applicable for industrial as well as for laboratory samples.

2 Terms and definitions

IE: Ink Elimination, calculated as the ratio of the difference of the absorption coefficient k of the undeinked and deinked samples to the difference of the absorption coefficient k of undeinked and unprinted samples.

ERIC: Effective Residual Ink Concentration, calculated as the ratio of the absorption coefficient k of a pulp or paper sample divided by the absorption value of black printing ink and multiplied by 10^6. For black printing ink, a constant k value of 10 000 m²/kg may be used. For further details please refer to TAPPI T 567 om-09 or ISO 22754.

3 Principle

Industrial or laboratory samples of pulp and filtrates in deinking processes are transformed to filter pads and handsheets by means of INGEDE Method 1. This INGEDE Method 2 describes and defines the parameters and the settings of the measurement devices to obtain results for optical characterisation of the samples. The calculation of the Ink Elimination is also part of this method and allows an assessment of the deinking process.

4 Equipment and auxiliaries

4.1 Equipment calibration for reflectance measurements

Any measuring equipment set-up which meets the ISO 2470-1 and ISO 5631-2 (colour) requirements may be used for measuring.

- **Zero point initialisation**

A black standard which meets the requirements which are specified in ISO 2469 is used to check the zero point.

- **Upper limit initialisation**

A white standard which meets the criteria described in ISO 2469 is used to set the upper limit.

4.2 Dirt particle measurement (A)

For the determination of dirt particle area A, a scanner based image analysis system is needed for optical analysis. The scanner is to be calibrated to ensure reproducibility of the measurements.

Technical requirements of flatbed scanner:

- Scanning area ≥ ISO A4
- Optical scan resolution ≥ 2000 dpi,
- Colour depth 48 bit,
- Optical density $D_{MAX} \geq 4{,}0$

Requirements on measuring accuracy of flatbed scanner after warm-up period (see scanner manual) and under scanning conditions (see chapter 5.3)

- Reproducibility of mean grey value (8 Bit) ±1 (A ISO A4 sample has to be scanned 10 times without any movement of the sample. All mean grey value of total sample area should be within 2 grey values.)
- Deviation of colour value (RGB-8 Bit) ≤ 5 (After calibration a scanned image of IT8-Target shouldn't have more deviation to associated reference file than ± 5 values in every colour channel - R,G,B.)

Suitable scanners: DOMAS Scanner*Advanced*, Techpap proposed scanner

NOTE:

"Scanner*Advanced*" is a name given by PTS to a commercial scanner that was accredited by PTS. This scanner device is delivered with the DOMAS 3.0 version.

The image analysis software is to be parameterised according to the specifications as described in chapter 5.9.

Suitable software packages are: DOMAS 3.0 and above image analysis software, SIMPALAB Image Analysis Software.

5 Analysis

5.1 General

5.1.1 Sample preparation

The sample preparation is described in INGEDE Method 1. According to Table 1 use either a filter pad or a handsheet to determine the optical parameter and state in the report, which specimen was measured. The samples have to be air-conditioned in accordance with ISO 187.

5.1.2 Sample illumination for reflectance measurements – edge filter

For deinkability testing according to INGEDE Method 11, the samples are illuminated with C/2° conditions while using the edge filter of 420 nm (UV filter)[1]. This applies to all reflectance measurements. Other tests are conducted according to the stated standards.

5.1.3 Measuring points and number of measurements for reflectance measurements

Both sides of the test sheets should be measured (filter pads and laboratory handsheets). Best care and attention is given to avoid measurements too near to edges, kinks or on visible non-uniformities of the test sheets.

Respectively two samples should be measured with four measurements on each side of filter pads and laboratory handsheets. Just one measurement is made on the top side of membrane filter samples.

NOTE: When measuring laboratory handsheets, these ought to be stacked in a way to guarantee an opaque pile of sheets.

5.2 Overview of measurements

The luminosity Y, R_{457} and the reflectance factors R_∞ and R_0, the CIELab colour coordinates (L*, a*, b* values) are measured from the samples. The absorption coefficient *k* and scattering coefficient *s* and ERIC are determined based on reflectance factors, commonly provided by the measuring device. The Ink Elimination IE is calculated from the absorption coefficients or ERIC of the undeinked, deinked and unprinted samples. The dirt specks particle area A is analysed with the help of scanner based image analysis system. For more details see the following chapters.

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[1] It has been shown that the results with light source C/2° with an edge filter of 420 nm and D65/10° with an edge filter of 420 nm are nearly identical. For this reason and because the method measured originally C/2° it was decided that the measurement is performed with C/2°.

Table 1: Overview of sample types, parameters to be measured and corresponding chapter in INGEDE Method 1

Sample	Chapter in INGEDE Method 1	Parameters
Filter pad	5.1.	Y, R_{457}, ERIC, IE_{700}, IE_{ERIC}, L*, a*, b*
Handsheet without recirculated white water	5.3	Dirt particle area A
Handsheet with re-circulated water	5.4	ERIC, *s*, *k*, IE_{700}, IE_{ERIC}
Filtrate	5.5	Y, ΔY

5.3 Reflectance factors

The reflectance R_∞ is measured with a device according to ISO 2469 at a wavelength of 700 nm and 950 nm. R_∞ is the reflectance factor of a layer handsheets or pad that is thick enough to be opaque.

R_∞ at a wavelength of 457 nm (brightness) is measured with a device in accordance with the standard ISO 2470-1 ISO brightness.

The reflectance of a single sheet R_0 is measured at 700 and 950 nm with the stated conditions above. In accordance to ISO 9416, the single sheet must meet the requirements, that the opacity must not exceed 95 %. R_0 is the reflectance factor of a single sheet of paper with a black cavity as backing.

5.4 Y, L*, a*, b* and opacity

The luminosity Y is determined in accordance with DIN 6174. The CIELab colour coordinates L*, a* and b* are determined according to ISO 5631-2. From handsheets, the opacity following ISO 2471 is determined.

5.5 Determination of the light absorption coefficient k and the light scattering coefficient s

The light absorption coefficient *k* in m^2/kg and the light scattering coefficient *s* in m^2/kg are obtained by means of the measured reflectance factors R_0 and R_∞ as well as basis weight according to Kubelka-Munk in compliance with ISO 9416. In addition to ISO 9416 where *k* and *s* are obtained by means of the tristimulus filter used to determine reflectance factor, the reflectance factor in the case of Ink Elimination has to be determined at a wavelength of either 700 nm or 950 nm.

The use of the method ISO 9416 is restricted to samples with opacity less than 95 %, otherwise inaccuracy in calculation of *s* will occur, for more details see ISO 9416. Therefore it is not possible to determine *s* from filter pads or thick handsheets. Handsheets with recirculated water meet possibly the requirements of ISO 9416.

Equation 1: Light absorption coefficient in m^2/kg

$$k = s \cdot \left(\frac{(1-R_\infty)^2}{2\,R_\infty} \right)$$

R_∞ is expressed as decimal.

Equation 2: Light scattering coefficient in m^2/kg

$$s = \left(\frac{1000}{w} \right) \cdot \left(\frac{R_\infty}{1-R_\infty^2} \right) \cdot \ln \frac{R_\infty\,(1-R_0 \cdot R_\infty)}{R_\infty - R_0}$$

w= grammage (g/m^2)

R_∞ and R_0 are expressed as decimal.

5.6 Ink Elimination IE

Generally speaking, Ink Elimination is obtained using the light absorption coefficient *k* of the undeinked, deinked and unprinted samples. For known scattering coefficient *s*, Equation 1 gives the determination of *k*. Ink Elimination (IE) is calculated as follows:

Equation 3: Ink Elimination in %

$$IE = \frac{K_{UP} - K_{DP}}{K_{UP} - K_{unpr}} \cdot 100$$

Where:

UP= undeinked pulp

K_{UP}= light absorption coefficient k of undeinked sample

DP= deinked pulp

K_{DP}= light absorption coefficient k of deinked sample

unpr= unprinted sample

K_{unpr}= light absorption coefficient k of unprinted sample

It is assumed that the difference in *s* of filter pads before and after the flotation is as magnitude as the losses of pulp components during hand sheet preparation. Assuming *s*=const, Equation 3 can be used simplified by neglecting the light scattering coefficient *s*, calculating IE only with R_∞ from filter pads (Equation 4). Alternatively, the scattering coefficient *s* of the deinked pulp in the investigated plant or of the investigated sample has to be determined for the specific sampling point in the process and its value used as approximation.

Equation 4: Ink Elimination in %

$$IE = \frac{\left(\frac{(1-R_{\infty,UP})^2}{R_{\infty,UP}}\right) - \left(\frac{(1-R_{\infty,DP})^2}{R_{\infty,DP}}\right)}{\left(\frac{(1-R_{\infty,UP})^2}{R_{\infty,UP}}\right) - \left(\frac{(1-R_{\infty,unpr})^2}{R_{\infty,unpr}}\right)} \cdot 100$$

Where:

$R_{\infty,UP}$ = *reflectance factor* R_∞ *of undeinked sample*

$R_{\infty,DP}$ = *reflectance factor* R_∞ *of deinked sample*

$R_{\infty,unpr}$ = *reflectance factor* R_∞ *of unprinted sample*

R_∞ is obtained either at a wavelength of 700 nm (for IE_{700}) or at 950 nm (for IE_{ERIC}).

- **IE_{700}**

The R_∞-values measured at 700 nm on filter pads of deinked pulp (DP) and undeinked pulp (UP) are not used in %, but as absolute values, e. g. 0,69. If no unprinted samples are available, the value for the term $(1–R_{\infty,unpr})^2/ R_{\infty,unpr}$ may be set to 0.

Equation 5: IE_{700} in %

$$IE_{700} = \frac{\left(\frac{(1-R_{\infty,UP})^2}{R_{\infty,UP}}\right) - \left(\frac{(1-R_{\infty,DP})^2}{R_{\infty,DP}}\right)}{\left(\frac{(1-R_{\infty,UP})^2}{R_{\infty,UP}}\right) - \left(\frac{(1-R_{\infty,unpr})^2}{R_{\infty,unpr}}\right)} \cdot 100$$

- **IE_{ERIC}**

The ERIC values (chapter 5.7) are measured at 950 nm of DP and UP. If no unprinted samples are available, the value for $ERIC_{unpr}$ may be set to 0.

If the deinkability of different paper grades is to be compared, the measurement of the corresponding unprinted papers is recommended.

Equation 6: IE_{ERIC} in %

$$IE_{ERIC} = \frac{ERIC_{UP} - ERIC_{DP}}{ERIC_{UP} - ERIC_{unpr}} \cdot 100$$

5.7 ERIC

The calculation for ERIC follows ISO 22754 and TAPPI T567 om-09:

Equation 7: ERIC

$$ERIC = (k_{Sheet} / k_{ink}) \cdot 10^6$$

R_0 and R_∞ are determined at a wavelength of 950 nm of specimen, which meet the requirements to ISO 9416. If a lightweight sample is not available, make certain that the scattering coefficient *s* is truthfully representative of the sample being tested. For this case, ERIC value and the value for *s* has to be stated together in the report.

5.8 Filtrate Darkening

The filtrate darkening ΔY is the difference in luminosity Y between membrane filter pads made from filter pad filtrate and tap water as reference. The preparation of membrane filter pads is described in INGEDE Method 1.

The luminosity Y of the filtrate membrane filter pad ($Y_{filtrate}$) and of the reference membrane filter pad ($Y_{reference}$) are determined at identical conditions according chapter 5.4. $Y_{filtrate}$ is the average value of the two membrane filter pads- see INGEDE Method 1. By subtracting $Y_{filtrate}$ from $Y_{reference}$, ($\Delta Y = Y_{reference} - Y_{filtrate}$), all factors affecting filtrate quality and not attributable to the pulp are eliminated.

5.9 Procedure for dirt particle measurement (A)

A scanner based image analysis system is to be used for the determination of the dirt specks area "A".

The top and the bottom side of at least two laboratory handsheets per specimen are to be assessed by the image analysis system. The arithmetic mean of min. 4 measured values is to be calculated. This mean value is to be taken as the dirt specks area "A".

Scanning conditions:

The sheets should be free of crinkles and waves to lie flat on the scanner. The sheets are to be scanned individually. As background an opaque batch of woodfree copy paper (min. 5 sheets with a luminosity of Y= 84 ± 2 measured with illumination D65/10° and 420 nm edge filter) should be used. Every handsheet should be scanned one time from top and from the bottom with 8-bit grey modus, 600 dpi and reflective light.

If the scanner is idle for more than 15 minutes a blank scan has to be made in advance of any new measurement.

Image analysis software parameterisation: The threshold values and the size classification are to be defined as described in the appendix.

In case of using DOMAS image analysis system the following parameters are recommended:

- The threshold of measurement is determined by file "ingede2.sw"
- The size classification is determined by file "ingede2.kls"
- Select: "Circular specimen with border" if specimen is circular
- Select threshold method "file" and select "ingede2.sw"
- Select size classification "circle equivalent diameter" and select "ingede2.kls"
- Select: image source "scan series" and select "specks_1.scn"
- Set "No of specimens" to "4"
- Select: "Average series of results"

In case of using SIMPALAB software (Techpap SAS):
Select the family "Ingede2.cfg", to take pre-installed parameters for the measurement of optical characteristics into account. The threshold of measurement, sizes for classification (50–100 µm, 100–150 µm, …) and other parameters are already determined in the file "ingede2.cfg" and set automatically.

6 Report

When measuring laboratory handsheets and filter pads, where top and bottom are measured separately, the mean of the two values should always be reported. If the top and bottom values differ considerably, the individual values should also be reported.

The following should be noted in the test report:

- Type of test specimens the optical measurements refer to (laboratory handsheets or filter pads),
- Type of light and the inspection angle for which the values were calculated,
- The light absorption coefficient *k* in m^2/kg, the light scattering coefficient *s* in m^2/kg, ERIC or R_∞ at 700 nm of the undeinked and deinked pulp samples and the Ink Elimination derived in %,
- For filtrate samples, the test report should list the mean of both optical measurements ($Y_{filtrate}$ and $Y_{reference}$).

7 References

7.1 Cited Standards and methods

- IFRA Newsshade 2003, IFRA Special Report 1.11.2.
- INGEDE Method 1: Test sheet preparation of pulps and filtrates from deinking processes
- ISO 187: Paper, board and pulps: Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples (1990)
- ISO 2469: Paper, board and pulps – Measurement of diffuse radiance factor (diffuse reflectance factor) (2014)
- ISO 2470-1: Paper, board and pulps – Measurement of diffuse blue reflectance factor – Part 1: Indoor daylight conditions (ISO brightness) (2009)
- ISO 2471: Paper and board – Determination of opacity (paper backing) – Diffuse reflectance method (2008)
- ISO 4119: Pulps: Determination of stock concentration (1995)
- ISO 5269-2: Pulps – Preparation of laboratory sheets for physical testing – Part 2: Rapid-Köthen method (2004)
- ISO 5631-2: Paper and board - Determination of colour by diffuse reflectance - Part 2: Outdoor daylight conditions (D65/10 degrees) (2014)
- ISO 9416: Determination of light scattering and absorption coefficients (using Kubelka-Munk theory) (2009)
- ISO 22754: Pulp and paper - Determination of the effective residual ink concentration (ERIC number) by infrared reflectance measurement (2008)
- TAPPI T 567 om-09: Determination of effective residual ink concentration by infrared reflectance measurement (2009)

7.2 Sources of the material used

DOMAS

- Files:
  “ingede2.sw”, and “ingede2.kls”: www.INGEDE.org
- Software:
  “DOMAS Calibration Tester”, PTS Heidenau and Munich www.ptspaper.de
- Scanner:
  DOMAS Scanner*Advanced*, PTS Heidenau and Munich
- Image analysis software:
  DOMAS 3.0, PTS Heidenau and Munich

SIMPALAB

- Files:
  “ingede2.cfg”
- Software:
  SIMPALAB_[]_3.00.[1x], Techpap SAS Grenoble
- Scanner:
  A list of compatible scanners is available from Techpap SAS Grenoble
  (www.techpap.com, sales@techpap.com)

Contact:
INGEDE e. V. (International Association of the Deinking Industry)
Office
Gerokstr 40
74321 Bietigheim-Bissingen, Germany
Tel. +49 7142 7742-81
Fax +49 7142 7742-80
E-Mail office@ingede.org
www.ingede.org

Annex

Threshold value determination

Use this formula: Threshold = mean – k_factor

Linear interpolation between two pairs of values gives the threshold value demanded.

mean (8-bit grey value)	k_factor
167,42	35,81
202,01	30,43
221,37	30,91
239,17	35,38
248,16	33,75

For use within DOMAS software the threshold of measurement is determined by the file “ingede2.sw“(see software attachment).

For use within Techpap SIMPALAB Software the threshold of measurement is determined by file “ingede2.cfg”.

Size classification

Definition of the size classes of an equivalent diameter of a circle:

from (µm)	to (µm)
> 50	≤ 100
> 100	≤ 150
> 150	≤ 200
> 200	≤ 250
> 250	≤ 500
> 500	≤ 50 000

For use within DOMAS software the size classification is determined by file “ingede2.kls“ (see software attachment).

For use within Techpap SIMPALAB Software the size classification is determined by the file “ingede2.cfg”.

INGEDE Method 4

April 2013

Analysis of macrostickies in pulps

This document was originally developed and launched by INGEDE, its members and its research partners. In the frame of the EcoPaperLoop Project INGEDE Method 4 was translated into several languages. However, in case of any discrepancies the only valid version is the one in English language.

INGEDE Method 4 **April 2013** 13 Pages	**Analysis of macrostickies in pulps**	INGEDE International Association of the Deinking Industry

Introduction

Stickies in pulps originate from tacky components in paper for recycling. They cause problems during paper production and converting as well as quality defects.

This method is widely accepted to measure the macrosticky content of pulps.

1 Scope

This INGEDE Method is used to analyse macrostickies in pulps.

2 Terms and definitions

Macrostickies:

Tacky components originating from paper for recycling which can be analysed from the residues of a laboratory screening (see also the corresponding leaflet of ZELLCHEMING).

3 Principle

The method describes a laboratory screening procedure for pulps of a paper recycling process. The reject of this screening procedure is prepared in such a way that the macrostickies can be determined by means of an image analysis system.

4 Equipment and auxiliaries

4.1 Equipment

4.1.1 Disintegration

Any device which fulfils the requirements of ISO 5263-1 may be used for disintegration of samples.

4.1.2 Screening

Macrostickies can be separated from recycled pulp suspensions using various laboratory screening devices. Possible screening devices are the Haindl classifier (ZM V/1.4/86), the Somerville tester (TAPPI T 275 sp-07) or the Pulmac Master Screen (TAPPI 274 sp-08).

4.1.3 Slotted plate

For pulps in deinking, the use of a slot width of 100 µm is recommended. Other slot widths have to be reported as deviation from the method.

NOTE:

Screening investigations with slotted plates of nominally the same slot width showed significant differences in the screening result (see INFOR Project 118). The maximum slot width correlates with the macrosticky area. Therefore it is recommended to measure all slots widths on the slotted plate. A ZELLCHEMING test method for the quality requirements of slotted plates in laboratory screening devices is available.

4.1.4 Reject dewatering and drying

Any device which fulfils the requirements of ISO 5269-2 may be used for dewatering and drying the dewatered screening rejects e. g. the Rapid-Köthen unit. Additionally, an oven which fulfils the specifications of ISO 287 is required.

4.1.5 Image analysis

An image analysing system comprising a flatbed scanner and PC with a suitable control and analysis program is used for the measurements. The scanner is to be calibrated to ensure reproducibility of the measurements.

Technical requirements of the flatbed scanner:

- Scanning area ≥ ISO A4
- Optical scan resolution ≥ 2000 dpi
- Colour depth 48 bit
- Optical density DMAX ≥ 4,0

Requirements on measuring accuracy of flatbed scanner after warm-up period (see scanner manual) and under scanning conditions (see chapter 5.6).

- Reproducibility of mean grey value (8 Bit) is ±1. That means that an ISO A4 sample has to be scanned 10 times without any movement of the sample; all mean grey values of total sample area should be within 2 grey values.
- Deviation of colour value (RGB 8 Bit) ≤ 5. That means that after calibration a scanned image of IT8-Target should not deviate more from associated reference file than ± 5 values in every colour channel R, G, B.

Suitable scanner: DOMAS ScannerAdvanced or Techpap SIMPALAB proposed Scanner

"ScannerAdvanced" is a name given by PTS to a commercial scanner that
was accredited by PTS. This scanner device is delivered with the DOMAS 3.0 version.

The software should be able to detect white particles on a black background. Suitable software package are DOMAS 3.0 and above image analysis software as well as Techpap SIMPALAB software.

4.2 Test material

The following testing material may be used:

- Black water-based ink, e. g. Pelikan No. 4001
- One sided, silicone-coated release paper (60 g/m²)
- Filter paper: medium to large pores, medium filtration speed, machine finished, good wet strength, white, e.g. Munktell Filtrak 1289, 240 mm diameter
- Special fused alumina powder: white, sharp-edged particles, grain size 220 according to FEPA Method.

(Sources of supply see chapter 7.4)

Analysis of macrostickies in pulps

5 Procedure

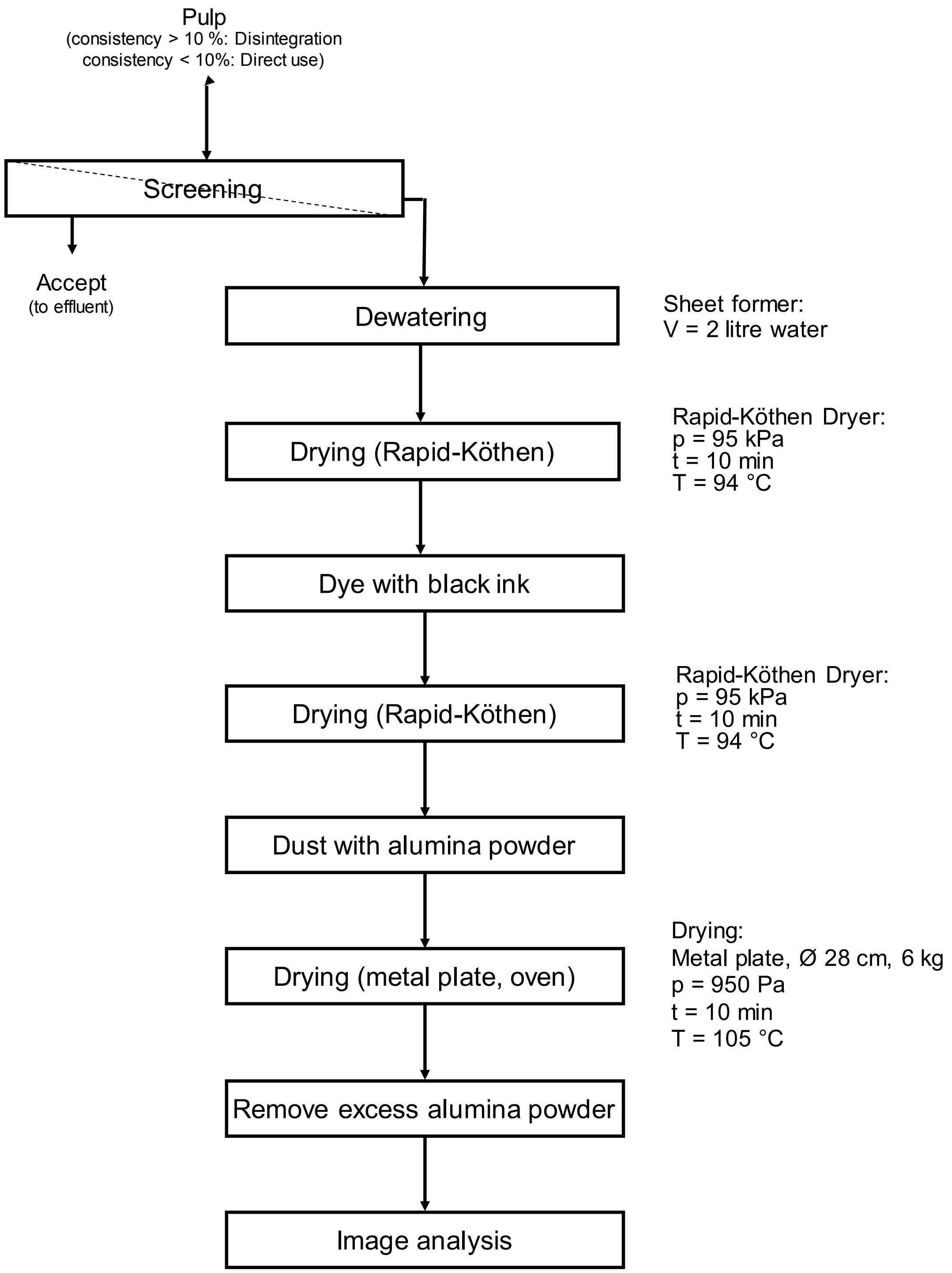

Figure 1: Test procedure INGEDE Method 4

5.1 Sampling and sample preparation

Pulp suspensions with a consistency up to 10 % can be used immediately for screening without further preparation. However, pulp with higher consistency must be disintegrated before screening. 50 g oven-dry pulp in 2000 ± 25 ml is disintegrated. Disintegration is fulfilled in a device in accordance with ISO 5263-1 whereby the disintegration process is restricted to five minutes. Longer periods of mechanical stress should be avoided in order to prevent changes of the sticky size distribution in the sample.

5.2 Screening

5.2.1 General

For a statistically sound statement about the macro sticky content, the screening of three individual portions, each containing 50 g of oven-dry material from one sample, is recommended. Some pulps may cause difficulties during screening due to high long fibre content or high level of contamination. In this case the pulp amount can be split into portions (e.g. 2 x 25 g) and/or the screening time can be elongated. In case of Pulmac Master Screen the reduction is preferred vs. the change of the screening programme. A reduction of the sample's quantity is also necessary if the load of stickies is so high that the stickies overlap heavily after contrasting.

Any deviation has to be reported.

When using a plastic screen plate, mechanical stress can lead to material fatigue and destruction of the slotted plate. For this reason the use of a metal plate is recommended.

5.2.2 Screening conditions overview

The following table gives an overview about screening equipment and conditions.

Table 1: Screening conditions

Equipment	Reference	Water flow	Stroke	Duration (Pulp input + further screening)
Haindl classifier	ZM V/1.4/86	10 l/ min	480 double strokes per minute	5 min + 5 min
Somerville tester	T 275 sp-07	8,6 l/ min	700 rpm	2 min + 18 min
Pulmac Master Screen	T 274 sp-08	Depends on programme setting (Modus B)		

5.2.3 Haindl classifier

The screening with the Haindl classifier is performed according to ZM V/1.4/86, without using the McNett unit. In order to guarantee problem-free screening of 50 g of oven-dry pulp, unlike ZM V/1.4/86 the screening conditions should be set up as follows. The stroke frequency of the membrane should be increased to 480 double strokes/ minute (maximum stroke rate). Because of the resulting turbulence increase in the screening chamber, the height of the cylindrical supply vessel wall should be increased from 130 mm to 370 mm. The container can be extended using an acrylic glass top. The washing water flow should be 10 litres per minute for the entire screening duration. After continuously adding pulp for 5 minutes, the pulp continues to be screened for 5 minutes until screening is complete.

5.2.4 Somerville tester

The screening in a Somerville tester is performed referring to T 275 sp-07. 50 g oven dry pulp is poured into the screen box within the first 2 minutes of 20 minutes overall screening duration.

5.2.5 Pulmac Master Screen

When using the Pulmac Master Screen, 50 g of oven-dry pulp is added to the supply chest. The screening which follows is automatic. Programme setting should be “Modus B”. Before screening, a wet filter paper which retains the reject when the screening is complete must be placed onto the sieve in the dewatering unit (autofilter).

5.3 Dewatering the reject

The reject is flushed from the slotted plate into a container using about one litre of water. Using a moistened white paper filter above the sheet forming wire the reject is dewatered in the sheet former (Rapid-Köthen model). It is advisable to operate the sheet former manually. When the reject sample and an additional litre of water are in the sheet former, the aeration is started before dewatering. After dewatering, the specimen which has been formed is placed onto a couching board with the bottom of the filter (reject-free side). If the load of stickies is so high that the stickies overlap after contrasting (chapter 5.5), the reject has to be portioned to several filter papers. It is also possible to separate overlapped stickies carefully on the filter or transfer the larger sticky fragments on an additional filter. Big, cubic sticky particles must be transferred on an additional filter (in a later step smaller and flat particles are better covered by the alumina powder).

When using the Pulmac Master Screen, the reject is dewatered in the unit automatically using the same type of filter paper. The dewatered specimen can be removed after the screening is complete. It is also laid onto a couching board with the bottom side of the filter.

5.4 Drying

The top side of the specimen is then covered with the coated side of the silicone-coated sheet of release paper. Then the sample is dried for 10 minutes in the sheet dryer (Rapid-Köthen model) at 94 C and a pressure of 95 kPa.

5.5 Sticky examination

After drying, the stickies are examined by utilising their adhesive properties in order to provide the contrast to the specimen's background which is required for image analysis. Before removing the silicone coated release paper the specimen is cooled down for a short time. Heavy sticky particles could adhere to the silicon paper and must be transferred back to the filter paper.

The dried specimen is then drawn through a submersion bath containing black water-based ink, so that the entire surface is covered. The dyed specimen is then laid with its bottom side on a piece of blotting paper (bleached sheet of cellulose or tissue), so that any excess ink is absorbed. Then the specimen is dried for another 10 minutes, the top side covered with the previously used silicone-coated release paper.

In order to avoid discoloration of the drying equipment, the specimen should be placed between two couching boards during drying.

Subsequently after a short cooling down, the specimen is completely covered with a thick, even layer of white special fused alumina powder, the top and bottom sides are covered with couching board and it is then dried for 10 minutes in an oven at 105 °C. The specimen is loaded with a pressure of 950 Pa (6 kg metal plate, Ø 28 cm) to fix the powder on the tacky areas. The metal plate should be stored in the oven permanently to keep the high temperature. After the procedure is complete, the specimen should be removed from the oven. Excess, loose powder has to be removed with a soft cosmetic brush, without applying pressure, whilst holding the specimen in a vertical position.

After the stickies have been contrasted inspect the stickies visually. It is important that the stickies do not overlap. The visual inspection also serves to check whether all white hydrophobic impurities such as pieces of plastic film have been removed. In order to do this, the components to be eliminated should either be removed using tweezers or marked using a black permanent marker so that they are not detected during the subsequent image analysis.

5.6 Image analysis

The prepared specimen is then analysed using a scanner-based image analysis system. When selecting the measuring area, the preparation area should be used in order to analyse as many of the stickies which were retained during screening as possible. The largest possible measuring area should be selected.

The top side of the recommended 3 specimens per sample are to be assessed by the image analysis system. The arithmetic mean of the 3 measured values is to be calculated. Scanning conditions: The sheets should be free of crinkles and waves to lie flat on the scanner. An opaque batch of black carton should be used as background. Every specimen should be scanned one time from top side with 8-bit grey modus, 600 dpi and reflective light.

If the scanner is idle for more than 15 minutes, a blank scan has to be made before any new measurement.

Parameterisation of image analysis software: The threshold value and the size classification are defined in the following. Other threshold setting is regarded as deviation from this method and must be reported. When setting the class limits, the size of the slots in the slotted plate which was used for screening is set as lower limit (regular 100 µm). Smaller stickies cannot be expected because of the sticky surface increase which is associated with the drying process. The final class may not have an upper limit, so that all stickies are recorded.

The amount of pulp used (typically 50 g oven-dry) has to be known as input value for the image analysis software to calculate the macrosticky area as described in chapter 5.7.

In case of using DOMAS image analysis system the following parameters are recommended:

- Set “Slot width” to “100” (µm)
- Select “Circular sample with border”
- Select “Light contrasted stickies”
- Select Threshold method “fixed threshold” and set parameter to “95”
- Select “Size classification” with “circle equivalent diameter” and select “ingede4.kls”
- Set “Pulp mass depended” and “…g”
- Select “Image source” “scan series” select “stickies_1.scn”
- Set “No. of samples” to “3”
- Select “Average series of results”

NOTE:

If the load of stickies is very high, it is recommended to reduce the amount of stickies on the filter paper instead of changing the threshold. In that case follow the same procedures as for over-lapping (chapters 5.3 and 5.5).

In case of using Techpap SIMPALAB software:

- Open Family (from Menu Parameter)
- Select the family "ingede4.cfg" from the list

All the settings are pre-installed for the measurement of stickies. The threshold of measurement, sizes for classification (100–200 µm, ...) and other parameters are already determined in the file "ingede4.cfg", and set automatically.

5.7 Calculation of the macrosticky content

The results of the image analysis should be given in mm² of stickies per m² of specimen. This value should be then converted into mm² of sticky area per kg of pulp (see Equation 1). The specimen area which was actually measured by the image analysis system in relation to the covered filter paper surface (or in maximum the inner diameter of the sheet former) and the amount of material used during screening (recommended 50 g of oven-dry pulp) have to be taken into consideration.

Equation 1: Macrosticky area in mm²/kg

$$Macrosticky\ area = \frac{Sticky\, area\ in\ \frac{mm^2}{m^2} \cdot Specimen\ area\ in\ m^2}{Amount\, of\, material\ in\ kg}$$

The use of 50 g of oven-dry pulp and dewatering using the Rapid-Köthen unit results in a conversion factor of 0,634 for converting the area-based sticky area into a weight-based sticky area. Then the mathematical mean of the individual results should be calculated for the three specimens which were made from each pulp sample.

It is advisable to calculate the coefficient of variation and to repeat the measurements if the coefficient of variation is higher than 10 %.

The measurements can be shown separately for the determined size classes and also as the total sticky area for all size classes.

6 Report

The following should be noted in the test report:

- Designation of the sample
- Type of screening unit used
- Type of slotted plate used
- Type of image analysis system used
- Threshold setting if other than defined
- Average macrosticky content in mm²/kg of the recommended three individual samples and coefficient of variation
- Any deviation from this method.

7 References

7.1 Cited standards and methods

- ZELLCHEMING Technical Leaflet RECO 1, 1/2006 “Terminology of Stickies”; www.zellcheming.com/service/ , follow “leaflet” and “RECO”
- ZM V/1.4/86: Simultaneous determination of shives and fibre fraction content (in German); www.zellcheming.com/service, follow “leaflet” and “TEST”
- ZELLCHEMING Technical Leaflet RECO 1, “Anforderungen an die Güte von Schlitzplatten für Labor-Sortieraggregate” (engl.: “Quality Requirements of Slotted Plates for Laboratory Screening Devices”); www.zellcheming.de
- TAPPI T 275 sp-07: Screening of Pulp (Somerville-Type Equipment)
- TAPPI T 274 sp-08: Laboratory screening of pulp (Master Screen-type instrument)
- ISO 5263-1 (2004): Pulps – Laboratory wet disintegration – Part 1: Disintegration of chemical pulps
- ISO 5269-2 (2005): Pulp – Preparation of laboratory sheets for physical testing – Part 2: Rapid-Köthen method
- ISO 287 (2009): Paper and Board – Determination of moisture content – Oven drying method
- FEPA: www.fepa-abrasives.org

7.2 Literature and other related documents

- Ackermann, C.; Putz, H.-J.; Göttsching, L.: INGEDE Method for the Analysis of Macro Stickies in DIP. Das Papier 51 (1997), no. 6, 271-282 (in German)
- Ackermann, C.; Putz, H.-J.; Göttsching, L.: Improved Macro Sticky Analysis for DIP based on Screening. Progress in Paper Recycling 7 (1998), no. 2, 22-32
- German INFOR Project 118: Improvement of Reproducibility of standardized Macrosticky Methods (Final Report: PMV/PTS September 2009)
- H.-J. Putz, E. Hanecker: Untersuchung relevanter Einflüsse auf Makro-Stickyergebnisse. Wochenblatt für Papierfabrikation, 139 (2011), no.2, 116-123

7.3 Sources

The INGEDE Method is based on the INGEDE Project 38 94 PTS/PMV “Developing methods for performing quantitative analyses of micro and macro stickies”.

PTS (www.ptspaper.de), PMV (www.pmv.tu-darmstadt.de)

7.4 Sources of supply

Silicone paper:

- 60 g/m^2, for example from Gieselmann Stanztechnik GmbH, Germany, www.gieselmann-stanztechnik.de

Special fused alumina powder:

- Elektrokorund Alodur SWSK 220 from Treibacher Schleifmittel
- Obtained from PMV (Papierfabrikation und Mechanische Verfahrenstechnik), TU Darmstadt, Alexanderstraße 8, 64283 Darmstadt, Germany

Filter paper:

- Type 1289, Munktell & Filtrak GmbH, Niederschlag 1, 09471 Bärenstein, Germany, www.munktell.com

Ink:

- Pelikan No. 4001 or Parker Quink

DOMAS

- File:

  “ingede4.kls”: www.ingede.org
- Software

  “DOMAS Calibration Tester”, PTS Heidenau and Munich
- Scanner:

  DOMAS ScannerAdvanced, PTS Heidenau and Munich
- Image analysis software:

  DOMAS 3.0, PTS Heidenau and Munich

SIMPALAB

- File:

  “ingede4.cfg"
- Software:

  Simpalab, current version 3.02.00 Techpap SAS Grenoble
- Scanners:

A list of compatible scanners is available from Techpap SAS Grenoble (www.techpap.com, sales@techpap.com).

Contact:
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Annex A

Size classification

Definition of the size classes of an equivalent diameter of a circle:

from (µm)	to (µm)
>100	≤ 200
>200	≤ 300
>300	≤ 400
>400	≤ 500
>500	≤ 600
>600	≤ 1 000
>1 000	≤ 1 500
>1 500	≤ 2 000
>2 000	≤ 3 000
>3 000	≤ 5 000
>5 000	≤ 10 000
>10 000	≤ 20 000
>20 000	≤ 50 000
>50 000	≤ 200 000

For use within DOMAS software the size classification is determined by file “ingede4.kls“(see software attachment).

For use within Techpap SIMPALAB Software the size classification is determined by file “ingede4”.

Guideline Document:

Eco-design for recycling:

criteria for sustainability

DECEMBER 2014

Sustainability Assessment

Contents

1. Introduction

The purpose of this guideline document is to portray how sustainability can be understood in the context of life cycle of paper products like for example graphic products and packaging. This document will primarily focus on the sustainability of end-of-life phase of paper products – especially regarding the stock preparation of the recycling process.

The document comprises of the following parts:

Definitions – where recycling, sustainability and life cycle relevant definitions are presented,

Sustainability assessment – introduction about sustainability, life cycle, life cycle thinking, impact assessment and how it can be understood in paper products context.

Impact assessment of recycling of paper products – description of relevant parameters of recycling depending on the recyclability laboratory results of graphic and packaging paper products and their environmental impacts for the calculation of the end of life phase of LCA.

Sustainability calculator – description of the web based tool that translates the recyclability parameters into specific environmental emissions and carbon footprint score.

2. Definitions

Environmental impact[1] **–** any change to the environment, whether adverse or beneficial, wholly or partially resulting from and organization’s activities, products or services.

Deinkability – Removal of ink and/or toner from a printed product to a high extent by means of a deinking process. This shall restore as well as possible the optical properties of the unprinted product.

Recyclability – Design, manufacturing and converting of paper- and board-based products in such a way as to enable a high quality recycling of fibres and minerals in a manufacturing process in compliance – where appropriate – with current standards in the Community: as a minimum, recyclability requires that sufficient information is exchanged for appropriate risk management and safe re-use of fibres.

Recycling parameters – Test parameters measured in the Laboratory test method for the evaluation of deinkability/recyclability of paper products.

Unit process[1] **–** smallest portion of a product system for which data are collected when performing a life cycle assessment

Product system[1] **–** collection of materially and energetically unit processes which perform one or more defined functions

Life Cycle[1] **–** consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to the final disposal

Life Cycle Assessment[1] **–** compilation and evaluation of the inputs, outputs and the potential environmental impact of a product system throughout its life cycle

Life Cycle impact assessment LCIA[1] **–** phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts of a product system

Impact category – class representing environmental issues of concern into which LCA results may be assigned[1]

Carbon Footprint – the amount of greenhouse gases and specifically carbon dioxide emitted by something (as a person's activities or a product's manufacture and transport) during a given period

Sustainability – The use of resources without jeopardizing the ability of future generation to do so as well - in other words ensuring that today's growth does not jeopardize the growth possibilities of future generations. Sustainable development comprises of three elements – economic, social and environmental - which have to be considered in equal measure at the political level. The strategy for sustainable development, adopted in 2001 and amended in 2005, is complemented inter alia by the principle of integrating environmental concerns with European policies which impact on the environment.

[1] ISO 14050:2009 – Environmental management – Vocabulary

3. Sustainability Assessment: general aspects

Activities of environmental organisations, higher level of society environmental awareness, increasing legal requirements and last but not least the development of knowledge concerning impacts of many products on the environment, have led to the creation of various methods of evaluating the impact of products and services on nature. An example of such successfully industrially implemented method, that is directed at identifying and reducing the negative impacts on the environment, is called *Life Cycle Assessment* (LCA).

LCA allows to track life cycle of the product since its production up to the stage of recovery or disposal of waste, and seems to be a natural extension of both the strategy for waste management and environmental management systems.

The LCA methodology can be used for the assessment of products, selected production processes, services, companies operations and management and even whole economies. LCA allows the assessment of aspects and environmental impacts resulting from all stages of life cycle, including:

- natural resources acquisition and processing,
- manufacturing,
- distribution,
- transportation,
- use,
- re-use,
- recycling and other recovery methods,
- final disposal of waste.

International Standard Organization (ISO) defines LCA as a technique of identifying environmental aspects and potential impacts associated with the product assessment. LCA according to ISO should follow these four steps:

- identification of the purpose and the scope of research,
- inventory of inputs and outputs in the product system,
- potential environmental impacts associated with inputs and outputs of the system assessment,
- interpretation of results.

LCA relates to complex interactions between a product and the environment. Main categories of environmental impacts require taking into consideration human health, usage of natural resources and the quality of the ecosystems.

LCA method, allows to define the methodology of effective resource management, according to both the environmental and economic aspects. It is therefore a powerful tool in developing solutions to reduce consumption of natural resources and energy while maintaining a sufficient supply of goods and services. Additionally LCA can be used to evaluate differences of environmental impacts in used technology and modelled or existing alternatives. Future LCA applications will be integrated with other decision making supporting tools in every situation where environmental issues are important. The availability and scope of information to be assessed in LCA is still growing, which gives the possibility to extend LCA on new products and application areas. Also together with the increasing amount of information that is available about processes, LCA will be more and more precise. LCA can lead to implementation of optimal environmental solutions and elimination of unfavourable processes from the point of view of sustainability.

Potential area of further development of the LCA methodology is an integration of LCA with other environment management methods. Most environment management tools neglect many indirect environmental aspects that can be supplemented with LCA. If we want to develop a LCA method as a tool for quantifying of direct and indirect environmental aspects and potential influence exerted in the whole lifecycle of products, some classification of data collection process is necessary. Another crucial question concerns the development of agreed methodology of data availability. Both methodologies and data are becoming better documented, which proves, that together with the development of ISO norms according LCA standards, future development of LCA method will be even more standardized than before[2,3].

Every single product has a specific impact on the environment, and its life cycle is often long and complicated. For that reason it is important to minimize the environmental impact in all phases of product's life cycle, especially in phases where this impact is greatest, and take action in the most efficient way[4].

Very recently the European Commission has launched an initiative called *Single Market for Green Products* with the objective to simplify and standardize the principles for communicating environmental performance. The new approach establishes two methods to measure environmental performance throughout the lifecycle: the Product Environmental Footprint (PEF) and the Organisation Environmental Footprint (OEF). LCA will be the main instrument used for measurement in these new methods.

When looking specifically at packaging products, life cycle includes the production of feedstock materials, production of packaging materials, production of packaging, packing/filling, packaging use and disposal scenarios. Figure 1 presents typical packaging life cycle in details:

[2] Rebitzer G. et al. ‚*Life cycle assessment, Part 1: Framework, goal and scope definition, inventory analysis, and applications*', Environment International 30. **2004** pp. 701-720.
[3] Pennington D.W. et al*., Life cycle assessment Part 2: Current impact assessment practice*', Environment International 30. **2004** pp. 721-739.
[4] ISO 14040:2006 Environmental management -- Life cycle assessment -- Principles and framework

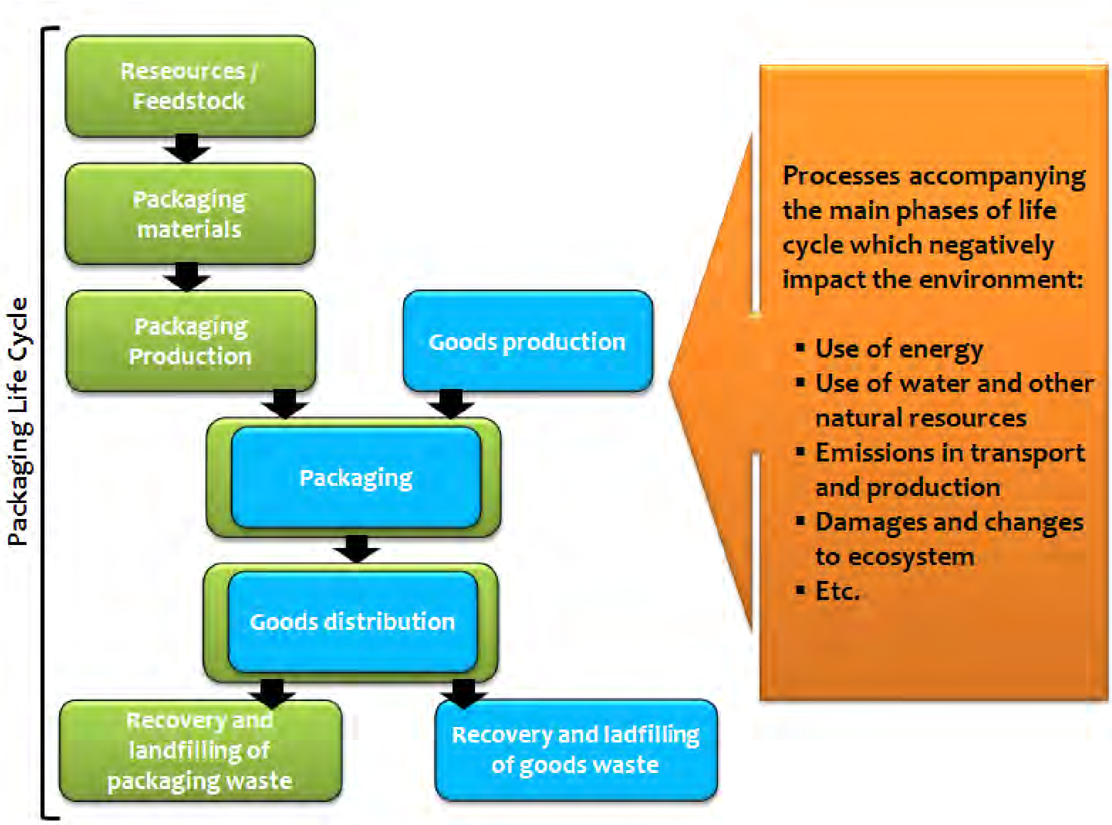

Figure 1: Main phases of life cycle in the example of packaging considering stages when the packaging should be seen together with the goods.

A similar approach should be considered for graphic paper products, taking into consideration all the processes from the pulp feedstock production to the end of life disposal scenario.

Collection of data for LCA of paper products should take into consideration principles set in ISO 14044[5]. It includes procedures for collecting data and calculations leading to the determination of the quantity of materials and energy introduced to the unit processes (input) and leaving the processes (output). These inputs and outputs may include resources use and related emissions to air, water and soil.

Generally, the relevant Impact categories for the life cycle of paper products are the ones connected to the processes of:

- Paper production
- Paper converting
- Paper finishing (printing/varnishing/embossing etc.)
- End-of-life options – paper recycling.

[5] ISO 14044:2006 Environmental management -- Life cycle assessment -- Requirements and guidelines

As an example when using one of the most common calculation method (ReCiPe) among the 18 impact categories addressed , three shall be considered the most important for the analysis of graphic and packaging paper products:

- Agricultural and urban land occupation (in particular for Paper Production process)

The amount of either agricultural land or urban land occupied for a certain time. The unit is m^2*yr.

- Natural land transformation (in particular for Paper Production process)

The amount of natural land transformed and occupied for a certain time. The unit is m^2*yr.

- Fossil fuel and minerals depletion (for all the processes)

Giving the assumption that most of the paper products are recyclable, in the present guidelines special attention is given to the parameters affecting the quality of the new product and their effect on the most relevant impact categories mentioned above. In the paper recycling process, the stock preparation of the pulp is mostly affected by the nature of the converted graphic or packaging product that enter the gate of the recycling process. From this point of view the most relevant impact parameters for the LCA studies are the ones related to energy consumption and waste production. For the graphic products the use of chemicals is also related to the deinking process.

4. Impact assessment of recycling of paper products

Eco-design and manufacturing solutions of paper products affect different parameters of the recycling process for the pulp stock preparation and production of new paper products. This can lead to limitations in the possibility of recycling or different levels and efficiency of the recycling process, affecting the environmental performances of the process itself, for instance in terms of emissions or energy consumptions.

Different approaches for the assessment of the end of life recycling of paper based products can be considered, depending on the goal and scope of the study and on the product system evaluated.

If the scope is mainly the screening impact assessment of different disposal scenarios related to different products - for instance: paper recycling versus incineration, or recycling in different recycling loops, like the effect of downgrading from a higher quality recycling loop to a lower quality recycling loop - the study should assess the possible effect of material recovery in a close loop approach. This happens when a product or a part of the product material can be recycled at the end of life in the same production loop, for producing the same paper grade as the original product. This option enables the reduction of the amount of the new raw material required for the manufacturing of new products, with a general positive effect in most of the impact categories of the LCA.

These important issues where demonstrated in two screening LCA performed in EcoPaperLoop, one study regarding newspapers with different printing solutions and one study regarding packaging paper shoppers with different composition and design solutions. The case studies were chosen as example, because the main scope was to compare the effect of different recycling destinations or disposal scenarios of the products.

The most important evidence of the studies, to be used as general indication, is that from the environmental point of view it is important not only that a paper product is recyclable (instead of a final disposal), but, that it is recyclable within the same recycling loop. This allows for accounting of a possible saving of raw material of a similar grade.

On the other hand, if the scope of the LCA is the assessment of different levels of recyclability in a similar quality recycling loop - for instance: graphic products recyclable in the graphic paper loop but with different levels of deinkability or packaging products recyclable in the same loop but with different recycling results - it is necessary to provide quantitative relations between different levels of recyclability, obtained from laboratory results and related environmental impacts to be used for the calculation of end-of-life phase of the LCA.

This is an innovative aspect that was deeply studied in the EcoPaperLoop project and integrated in the impact assessment methodology for the characterization of the recycling scenario. The approach is similar for graphic paper products and paper packaging, even if different recycling parameters should be taken into account and different environmental parameters are affected.

4.1 Graphic paper products:

Recycling of graphic products is normally performed by using an alkaline flotation deinking process, for the separation of the detached ink particles from the pulp, thus enabling the reuse of fibres for the production of new graphic paper with the proper required optical properties.

Deinking results are affected by different manufacturing features and design solutions of the printed products, e.g. type of paper and inks used, printing technology, post-treatments.

The most significant deinking parameters to be taken into account for the environmental assessment are the **luminosity** and the **dirt speck** content of deinked pulp. These parameters can be assessed for individual products using the standard laboratory method INGEDE Method 11:2012[6].

These two parameters are the most important quality indicators for the deinked pulp, when the desired quality is not achieved, some additional operation in the recycling process are needed, thus increasing the overall environmental impact of the production.

Considering a standard deinking plant, it is assumed that additional operations are needed to achieve the necessary deinked pulp quality when luminosity and/or dirt speck content of deinked pulp do not match the average acceptable range. Conversely, some operations can be avoided when these parameters are better than the acceptable range of results.

If the luminosity of a tested product is lower than the average value for the category, the luminosity should be increased. There are different options depending on specific plants, but generally the most common action is to increase the chemical dosage → high chemicals consumption.

If the luminosity of a tested product is higher than the average value for the category, a possible reduction of the deinking process can be assumed, e.g. a simplification of the flotation loop → less energy consumption.

In the case of dirt speck content higher than the average value for the category, there are different options for decreasing this value depending on specific plants, but generally the actions with their related environmental impacts are:

i) to increase the energy for the dispersion stage → high energy consumption.

ii) to add an additional dispersion stage → high energy consumption

The most important environmental impacts for printed graphic products are the ones related to **chemicals** and **electricity consumption**, which affect the selected impact categories for LCA.

Quantitative variations in the chemicals and electricity consumption with respect to luminosity and dirt speck results were studied in EcoPaperLoop and validated in a LCA study regarding the comparison of different magazines, with different levels of deinkability. The specified values for

[6] INGEDE Method 11 : 2012. Assessment of print product recyclability- Deinkability test.

each parameter are reported in Annex 1: “Graphic paper products, recycling parameters and environmental emissions to be considered for the recycling scenario”.

This validated methodology can be integrated and used in the impact assessment of the recycling process of the LCA.

4.2 Packaging paper products:

In the production of packaging using paper for recycling, the stock preparation is normally performed in water without the aid of chemical additives. The main steps are the separation of plastic or metal parts, adhesives and all the other non-paper unwanted components from the pulp, thus enabling the reuse of fibres for the production of new packaging paper with proper quality and mechanical properties.

Recyclability results are affected by different manufacturing features and design solutions of the paper based packaging products, e.g. type of paper used, plastic or foil lamination, surface treatments like coating, varnish or wax application, additives used in the stock preparation, type and amount of adhesives.

The most significant recycling parameters selected for the scope of this study are the **coarse rejects** separated during the cleaning of pulp and the **macrosticky** content of recycled pulp. These parameters can be assessed for individual products using the standard laboratory method EcoPaperLoop Leaflet 1: July 2014.[7].

Coarse rejects and macrosticky content are the most important process and quality indicators for the recycled pulp and if their level is too high, some additional operations in the recycling process are needed and/or more waste is produced, thus increasing the overall environmental impact of the production.

Based on a standard packaging paper technology plant production, it was assumed which additional operations are needed in the stock preparation when coarse rejects and/or sticky results are over the standard average acceptable range or potential avoidable operations when they are lower than the average acceptable values.

Coarse rejects: (i) If the coarse reject CR of a tested product is higher than the average, an additional amount of reject is accounted as waste production to be disposed, (ii) If the measured value for the coarse reject is lower than the average, a minor amount of reject is accounted as recycling waste to be disposed.

High levels of macrostickies in the pulp stock are determined by the presence of high amount of un-soluble adhesive particles below a certain particle size, which are potentially difficult to be separated in standard fine screen units.

[7] EcoPaperLoop Leaflet : July 2014. Recyclability Test for Packaging Products.

In order to decrease the amount of macrostickies, there are few options and generally it can be limited to operations intended to better separate the adhesive particles or disperse them if they have small size:

i) to add more effort in the screening stage → higher electricity consumption in the process.

ii) to add a dispersion step → higher electricity consumption in the process.

If the product has macrostickies lower than the average level, a possible reduction of the energy for the screening and/or dispersion stage can be assumed → less energy consumption.

The most important environmental impacts for packaging products recycling are the ones related to **waste production** and **electricity consumption**, which affect the selected impact categories for LCA.

Quantitative variations in the waste and electricity consumption with respect to coarse reject and macrosticky results were studied in EcoPaperLoop and validated in a LCA study regarding the comparison of different packaging board, with different levels of recyclability. The specified values for each parameters are reported in Annex 2: “Packaging paper products, recycling parameters and environmental emissions to be considered for the recycling scenario”.

This validated methodology can be integrated and used in the impact assessment of the recycling process of the LCA.

5. Sustainability calculator

The validated methodology explained in the previous chapter and the quantitative relations between recycling parameters and environmental impacts, in terms of calculation functions, were implemented in a Sustainability Calculator tool, which is a free calculator software available on the web.

The Sustainability Calculator is intended as a tool for paper and packaging producers, converters, brand-owners and final users of paper and packaging products. The scope is to enhance the environmental sustainability of paper base products, starting from the analysis of the recycling performances.

The Sustainability Calculator enables to quantify the most important environmental indicators related to the recycling behaviour and solutions of paper products. The requested inputs are the deinking and recycling parameters obtained in laboratory tests, according the international test methods previously mentioned. The outputs of the calculator are the values of chemicals and electricity consumption for the standard deinking of the tested graphic product and the values of waste production and electricity consumption for the standard recycling of the tested packaging product.

In addition, the carbon footprint of the deinking/recycling process is calculated, according to IPCC 2013 GWP100 and reported as CO_2 equivalent emission per functional unit of paper products.

Data and results are representative of the average situation of the considered product categories and recycling options, according to the most updated sector and literature information.

GUIDELINE DOCUMENT:
ECO-DESIGN FOR RECYCLING: CRITERIA FOR SUSTAINABILITY

ANNEX 1

Graphic paper products, recycling parameters, and environmental emissions to be considered for the recycling scenario in LCA

In the following tables are reported the most relevant deinking parameters (luminosity and dirt speck content) affecting the quality of deinked pulp and the related environmental emission (chemicals and electricity consumption), for the three most important graphic product categories (newspapers, uncoated magazines and coated magazines).

Table 1. Offset newspapers. Luminosity versus electricity and chemicals.
N1 and N2 are linear functions for the correlation of the luminosity, from the low limit to the average, and chemicals consumption.
N3 is a linear function for the correlation of the luminosity, from the average to the high limit, and electricity consumption.

OFFSET NEWSPAPERS (including Flyers)	**Luminosity (Y)**				
	Y < 33,5	**Low limit: Y = 33,5**	**Average: Y = 53,0**	**High limit: Y = 72,5**	**Y > 72,5**
energy consumption, electricity, kWh/kg pulp	Poor deinkable, the most sustainable option is to improve the design of the product	**constant = 0,300**	**0,300 (N3)**	**0,270 (N3)**	**constant = 0,270**
deinking chemicals consumption, g/kg pulp		**13 g/kg NaOH (N1)** **40 g/kg silicate (N2)**	**5 g/kg NaOH (N1)** **10 g/kg silicate (N2)**	**constant =** **5 g/kg NaOH** **10 g/kg Silicate**	**constant =** **5 g/kg NaOH** **10 g/kg Silicate**

Table 2. Uncoated magazines. Luminosity versus electricity and chemicals.
U1 and U2 are linear functions for the correlation of the luminosity, from the low limit to the average, and chemicals consumption.
U3 is a linear function for the correlation of the luminosity, from the average to the high limit, and electricity consumption.

UNCOATED MAGAZINES (including flyers)	**Luminosity (Y)**				
	Y < 52,0	**Low limit: Y = 52,0**	**Average: Y = 68,0**	**High limit: Y = 83,0**	**Y > 83,0**
energy consumption, electricity, kWh/kg pulp	Poor deinkable, the most sustainable option is to improve the design of the product	**constant = 0,300**	**0,300 (U3)**	**0,270 (U3)**	**constant = 0,270**
deinking chemicals consumption, g/kg pulp		**13 g/kg NaOH (U1)** **40 g/kg silicate (U2)**	**5 g/kg NaOH (U1)** **10 g/kg silicate (U2)**	**constant =** **5 g/kg NaOH** **10 g/kg Silicate**	**constant =** **5 g/kg NaOH** **10 g/kg Silicate**

Table 3. Coated magazines. Luminosity versus electricity and chemicals.
C1 and C2 are linear functions for the correlation of the luminosity, from the low limit to the average, and chemicals consumption.
C3 is a linear function for the correlation of the luminosity, from the average to the high limit, and electricity consumption.

COATED MAGAZINES (including flyers)	**Luminosity (Y)**				
	Y < 52,0	**Low limit: Y = 52,0**	**Average: Y = 73,5**	**High limit: Y = 87,0**	**Y > 87,0**
energy consumption, electricity, kWh/kg pulp	Poor deinkable, the most sustainable option is to improve the design of the product	**constant = 0,300**	**0,300 (C3)**	**0,270 (C3)**	**constant = 0,270**
deinking chemicals consumption, g/kg pulp		**13 g/kg NaOH (C1)** **40 g/kg silicate (C2)**	**5 g/kg NaOH (C1)** **10 g/kg silicate (C2)**	**constant =** **5 g/kg NaOH** **10 g/kg Silicate**	**constant =** **5 g/kg NaOH** **10 g/kg Silicate**

Table 4. Offset newspapers. Dirt Specks versus electricity and chemicals.
N4 is a linear function for the correlation of the dirt speck content, from the average to the high limit, and electricity consumption.

OFFSET NEWSPAPERS (including Flyers)	Dirt specks (A_{50}), mm^2/m^2			
	Low limit: $A_{50} = 0$	Average: $A_{50} = 630$	High limit: $A_{50} = 3000$	$A_{50} > 3000$
energy consumption, electricity, kWh/kg pulp	constant = 0,300	0,300 (N4)	0,340 (N4)	Poor deinkable, the most sustainable option is to improve the design of the product
deinking chemicals consumption, g/kg pulp	-	-	-	

Table 5. Uncoated magazines. Dirt Specks versus electricity and chemicals.
U4 is a linear function for the correlation of the Dirt Specks content, from the Average to the High Limit, and electricity consumption.

UNCOATED MAGAZINES (including flyers)	Dirt specks (A_{250}), mm^2/m^2			
	Low limit: $A_{50} = 0$	Average: $A_{50} = 190$	High limit: $A_{50} = 1500$	$A_{250} > 1500$
energy consumption, electricity, kWh/kg pulp	constant = 0,300	0,300 (U4)	0,340 (U4)	Poor deinkable, the most sustainable option is to improve the design of the product
deinking chemicals consumption, g/kg pulp	-	-	-	

Table 6. Coated magazines. Dirt specks versus electricity and chemicals.
C4 is a linear function for the correlation of the dirt speck content, from the average to the high limit, and electricity consumption.

COATED MAGAZINES (including flyers)	**Dirt specks (A_{250}), mm^2/m^2**			
	Low limit: $A_{50} = 0$	**Average: $A_{50} = 290$**	**High limit: $A_{50} = 2000$**	**$A_{250} > 2000$**
energy consumption, electricity, kWh/kg pulp	**constant = 0,300**	**0,300 (C4)**	**0,340 (C4)**	Poor deinkable, the most sustainable option is to improve the design of the product
deinking chemicals consumption, g/kg pulp	**-**	**-**	**-**	

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GUIDELINE DOCUMENT:
ECO-DESIGN FOR RECYCLING: CRITERIA FOR SUSTAINABILITY

ANNEX 2

Packaging paper products, recycling parameters, and environmental emissions to be considered for the recycling scenario in LCA

The following tables report the most relevant recycling parameters (coarse rejects and macrosticky content) affecting the quality of recycled pulp and the related environmental emission (waste production and electricity consumption), for the two most important packaging product categories (corrugated boxes and folding cartons).

Table 1. Corrugated Boxes. Coarse rejects content versus waste production.
CB1 is a linear function for the correlation of the coarse reject value, from the low limit to the high limit, and waste production.

CORRUGATED BOXES	Coarse rejects, CR %			
	Low limit: 0,0	**High limit: 20,0**	**20,0 < CR < 30,0**	**CR ≥ 30,0**
energy consumption, electricity, kWh / kg pulp	-	-	Tolerable recyclability, but needs design improvements and/or process adaptations	Not suitable for use in standard recycling processes, but can possibly be used in specialized processes
waste production kg waste / kg raw material	**0,0 (CB1)**	**0,2 (CB2)**		

Table 2. Folding Cartons. Coarse Rejects content versus waste production.
F1 is a linear function for the correlation of the coarse reject value, from the low limit to the high limit, and waste production.

FOLDING CARTONS	Coarse rejects, CR %			
	Low limit: 0,0	**High limit: 20,0**	**20,0 < CR < 30,0**	**CR ≥ 30,0**
energy consumption, electricity, kWh / kg pulp	-	-	Tolerable recyclability, but needs design improvements and/or process adaptations	Not suitable for use in standard recycling process, but can possibly be used in specialized processes
waste production kg waste / kg raw material	**0,0 (F1)**	**0,2 (F1)**		

Table 3. Corrugated Boxes. Macrosticky content versus electricity consumption.
CB2 is a linear function for the correlation of the macrosticky content, from the low limit to the average, and electricity consumption.
CB3 is a linear function for the correlation of the macrosticky content, from the average to the high limit, and electricity consumption.

CORRUGATED BOXES	Macrostickies <2000, MSA mm^2/kg				
	Low limit: 0	Average: 2600	High limit: 20000	20000 < MSA < 30000	MSA ≥ 30000
energy consumption, electricity, kWh / kg pulp	0,120 (CB2)	(CB2) 0,140 (CB3)	0,220 (CB3)	Tolerable recyclability , but need improved adhesive applications	Not suitable for use in any recycling process as individual product
waste production kg waste / kg raw material	-	-	-		

Table 4. Folding Cartons. Macrosticky content versus electricity consumption.
F2 is a linear function for the correlation of the macrosticky content, from the low limit to the average, and electricity consumption.
F3 is a linear function for the correlation of the macrosticky content, from the average to the high limit, and electricity consumption.

FOLDING CARTONS	Macrostickies <2000, MSA mm^2/kg				
	Low limit: 0	Average: 2400	High limit: 20000	MSA > 20000	MSA ≥ 30000
energy consumption, electricity, kWh / kg pulp	0,120 (F2)	(F2) 0,140 (F3)	0,220 (F3)	Tolerable recyclability , but need improved adhesive applications	Not suitable for use in any recycling process as individual product
waste production kg waste / kg raw material	-	-	-		

References:

Definition of the Limits and Average values for the recycling parameters coarse rejects and macrosticky content:

- EcoPaperLoop, Recyclability Database of packaging products.

Definition of waste production and energy consumption values:

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- Blechschmidt J., Altpapier, Abwasserreinigung und Energienutzung. **2011**.

Eco Paper Loop

Guideline Document:

Recommendations on collection strategies

DECEMBER 2014

Recommendations on collection systems for paper for recycling

Contents

Glossary

Terminology	Definition
Bring system	Type of collection system where citizens have to bring their waste/recyclables to certain collection points, e. g. public containers or recycling yards.
Collection (of paper and board)	Gathering of paper and paper products from industrial and commercial outlets, from households and offices for recycling (collection includes transport to the sorting/processing or recycling plant/paper mill).
Collection system	Waste and recyclable can be collected in different ways. The most suitable and common systems to collect paper for recycling are described and reviewed in the appendix.
Collection schemes	Is a model how to organise collection of different types of waste/recyclables countrywide, mostly including target rates (e. g. dual systems for packaging, take back systems for batteries).
Commingled collection	All recyclable fractions are collected together in a single bin/container including a mix of paper, board, glass bottles, cans, plastics, etc. and are sorted afterwards.
Mixed paper for recycling	Means that used graphic paper and board/cardboard are collected in one bin/container.
Paper and board for recycling /1/ (often referred to as "paper for recycling")	Natural fibre based paper and board suitable for recycling and consisting of • paper and board in any shape, • products made predominately from paper and board, which may include other constituents that cannot be removed by dry sorting, such as coatings and laminates, spiral bindings, etc. Remark: Previously known as "recovered paper".
Pay-as-you-throw	Households are charged waste fees according the amount of residual waste they dispose (e. g. paying by bought waste sack, pay-by-weight, pay-by-volume).

Pick up system	All collection systems where waste/recyclables are picked up from citizens' homes, e. g. bins/containers on the premises (onsite bins/containers), bundle collection of graphic paper for recycling and board/cardboard.
Residual waste	Remaining solid waste after separation of recyclables and hazardous waste collected in households (ideally not including any recyclable fractions/hazardous waste).
Separately collected graphic paper for recycling	Means that graphic paper and board/cardboard are collected in different bins/containers.
Separately collected paper for recycling	Means that paper for recycling is collected separately from other recyclable fractions and from residual waste.
Waste lock	Systems where residents need to use a special key (very often a chip) to open a lock to dispose their waste. Commonly they are combined with identification systems for the usage of pay-as-you-throw systems.

List of figures

1. Introduction

Paper represents one of the best recycled material in Europe and a good example how the circular economy may work promoting proximity recycling thus creating new job opportunities at local level. Currently, the statistics /2/ show that at European level 71.7 % of this material goes back into new paper products. Nonetheless, the quality of this material is clearly affected by some present mega trends. The sharp decline of newspapers consumption in most of the European countries is reducing one of the best known recycled paper products meanwhile the concomitant increase in the share of paper based packaging products poses new challenges due to the high diversification of these products. In order to keep the currently high paper recycling rate or even improve it in the future, a clearer definition of recycling oriented eco-design is necessary as well as a further development of the life cycle thinking in the whole paper value chain. The quality of the collected paper for recycling has to be considered as equally important as the amount of collected paper by local decision makers. Besides, the extended producer responsibility for an effective material recycling shall become a key driver in the decision process of environmentally focused companies.

The collected paper for recycling in Central Europe (CE) accounts for approximately 16 million tonnes, representing about one third of the amount used by the European paper industry. However, the recycling rates are quite different among the CE countries. Some of them are approaching the theoretical limit in collection whereas others still show a significant potential that must be exploited. Lesson learning from best practices is a key point and communication through suitable expert based guidelines is very much relevant to spread correct information thus helping the paper value chain stakeholders to better contribute at the sustainability of the paper recycling loop.

This document gives a brief overview about interests of different stakeholder groups in the value chain followed by recommendations for an optimised collection of paper for recycling. It focuses on the collection from households as there lies – especially in countries and regions with low recycling rates – the most potential for improvements considering quality and quantity of the collected material. Households also have special requirements for the organisation of collection in respect to multitude of sources, variety of paper products and socio-economic diversity.

2. Guidelines on reducing the areas of conflicts

2.1 Overview

What virtually all waste management systems have in common is a certain divergence of the business objectives of their various stakeholders. In paper recycling these stakeholders are in the first place municipalities, waste management companies and paper mills.

Their overarching objectives are profitability (waste management companies), quantity (municipalities) and quality (paper mills) respectively (s. figure 1).

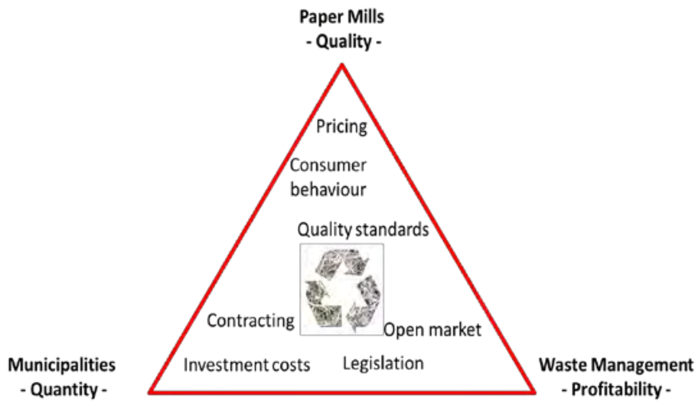

Figure 1: Objectives of stakeholders and areas of conflicts

Experience has shown that these very interests can diverge to an extent which creates a significant potential for conflicts which might render the installation of an efficient collection system difficult or hardly possible. In order to make corresponding attempts successful it is crucial to identify and analyse the areas of potential conflicts, to address them properly, to develop strategies which do not allow difficulties to become problems and to eventually find a common understanding for a set of rules on the basis of a well-balanced agreement to which all stakeholders can adhere.

This chapter of the guideline report focuses on the analysis of the main actors' roles, their constraints and flexibilities and the different agendas resulting from their diverse expectations. It undertakes an attempt to give guidelines of how to pave the way for proper and sustained solutions.

2.2 Contracting and concepts

2.2.1 Long-term contracts between stakeholders and other contracting aspects

Legally, the municipalities in CE countries have the responsibility to organise the collection of waste from households. As decision makers they can conclude contracts with waste management companies and/or paper mills or any other party able to provide the required service.

In some countries waste management companies are only offered short contract terms by the municipalities. This might result in insufficient planning security for the service providers and thus in less sustainable approaches and in the worst case in a pronounced disinclination to invest in new technologies. Increasing competition between waste management companies in times of dwindling profit margins further exacerbates the situation /3/.

In order to mitigate such undesired consequences for both the municipalities and the waste management companies both parties should agree on reasonable terms of such contracts. Their minimum duration should not be shorter than 5 years /3/.

In a recent interview, BVSE (German Association for Secondary Raw Materials and Waste Management) emphasised the importance of contracts between waste management companies and paper mills which give room for adapting prices and fees /3/.

Another important aspect to be addressed when drafting a contract between stakeholders is the transparency of its design. In this context the new EU DIRECTIVE 2014/24 on public procurement and concessions, which entered into force in April 2014, is of particular importance. As far as best practice specifications for tendering the collection of paper for recycling is concerned, CEPI (Confederation of European Paper Industries) published corresponding guidelines in November of the same year /4/. According to these guidelines

"A waste management tender for the collection of paper for recycling should include the following specifications linked to EU public tendering rules:

- Collection method and quality
- Paper for recycling collection rate
- Life-cycle considerations
- Support in raising citizens' awareness
- Using only collectors guaranteeing sound environmental management
- Separation of collection, sorting and marketing of the collected material
- Health and Safety considerations"

2.2.2 RETHINK OF PUBLIC PRIVATE PARTNERSHIPS

Recycling facilities belong to the most capital-intensive components of efficient waste management systems /6/. This should be duly taken into account when a municipality has to make a decision as to which company they shall entrust the task because only financially sufficiently strong companies will be in a position to make the investments necessary to provide an appropriate and sustainable service.

Although chapter 3.2.2 discusses investments in new sorting plants in a more unbiased way, the project team recommends to consider as well public private partnerships (PPP), which involves a contract between a public sector and a private party as one option for setting-up e. g. a sorting plant – especially for urban and metropolitan areas where expected collection quantities might justify such an approach. Both parties may profit from each other: waste management companies from the technical equipment of municipalities and municipalities from the know-how of waste management companies /3/.

2.2.3 Inclusion of regional industries

Increasing both, quantity and quality of the collected paper for recycling and simultaneously keeping the conflicts between all stakeholders on a tolerable level should always be high on the agenda when discussing the introduction of a new collection system. In cases where such a system already exists it is advisable to rethink and, if necessary, revise the existing concept. An important issue in this context is the inclusion of the regional industries. The municipalities should ensure that the collection strategy for paper for recycling addresses the needs and requirements of the local paper industry as well as other industries (which could possibly make use of the residues generated by the recycling processes) and the existence and capacity of sorting plants in their areas. If there are, for instance, paper mills in the area producing graphic paper entirely or partly based on paper for recycling, the installation of a system providing the possibility to separately collect paper and board is possibly the better choice (see further information also in chapter 3.2.2).

2.3 Communication and education

2.3.1 Public relation (PR) activities for local use of paper for recycling

Due to the rapidly increasing awareness of the menace of an unabated climate change the meaningfulness of resource and energy efficiency in order to reduce our environmental footprint has in Europe been beyond dispute for many years. The necessity for transport efficiency, though, has not yet received the same attention, in spite of the fact that a substantial part of the CO_2-emissions in Europe results from transport activities. As quite some of those activities are related to waste management and recycling, both, industry and society should aim to use collected secondary raw materials to the largest possible extent close to where they were collected, i. e. close the various recycling loops.

To raise the awareness of the importance of regional recycling loops, municipalities supported by regional paper mills should take care of different PR activities for the local use of paper for recycling, e. g. publication of recycling ways on municipality websites. The federal state of Steiermark in Austria does it very exemplary (s. figure2).

Other ideas to support regional recycling loops by PR could be:

- to develop different events in cooperation with local waste management companies, e. g. PR events on recycling yards at an “open day” or
- to support environmental education in schools and kindergartens, e. g. excursion day to discover the paper way of life.

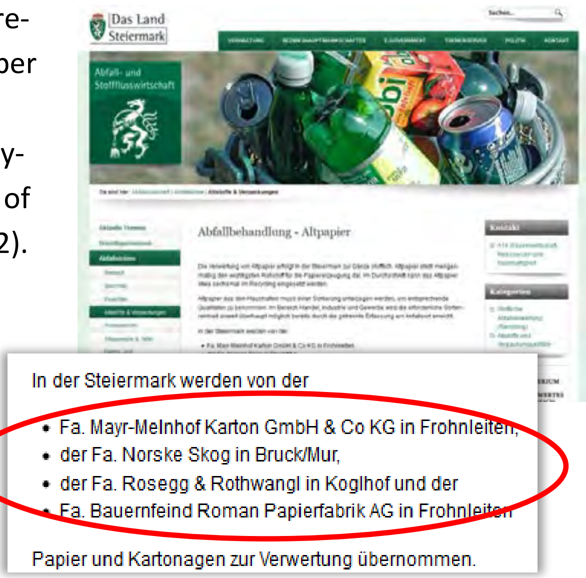

Figure 2: Example of publication of recycling ways on municipality’s website /7/

2.3.2 *DIALOGUE BETWEEN ALL MAJOR STAKEHOLDERS*

The main prerequisite for an efficient reconciliation of conflicts or problems between stakeholders is their readiness to openly present all relevant positions and arguments and to discuss them in order to – in due time – find appropriate solutions fairly balancing the diverse interests. To make this procedure happen it should be institutionalised in the form of joint meetings organised on a regular basis or on demand of one of the stakeholders.

2.3.3 *EDUCATION OF STAKEHOLDERS*

Some problems and conflicts in the paper recycling business only occur, because the stakeholders act in reciprocal though unconscious ignorance of the mutual benefit or detriment their individual actions trigger to other stakeholders. This just reflects the fact that all well-established industries have – over years or decades – developed their own language, their own control techniques, their own assessment procedures, all of which facilitate the communication within their own industry but are anything but instrumental when it comes to communicate with others. This also applies to the paper recycling business. Continuous efforts should therefore be made to give all stakeholders the opportunity to understand at least the basics of each other’s business and the constraints and expectations they have to cope with in order to become aware what is achievable and what is impossible in their specific business and that of their fellow-stakeholders.

There are quite a few examples for this. A typical and particularly problematic one is the use of different methods to characterise paper for recycling quality. If all stakeholders would agree to use only a limited number of well-established and proven methods (e. g. the various INGEDE methods which are widely accepted all over Europe and beyond) disputes regarding the quality of paper for recycling would largely become redundant. Furthermore, municipalities, especially in countries with less stringent legal standards, should also draft their waste management directives with a view to the requirements of the recycling industries. This, however, would require a certain expertise or at least the provision of sufficient background information about process requirements and product characteristics. It is up to the stakeholders to provide this information. This would also help to eliminate dispute concerning quality requirements.

2.4 Legislation and other aspects

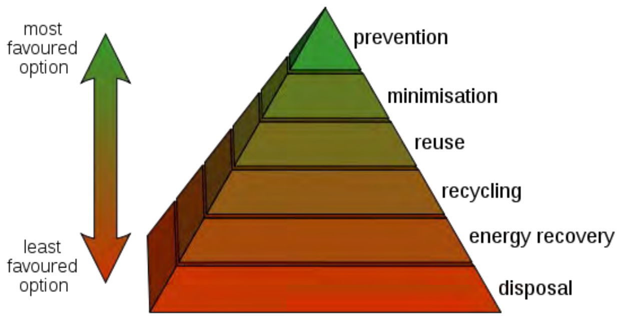

Figure 3: The waste hierarchy /34/

In spite of a common understanding of the general waste hierarchy (s. figure 3), legislation, directives and recommendations regarding environmental and recycling issues are not in all cases sufficiently harmonised among the EU member states. In countries like Germany or Austria where waste management and material recovery and recycling have a comparatively long history and are highly developed, the requirements are more stringent and clear than in countries like Poland, where e. g. countrywide standardised waste separation directives do not exit. This is undoubtedly one of the reasons why quantities and qualities of collected paper for recycling differ so strongly between the countries. Another most adverse result of these regional differences is the lack or complete unavailability of reliable statistics which makes it virtually impossible to exactly quantify the yet untapped potential of paper for recycling.

2.4.1 IMPLEMENTATION OF RECYCLING TARGETS

As any strategy also recycling strategies require a detailed plan for achieving their specific goals within a reasonable period of time. The more precisely this specific goal is defined, the higher is the probability of success. The first step in initialising or improving a collection system for paper for recycling in a given region or municipality, therefore, should be the definition of a reasonable collection rate. National and European averages could serve as references. But in order to be accepted by the local society, it is important that a target rate appears achievable and takes local conditions into account. And it is equally important that such rates are understood as dynamic targets which allow adjustments once the conditions for which they have been set have changed.

2.4.2 RULES CONCERNING RESPONSIBILITY

In order to make collection efforts independent from market prices, to cover the costs and investments for technology, infrastructure and transport and to avoid lengthy legal disputes, clear rules concerning responsibility for collection from households must be defined, established and put into force:

- Because of the high level of technology and infrastructure needed collection of paper for recycling from households should be organised by municipalities, which simultaneously bear all corresponding responsibilities. They, however, should be free to commission necessary activities entirely or partly to third parties which demonstrably are in a position to provide the required services.
- The project team came to the conclusion that the installation of intensive pick up systems, like onsite bins/containers by third parties not commissioned by local authorities cannot be recommended. But:
- Private collections shops (bring system) which in many cases offer a little compensation and thus give additional motivation in particular to low income citizens, typically provide high quality paper for recycling /20/. They should be allowed by authorities as long as this is compatible with the financing of the municipal waste system.
- The same applies to collections organised by schools, kindergartens or charity organisations which should also be supported by authorities not least as they can be regarded as part of an environmental education programme.

2.4.3 EVALUATION OF TAKE-BACK SYSTEM FOR PACKAGING

Take-back systems for packaging of no matter which material are organised differently in various CE countries. While most take-back system work smoothly and are very well accepted for instance in the Czech Republic (uniform labelling, nationwide educational campaigns, one organisation in charge) /8/, the “dual system” for packaging is discussed very critical in Germany. By some interest groups the system is regarded as too complicated and not transparent enough.

Such improvable take back systems for packaging should be evaluated concerning minimising organisational efforts in general and the usefulness of inclusion of pure paper and board packaging in particular as the latter are in most cases collected together with graphical paper for recycling, which is not included in the take back system.

2.4.4 *COUNTRYWIDE/EUROPE-WIDE STANDARDISED MINIMUM WASTE SEPARATION*

It is not only the collection and recycling rates of paper for recycling but also the level of waste separation which is crucial to paper for recycling quality but which varies a lot in the different CE countries and even between regions of the same country. This results in equally broad variations in the quality of the collected paper for recycling. Therefore, a minimum standard of waste separation for the whole country or across the whole EU should be defined and practised. In this context the collection of paper for recycling separately from any other recyclable must no longer be called into question. The decision on this issue should not be left to the municipality level, because this may lead to an insufficient spread of this strategy and consequently a poor quality paper for recycling.

2.4.5 *SUPPORT OF DEVELOPMENT OF USEFUL WASTE MANAGEMENT TECHNOLOGIES*

It is well known that financial incentives can lead to innovations. Waste management companies can invest more in their facilities, machines and personal in order to enhance recycling processes, once they receive public support for the development of useful waste management technology.

2.4.6 *STRICTER CONTROL OF WASTE / RECYCLABLE FRACTION FLOWS*

Example Poland: The legislation on the maintenance of cleanliness and order in municipalities („Ustawa o utrzymaniu czystości i porządku w gminach“) in Poland entered into force in 2013, but the recycling rate of paper and board in Poland is still very low, the lowest in the EU area /9/. There are a variety of reasons for this, but one of the main aspects is the laxity in monitoring waste flows /9, 10/. Therefore, in particular in countries with low recycling rates streams of waste and recyclable material should be monitored more strictly by authorities.

3. Guidelines to improve waste management

3.1 Overview

Own data and other sources /11/ did not give any clear indication that certain collection systems offer superior effects on quantities and qualities of paper for recycling. Instead, apart from legal framework, the success of collection systems is mainly influenced by other, mainly socio-economic factors on a very local level. Collection rates and the quality of the collected fractions vary often even between different parts of the same community /3, 12/. One of the most determinant factors is the building structure of a certain area which very commonly is also an indicator for the social structure of the people living there. The following guidelines focus on recommendations for local authorities as it is their responsibility to organise the disposal of municipal solid waste. They are simultaneously the interface to the citizens who represent the fourth important stakeholder group.

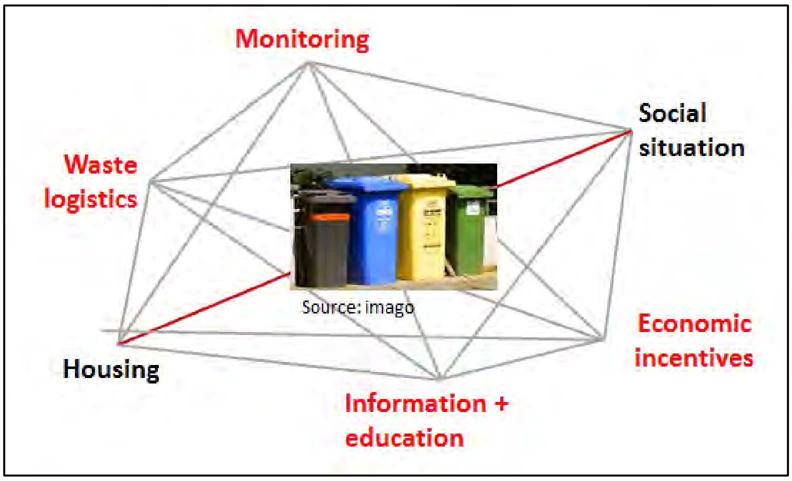

Figure 4: Factors for the success of collection systems (red: influenceable by municipalities)

The guidelines given below only work as a combination with each other and are supplemented by successful practical examples. These examples also show that a comprehensive approach of the different waste/recyclable streams is needed. Collection of paper for recycling cannot be addressed on its own.

Many of the recommendations mentioned are included in the online tool elaborated by the EcoPaperLoop project team to optimise paper for recycling collection depending on the conditions in a certain area. This tool can be found on the internet **http://www.ecopaperloop.eu/outcome**.

3.2 Waste logistics

3.2.1 *NO COMMINGLED COLLECTION*

There are strong opinions that the best strategy to collect municipal waste is commingled collection, i. e. a system in which all recyclable materials are collected together in a single container before they are split into different fractions. Until the latter happens, however, sufficient time is allowed for cross-contaminations between the different components, which can be critical in terms of the quality of what is collected.

In fact, it is only a small number of recyclables which can be extracted from municipal waste in huge quantities, namely glass, iron and non-iron metals, plastic material and last but not least paper and board. If only for that they all would deserve to be collected separately, i. e. not commingled with any other recyclables. This, however, is not always possible - for logistical, economic or organisational reasons. Once a selection has to be made as to which recyclable should preferably be collected separately, the total amount and possible detrimental effects of commingling on each of them should be taken into consideration. As far as paper and board is concerned there cannot be any reasonable doubt, that the total amount in which they normally occur would place them very high if not highest on such an agenda. What comes on top is that many of the contaminants which inevitably come together in commingled collections would by and large not interfere with the quality of plastics, metals or glass, while they could possibly cause irreversible quality losses of the paper and board fraction as well as problems with the respective recycling processes.

Against this background the collection of paper and board separate from all other recyclables is an indispensable prerequisite for both highest quantities and best qualities of paper for recycling.

There were and still are intensive discussions about the superior cost effectiveness of commingled waste collections. Even if this were true, it is in most cases only true for the collection as such – i. e. as long as the costs related to the necessary subsequent sorting process are ignored. They, in fact, can easily eat up all the alleged cost savings from the collection as recently published studies confirm. They suggest that if all the costs along the whole paper recycling chain are considered appropriately, commingled collection can no longer be regarded the most economic and even less a suitable collection method for paper and board /13/.

Collecting paper for recycling separately from other recyclables, however, is a necessity but not in itself sufficient prerequisite for the provision of high quality paper for recycling. Special care should, for instance, be given to certain products which are deemed acceptable in some cases but are firmly rejected in others. Paper-based liquid packages are just one example of this. Clear labelling on collection bins/containers (and on products) as well as information of citizens via other media are efficient tools to achieve positive results in this respect (see chapters 3.4.1 and 3.4.2).

3.2.2 SEPARATE COLLECTION OF GRAPHIC PAPER

While - in the light of resource efficiency - collection of paper and board separate from other recyclables is according to what has been said above indispensable, the separate collection of graphic paper and paper-based packaging material deserves more detailed considerations. As stated in chapter 2.2.3 it is important to include other stakeholders in the decision-making processes of municipalities concerning collection systems for the various recyclables.

The existence of a local paper industry in or close to a given region would surely suggest to regard this industry as an important stakeholder when it comes to improve waste management strategies. If the local paper industry comprises mills producing graphic papers from paper for recycling and if the expected potential for collectable graphic paper for recycling in the region would justify the efforts, the installation of a collection system providing both graphic and non-graphic paper fractions separately should be taken into consideration. Municipalities and waste management companies could benefit from better prices for deinking grades, paper mills from pre-sorted material. This seems to be particularly important as the amount of collected graphic paper is shrinking. The price difference between mixed and sorted paper for recycling, however, are usually too small to justify investments in automatic sorting plants /14/. Manual sorting might be an option though probably at least equally questionable from an economic point of view. Separating at the source, i. e. already in the households would be the best solution but it might require special efforts in motivation and education.

On the other hand the existence of state-of-the-art sorting plants should be duly taken into account in the decision-making process for new or improved collection systems. If such plants are already in operation their inclusion in the collections system, however, should not be envisaged without thoroughly balancing its pros and cons. Most probably it will turn out that the cons outweigh the pros considerably.

If there are mills in the region which produce paper or board based on paper for recycling and if the total production capacity of these mills is high enough there is no reason – besides possibly economic considerations – to collect anything but mixed paper for recycling.

3.2.3 USER-FRIENDLY COLLECTION SYSTEMS

User-friendliness, i. e. comfort and convenience are particularly decisive characteristics of successfull bring collection systems. There are, however, many factors determining in how far corresponding requirements and expectations are met. The most obvious and important characteristics of a user-friendly bring collection system are

- easy accessibility, which includes short ways for the user as well as sufficient and appropriate parking facilities allowing for easy unloading close to e. g. containers or bins,
- unmistakable and transparent information on what kind of recyclables have to be disposed of in which container,
- appropriate maintenance and cleanliness of the whole site
- helpful and competent supervisors (in particular in recycling yards).

These rather ambitious demands cannot be met everywhere. For that reason it is not surprising that the introduction of onsite paper bins resulted in improved collection rates in many municipalities /15/. Own data confirm that many communities in countries with high collection rates offer their citizens a mixture of pick up and bring systems.

But also the type of dwelling, the availability of space for the installation of collection points and the local infrastructure strongly determine which collection system is the most appropriate one. For distinctly rural areas with a relatively poor infrastructure, for instance, providing short distances to the next collection point is probably not a realistic criterion for a good solution. Here collection points like public containers at highly frequented locations, e. g. next to shopping centres, sport centres, local administration centres and the like could be reasonable alternatives.

The appendix includes an overview of collection systems regarded as suitable for collection of paper for recycling by the project team including possible applications, advantages and disadvantages.

Figure 5: Underground container system in Ljubljana /16/

Example: Ljubljana, Slovenia /16/: The dwelling situation in Ljubljana, the capital of Slovenia, is dominated by rented or privately owned flats in small or medium-sized apartment buildings as well as private properties. In 2008 the city of Ljubljana installed a new collection system for paper for recycling in order to significantly improve the local collection rate and to decrease the amount of residual waste in households. The core features of the collection system are underground containers providing 5 different deposit shafts for paper, packaging, glass, organic and residual waste respectively. Collection points are evenly distributed across the city’s area on paths frequently walked by the citizens in a way that the next collection point can be reached within less than 150 meters. For the disposal of residual waste each household has its own chip card. Containers are accessed via card and residual waste is weighed and charged. All containers are emptied on a weekly basis. Special emphasis is given to an effective maintenance of the collection points in order to ensure and safeguard the highest possible level of acceptance. After having been in operation now for several years the new system convincingly demonstrated its superiority over the previous system. The amount of residual waste decreased by more than 50 % from 97 kt in 2007 to 47 kt in 2013 while at the same time the amount of separately collected paper for recycling rose by almost 80 % from 6.4 kt in 2007 to 11.5 kt in 2013 /17/.

3.2.4 Design of collection points, adaptation of collection intervals and container capacities

A systematic and well-arranged installation of bins or containers as well as clear labelling supports correct recovery of all recyclable fractions. If the circumstances do not allow to provide an appropriate level of convenience and monitoring locked or fenced containers can help to minimise contamination, miss-sorting and paper thievery. It has as well emerged that the smaller the number of households is which use a specific collection point, the higher is the amount of paper for recycling collected, the better is its quality and the easier it is to keep it clean and tidy. In any case type and size of bins/containers need to be adapted to the given requirements in particular with respect to capacity and emptying frequency. An unkempt location will inevitably drastically reduce the acceptance of its envisaged clientele and the readiness to separate recyclables and residual waste properly /12/.

Figure 6: Inadequate capacities or too low emptying frequencies resulting in overfilled containers (photo: R. Zelm)

Modern waste management companies, no matter if public or private, already offer monitoring of filling levels for bins/containers to duly adapt collection frequencies or container capacities respectively /18/. Developments in sensors technology and remote control facilities make further progress in this field likely – provided the waste management companies' financial leeway is sufficiently large.

3.3 Guidelines concerning economic incentives

3.3.1 REWARD CITIZENS

Rewarding citizens for making their used paper and board products available for recycling can – irrespective of the amount – be an appropriate way to make them aware of the value of these products as precious raw materials and thus motivate them to use collection systems. Experience has shown that corresponding efforts are particularly effective with lower income groups but by far not exclusively.

In general there are a number of different ways how rewarding can be practised. Some examples are given below.

There are already some communities in CE which compensate their citizens for collecting paper for recycling in onsite bins/containers on the basis of weight /19/. This, however, requires collection vehicles equipped with weighing systems. Another approach would be to pay citizens for graphic paper for recycling already separately collected at home and brought to recycling yards similar to privately operated collections shops.

Other communities support the collection of paper for recycling by non-profit organisations, kindergartens and charity organisations, not least to use this as an instrument for environmental education. Profits are in many cases donated to charitable activities.

Another interesting approach is reported from Slovenia where the community of Vrhnika, close to Ljubljana – for budget reasons – refrained from installing an expensive pick-up system for recyclables. They instead provide so-called "eco-islands" evenly distributed on public or private ground all across the municipality with containers for paper for recycling, glass and other packaging material. Citizens who were prepared to transfer part of their property to the municipality to allow for the installation of such "islands" and to take the responsibility to keep these places tidy and clean, received credits (in the form of reduced waste charges) /16/. Possibly a good idea to get citizens better involved in waste management and worth to be considered in particular in regions with modest or low economic prosperity – provided that the demand for separate collection of paper for recycling is respected.

In any case, the minimum requirement should be that separate collection of paper for recycling needs to be free of charge for citizens.

3.3.2 PERSONALISATION OF DISPOSAL FEES FOR A FAIR WASTE CHARGING SYSTEM

The introduction of personalised (pay-as-you-throw) disposal fees for residual waste – while disposal of recyclables remains free or is offered at lower charges – has proven very effectively to redirect recyclable fraction streams and to minimise the amount of recyclables in residual waste /21, 22/. There is of course a certain risk that such a system encourages abuse, e. g. by disposing residual waste via cheaper recyclable waste streams or by dumping residual waste into the environment. But many case studies like the Ljubljana example (s. chapter 3.2.3) give evidence that the beneficial effects outweigh the risks.

Figure 7: Example for a waste look with identification system at Wohnungsgenossenschaft „Elbtal“ Heidenau, Germany (photo: S. Guerrero Mercado)

There exist a number of different types of pay-as-you-throw systems from technically sophisticated waste locks which charge disposed waste by volume or weight to simple sack fees as common in Switzerland. To demonstrate the effects one example from Germany is portrayed below.

Case Study Heidelberg, Germany /23/:

In 1999 a pilot pay-as-you-throw project was introduced for residual waste in two large residential complexes. The aims of the project were to improve the quality of selective collection and to simultaneously reduce the amount of residual waste significantly. The collection sites for the various fractions were fenced off and the necessary information was provided with the help of easily visible signboards. Residual waste could be disposed of in different volumes which were recorded by sensors in the waste locks. A two-part fee system was established comprising of an annual flat rate for all households and a variable fee which depended on the frequency of the use of the service and on the volume of waste disposed of in the refuse containers. A comprehensive communication campaign was carried out before implementing the system. As a result the selective collection of recyclables in the two areas increased from 50 % to 84 %, and there was an average overall reduction in residual waste of 21 %. Impurities detected in bins for recyclables increased from 1 to 3 %.

An investigation in one of the two complexes revealed that

- Most respondents were generally happy with the operation and appearance of the system.
- More than 70 % of the respondents agreed to the "polluter pays" principle.
- Only 13 % rejected this idea and another 13 % were undecided.

Personalisation of disposal fees of course only works if the waste disposal charge is high enough to provide a reasonable economic incentive for better separation of recyclables. This experience was also reported from Poland where fees for residual waste are far too low to motivate citizens for better separation /10/.

3.4 Guidelines regarding information and education

3.4.1 MULTICHANNEL MARKETING

Efforts to improve collection rates and quality of paper for recycling will only succeed with the cooperation of the public. Therefore appropriate and efficient communication and public relation strategies need to be developed and put into action. This is particularly important in cases where new collection systems or even national collection schemes are to be implemented. Professional communication activities initiated by local authorities and other stakeholders including environmental groups are a basic requirement for a successful realisation.

“Multichannel marketing” is the best way to reach the majority of the citizens of a region or municipality. The spectrum of potential means ranges from phone hotlines (especially after changes), web-based information and social media, posters, flyers, specific information for home owners and tenants and customer magazines as well as promotional messages on collection lorries, just to mention a few. If significant parts of the population in the region have different cultural and linguistic backgrounds all information campaigns also have to take this in due consideration.

The involvement of experienced waste management consultants can also be instrumental. Such experts are very often employed at local authorities in countries with a long and successful recycling history and should not only have the knowledge and experience but also the capability to disseminate and communicate relevant information in the proper way and to accompany interested parties like housing associations, public institutions, kindergartens etc. in the decision and implementation phase of the installation of a waste management system.

Another aspect which must not be underestimated are widely spread rumors and half-truths around the recycling business in general, be it on purpose or not. There are citizens who tend to believe that separately collected fractions will later be mixed with other fractions and used for different purposes than those announced. Therefore, it is very important to communicate openly and transparently information about purpose and recycling ways of paper for recycling and the other recyclables /12/ – and to act accordingly.

Case Study Cappanori, Italy /25/:

Cappanori is a town of 46,700 inhabitants near Lucca (Tuscany) which installed a pick-up collection system in several steps between 2005 and 2010. The motivation of this effort was Cappanori's participation in what is called the "Zero Waste Initiative", a campaign on European level to promote waste prevention, separate collection, the reduction of residual waste as well as driving cultural change and engaging communities /24/. Well in advance meetings were held in public places in Cappanori to involve citizens and to gather ideas of how to implement the system. Printed information was distributed to all inhabitants. A few weeks before the system was started in a given part of the town, volunteers distributed free waste separation kits to all homes, including the various bins and bags required as well as more detailed printed information. These volunteers were trained to give competent answer to the residents' questions about the new system. The result was an immediate and effective participation in the system. A study covering three Italian municipalities which had introduced a pick up system showed the best results for Cappanori concerning both, participation (99 %) and satisfaction (94 %). This gives a strong evidence for the importance of a well organised preparation phase - 98.6 % of all Capannori residents had received printed information about the changes, 46 % had attended meetings about the new system and 91 % knew where to go to ask for additional information about waste collection /25/.

3.4.2 CONSISTENT LAYOUT

The purpose of advertising and marketing is to make a product known and distinct in order to let it succeed on the market. In this context, the so-called recognition factor is a crucial characteristic. Basically the same also applies to waste management systems. Their recognition factor is made up of a consistent layout of e.g. containers or bins including uniform colour schemes and pictograms. The more distinct and wide-spread this programme identity is, the better it will perform.

Figure 8: Container for collection of paper for recycling in Czech Republic /8/

A good example for this is the waste management system established by ECO-KOM in the Czech Republic. This system organises the take back system for packaging countrywide. Their containers are easily visible all over the country due to their uniform colouring and labelling, which substantially contributed to the remarkable success this system has achieved /9/.

3.4.3 *ENVIRONMENTAL EDUCATION, AWARENESS BUILDING AND SOCIAL INCLUSION*

There has never been a voluntary change in human behaviour and attitudes without prior education, awareness building and training. This is also the case when people are to be familiarised with new habits and procedures – like making use of a new waste collection system. In this process many parties have to become involved like authorities on different levels, paper mills, waste management companies, kindergartens and charity organisations, schools as well as non-governmental organisations. The process should be accepted as a long-term and a dynamic objective for the whole society and should start as early as possible, already with the youngest. Environmental education definitely should be a part of early education. It should to the largest possible extent be supported by attractive pedagogical concepts and events e. g. visits paper mills, recycling yards, sorting plants and the like.

Motivating local enterprises to put more emphasis on environmental issues or even to create "green jobs" is also supposed to have a very positive effect on public awareness and can be a chance to include residents with poor qualification and modest income into the process, especially in regions with lower GDP. For instance the Catalan town of Argentona launched a pick up collection system for paper for recycling in 2008. The service is provided by a local social enterprise which employs people at risk of social exclusion. One of the conclusions of transforming the local collection system was "…apart from boosting recycling rates, the largest share of collection costs are shifted from costs related to equipment, technologies and disposal, to creating new jobs, which ultimately feeds back into the local economy /26/."

Figure 9: Environmental programme with mascot Tonda Obal on separate collection for schools in Czech Republic /8/

3.5 Special solutions for large housing estates

As different studies show large housing estates in many cases still offer potential for improvements even in countries with high recycling rates /12/.

Because of the typically pronounced anonymity and the lack of correlations between the amount of waste a tenant generates and the disposal costs he has to pay, it seems especially important to introduce personalised fees for residual waste to motivate for better separation.

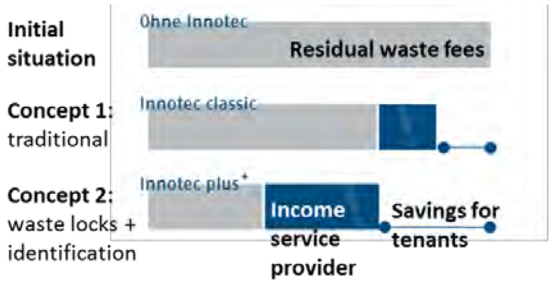

Figure 10: Example of reduction for waste fees and performance contracting /27/

For instance in Germany, and probably also in other countries with high recycling rates, private and public companies are specialised to offer closed concepts for such building estates. Services include waste analysis, consultancy, layout and management (cleaning, re-sorting etc.) of collection points, information of tenants, financial clearing of waste fees /18, 27/.

The implementation of such concepts is very often financed over performance contracting by saving waste fees as illustrated in figure 10.

3.6 Monitoring

Inclusion and motivation of citizens tops control and punishment. But the mere existence of instruments of monitoring may already show positive effects. Local authorities or the enterprises which are in charge to collect household waste often refuse to empty bins which contain not properly sorted recyclables, thus forcing property management and owners to re-sort or to install care takers as "waste policy".

Another way would be a regular quality control by local authorities especially for public collection points and the possibility for citizens to report problematic spots to the municipality.

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5. Appendix: Suitable collection systems for paper for recycling

The evaluation of the different collection systems reflects the project teams' opinion and means the following: ++ = very good, + = good, +- = pendant, - = bad, -- = very bad.

Onsite paper bins/containers (pick up system)

Bins/containers are positioned at the citizens' property. In CE countries with high collection rates this system is quite common. Many municipalities introduced it in the last couple of years and offer the paper bin as free of charge service to its residents. Commonly it is used to collect mixed paper for recycling. But it would be also possible to install separate bins/containers for graphic paper for recycling and board/cardboard if accepted by residents (less space, more separation). If there are two bins/containers, either two collection tours or a collection truck with two compartments is needed. As there needs to be enough space for onsite paper bins/containers on the property, it is sometimes unsuitable for densely build-up areas and buildings without reserved space for disposal systems.

	Onsite bin/container	
User-friendliness	Most comfortable system for citizens because of short ways => positive effects on collection quantities.	++
Quality of paper for reycling	Good quality with few impurities. Experiences: between 2–5 % non-paper components /28, 29/. Paper for recycling protected against moisture.	+
Costs	Experience (mixed paper for recycling): specific collection cost in €/t (incl. investments for bins) relatively high and in the same range of public containers /30/. Relatively high costs for replacement of bins.	-
Other aspects	Reasonable collection intervals needed. Installation of weighting system on collection vehicles would allow compensation for collected paper for recycling. Neighbourhood bin/container sharing as possible solution for little space. In case of high portion of impurities (especially were many people use the same containers) installation of waste locks or locked/fenced containers may have positive effects.	

Kerbside collection (pick up system)

The term kerbside collection system means a doorstep collection systems, where household are asked to leave their recyclable on the kerbside on specified dates to be separately collected. Concerning paper for recycling kerbside collection, it has to be properly prepared (without plastic wrappings and inserts, the cardboard flattened) and packed often with strings to bundles. In CE countries with high collection rates bundle collection decreased in the last decade /31/. Some municipalities require the use of special bags or citizens take own boxes to place their paper for recycling on the collection date. Graphic paper for recycling and board/cardboard are collected separately. Kerbside collection is suitable for most building structures, but could be difficult to realise for citizens and collectors were many people live on limited space, e. g. high risers.

	Kerbside collection	
User-friendliness	Short ways for citizens, but space for storage until collection day needed. Additional efforts for citizens in case of bundling.	+-
Quality of paper for recycling	Very good quality with impurities close to zero. Paper for recycling not protected against moisture in case no roofed collection spot near the doorstep is available.	++
Costs	Probably remarkable lower than onsite bins/containers. Better profitability for paper for recycling achievable because of very good quality and avoidance of sorting costs.	+
Other aspects		

Public conventional containers and underground containers (bring system)

Conventional containers and underground containers are placed on public ground at places where they are reachable for citizens. Conventional containers are suitable for urban areas, but also for rural areas with a relatively high population density. For areas with low population density installation close to highly frequented locations is a good option. Underground containers, in contrast to conventional containers, have the container body placed underground and offer higher collection capacities. Underground containers are particular recommended were smart appearance is an important point for decision finding. They are very well suited for urban and densely built-up areas.

For collection a special garbage truck is needed that can lift the containers up. In the case of separate collection of graphic paper for recycling and board/cardboard special trucks with 2 compartments or an extra collection tour is necessary.

Public containers are probably the best system if a municipality decides for separate collection of graphic paper for recycling and board/cardboard, because manual re-sorting of separately collected graphic paper for recycling seems to be economical (experience: 10 % miss-sorting in public containers) /28/.

	Conventional container	
User-friendliness	Depends strongly on the distance between the residents' home and the collection points. Beneficial if containers are situated on main paths or closed to highly frequented locations.	+-
Quality of paper for recycling	Varying a lot depending from the area. Example for good result: 2–3 % non-paper components /28/. Too small slots for bigger packaging may cause disposal of paper for recycling outside containers.	+
Costs	Experience for mixed paper for recycling: specific collection cost in €/t relatively high and in the same range of onsite bin /30/. Higher collection costs for separate containers for graphic paper for recycling and board/cardboard if two collection tours needed /29/. May be compensated by higher returns.	-
Other aspects	Experience with feasible distance: max. 500 m /16, 33/. Adequate collection intervals and container sizes/numbers avoiding disposal of paper for recycling outside containers. Easier to expand compared to underground containers.	

	Underground container	
User-friendliness	Depends strongly from the distance between the residents' home and the collection points. Beneficial if containers are situated on main paths or closed to highly frequented locations. More convenient to fill compared to conventional containers (e. g. for people with disabilities)	+
Quality of paper for recycling	See conventional containers	+
Costs	Higher investment costs than for public containers because of excavation of the pit and concrete casing (roughly 10 times higher /32/). Efficient emptying of containers and cost savings because of fewer emptying /32/.	-
Other aspects	Experience with feasible distance: max. 500 m /16, 33/. Save space on public area and integrate better into the townscape than conventional public containers. Noise reduction. No smell emissions. Offer good possibilities to integrate identification and weighting systems. No expansion possible.	

Recycling yard (bring system)

A recycling yard is an enclosed yard very often operated by municipalities where big containers for recyclables are assembled and commonly also hazardous substances and special waste can be disposed. It is possible to discard large objects e. g. big cardboard packaging, because the containers are usually open. Graphic paper for recycling and board/cardboard are in most cases collected separately. It is not recommended to offer recycling yards as the only system for residents because of their low user-friendliness.

	Recycling yards	
User-friendliness	Very often only accessible by car. Long distances to reach collection point, especially in rural areas. Causing fuel costs very often without compensation for separate collection. Good for large formatted paper for recycling. Less convenient for working people, because opening hours very often correspond with working hours.	--
Quality of paper for recycling	Very good with only very few impurities, because delivered paper for recycling is checked by staff. Educating of residents possible.	++
Costs:	Experience: specific collection cost in €/t roughly 30 % lower than for onsite bin/containers and public containers /30/.	+
Other aspects	Planning recycling yards the location should be chosen carefully as they require a high level of mobility of residents. With low mobility rates especially locations closed to frequented spots, e. g. shopping areas, are beneficial.	

Collection shop (bring system)

Collection shops are privately owned collection points where citizens can bring their recyclables like paper and board. In return they receive a small amount of money based on the weight. Often collection shops have the dimensions of recycling yards. Graphic paper and board/cardboard are selected separately at collection shops. Collection shops are very often used by resident with lower income.

	Collection shop	
User-friendliness	Often only accessible by car. If so => causing fuel costs, but offer small compensation for separate collection. Less convenient for working people, because opening hours very often correspond with working hours.	-
Quality of paper for recycling	Very good with only very few impurities, because delivered paper for recycling is checked by staff. Educating of citizens possible.	++
Costs	Probably similar to recycling yards.	+
Other aspects	Location of collection shops closed to frequented spots, e. g. shopping areas, are beneficial, especially in rural areas as they require a certain level of mobility. The existence of collection shops may motivate paper thievery from easy accessible onsite bins/containers and public containers.	

GUIDELINE DOCUMENT:

POLICY RECOMMENDATIONS AND GUIDELINES

DECEMBER 2014

Policy Recommendations and Guidelines

Contents

Glossary

Collection	Gathering of paper and paper products from industrial and commercial outlets, from households and offices for recycling. (Collection includes transport to the sorting/processing or recycling plant/paper mill).
Eco-design	Consideration of a product's environmental effects through its whole life cycle with the objective to reduce these effects during product design, development and planning.
End-of-waste	According to Article 6 (1) and (2) of the Waste Framework Directive 2008/98/EC, certain specified waste shall cease to be waste when it has undergone a recovery (including recycling) operation and complies with specific criteria to be developed in line with certain legal conditions.
Extended producer responsibility	Producers/packers/importers placing packaging and/or packaged products on the market are responsible for the appropriate management of the product/packaging, even after it has been discarded by the consumer. This applies to packaging and waste packaging in the EU.
Green Public Procurement	Using purchasing power of Europe's public authorities to choose environmentally friendly goods, services and works, to contribute to sustainable consumption and production.
Life-cycle thinking	Identification of possible improvements to goods and services in the form of lower environmental impacts and reduced use of resources across all life cycle stages to avoid burden shifting; this means minimizing impacts at one stage of the life cycle, or in a geographic region, or in a particular impact category, while helping to avoid increases elsewhere.
Municipal waste	Household waste and waste from retail trade, small businesses, office buildings and institutions (such as schools, hospitals, government buildings), similar in nature and composition to household waste, collected by or on behalf of municipalities.
Paper for recycling	Natural fibre based paper and board suitable for recycling and consisting of - paper and board in any shape - products made predominately from paper and board, which may include other constituents that cannot be removed by dry sorting, such as coatings and laminates, spiral bindings, etc. Remark: Previously known as "recovered paper".
Recycling	Reprocessing of used paper in a production process into new paper and board.

Recyclability	Design, manufacturing and converting of paper-and-board-based products in such a way to enable a high quality recycling of fibres and minerals in a manufacturing process in compliance - where appropriate - with current standards in the Community; as a minimum, recyclability requires that sufficient information is exchanged for appropriate risk management and safe re-use of fibres.
Residual waste	Remaining solid waste after separation of recyclables and hazardous waste collected in households (ideally not including any recyclable fractions/hazardous waste).

1. Introduction

Paper represents one of the best recycled material in Europe and a good example how the circular economy may work promoting proximity recycling thus creating new job opportunities at local level. Currently, the statistics[1] show that at European level 71, 7% of this material goes back into new paper products. Nonetheless, the quality of this material is clearly affected by some present mega trends. The sharp decline of newspapers consumption in most of the European countries is reducing one of the best known recycled paper products meanwhile the concomitant increase in the share of paper based packaging products poses new challenges due to the high diversification of these products. In order to keep the currently high paper recycling rate or even improve it in the future, a clearer definition of recycling oriented eco-design is necessary as well as a further development of the life cycle thinking in the whole paper value chain. The quality of the collected paper for recycling has to be considered as equally important as the amount of collected paper by local decision makers. Besides, the extended producer responsibility for an effective material recycling shall become a key driver in the decision process of environmentally focused companies.

The collected paper for recycling in Central Europe (CE) accounts for approximately 16 million tones, representing about one third of the amount used by the European paper industry. However, the recycling rates are quite different among the CE countries. Some of them are approaching the theoretical limit in collection whereas others still show a significant potential that must be exploited. Lesson learning from best practices is a key point and communication through suitable expert based guidelines is very much relevant to spread correct information thus helping the paper value chain stakeholders to better contribute at the sustainability of the paper recycling loop.

EcoPaperLoop, "Eco design for the Enhancement of the Central Europe Paper Based Product Recycling Loop" project is addressing these challenges. This document is one of the core outputs of the project. Roadmap for the improvement and harmonization of policy rules in the region has been developed as a set of policy recommendations and guidelines targeting European, national, regional and local policy makers designing regulatory environment for waste management and paper recycling in order to support the paper and board mills utilizing paper for recycling as raw material. Recommendations are based on the analyses of the present body of rules on paper for recycling and interviews with different stakeholders from the five project countries, Germany, Hungary, Italy, Poland Slovenia, and additionally from Austria and a number of international and national discussions with different stakeholders groups.

[1] CEPI – Confederation of European Paper Industries „Key Statistics European Pulp and Paper Industry 2013"

2. Policy recommendations and guidelines

The roadmap attempts to set supporting guidelines for the policy on how to further improve common strategy and legislative framework on paper recycling loop to achieve recycling targets and to ensure both availability and good quality of the raw material for the paper industry.

The set of policy recommendations regarding the present body of rules and future targets presented here is developed through the consultation process with a high consensus among the key stakeholders involved.

2.1 Recommendation No 1

Change of focus of the overall policy regarding paper recycling is needed, prioritizing material recovery and sustainability.

Maintaining and ensuring the quality of paper for recycling should be the main objective. The stakeholders involved in the consultation expressed their strong opinion on the need for well-defined policy goals at EU level, focusing on the sustainability, retrieving fibers as natural resources.

The need for stronger focus is justified in the market trends. The paper recycling rate in Europe has reached 71.7% in 2013. Recycling has increased by 45% since 1998, the base year for the first voluntary commitment set in the European Declaration on Paper Recycling by the European Recovered Paper Council (ERPC). The total amount of paper collected and recycled in the European paper sector remains stable at just over 57 million tons, despite decreasing paper consumption in Europe. Paper fibre is now recycled at an average of 3.5 times in Europe, far exceeding the worldwide average of 2.4 times.

Figure 1: CEPI, Key Statistics 2013

13 European countries have already exceeded the targeted 70% recycling rate. The countries which did not achieve the target yet (recycling rates below 60%) are also reporting improvements in recent years.

The EU is reaching limits regarding paper recycling rates. It is estimated that overall 22% of the paper consumption are not recyclable or collectable. At the same time, the streams of used paper are changing. Market trends and different consumption patterns are setting new challenges for paper recycling. The decline of the graphic paper markets (esp. newspaper consumption) is causing a decrease of the amounts of best quality paper for recycling while relative share of products more difficult to recycle is growing due to the growing market for paper based multi-functional and multi-material packaging products. The quality of paper for recycling from household waste is lower and presents a constraint to a higher and more efficient recycling.

Taking into account defined targets (increasing quantity of collected paper with growing share coming from households) and market trends (less newsprint, more packaging), maintaining the quality of paper for recycling is becoming more and more challenging.

Policy guidelines:

- A sound implementation of the legislation and supervision of efficiency regarding achievements of the targets at all levels is essential.
- Ambitious targets are achievable only if a comprehensive approach to policy design and implementation is ensured, following the objective to maintain the quality of paper for recycling and thus focusing on the key preconditions, being eco-design, and better collection and sorting.

- A more market-oriented approach is expected, based on the knowledge of real market issues and cost/benefit analyses.

2.2 Recommendation No 2

**There is room for improvement of the present regulation on paper products but no new bans or expand of legislation are expected.
Education, promotion and stimulation of all actors in the value chain are more important and efficient to reach the targets.**

The present legislation related to paper for recycling defines general requirements. No specific environmental obligations apply for paper products. The packaging waste directive gives reference to the EN packaging standards which provide guidelines on how to implement essential packaging requirements for all. When paper enters the waste stream, the general rules covered in the Waste Framework Directive apply, as for all other materials.

Regulation concerning collection, sorting and use of paper for recycling is generally acceptable. Overregulation that could become a barrier to development should be avoided. Nevertheless, obstacles and weaknesses in the present regulation exist that need to be improved. Separate collection is widely interpreted.

Policy guidelines:

- Legislation is lacking comprehensiveness; therefore more emphasis on the closed loop recycling management is needed with clear responsibilities of all actors involved.

- Recycling is adequately placed in the waste hierarchy of the Waste Framework Directive, but clear definitions and quality standards for determination of recyclability, including certification methods and guidelines, are needed at EU level.

- The priority should be ensuring implementation of existing legislation in all countries and consistency between EU, national/regional regulation. Higher transparency is needed to ease the implementation.

- Greater material flow traceability including economic aspects will give feedback to producers to improve the environmental performance of the products with regard to material recovery and to the policy for further improvements.

- Improvement of the legislation is needed, but higher awareness of the recyclability issues is even more important. More investment in education, awareness raising and promotion of good practice in paper recycling among all actors involved is necessary, including improvement of general knowledge on the whole paper loop, definitions (i.e. the difference between recyclability, recycling, and recycled paper) and the most important preconditions for the quality of the paper for recycling. Support for technological development should also be enforced.

- A more "life-cycle thinking" approach should be applied, promoting sustainability targets among all actors in the chain; eco-design for the paper value chain to improve production towards better recyclable products, and for the waste management to ensure higher collection levels, proper sorting and access to quality paper for recycling.

- Policy measures shall be strengthened to stimulate actors in the paper loop for more efficient recycling, i. e. rewarding tax and fees incentives, stimulating investment in technology development, strengthening market development initiatives (i.e. GPP) and others.

2.3 Recommendation No 3

New consumption patterns and market trends are bringing new challenges for paper recycling.
Improved collection strategies are needed to maintain and ensure the quality of paper for recycling.

Collection strategies differ from country to country, they can even vary from one another within the same country. Uniform collection strategies do not and cannot exist due to different local conditions, landscape and population, settlement and housing structure, legislation and similar. Nevertheless, collection strategies should follow the objectives of clean waste streams, efficient sorting and traceability.

In terms of quality of paper for recycling at the point of collection, the systems can be ranked (from best to worst):

- Collection shops (paper banks) with quality monitoring (and pay-back as incentive)
- Paper bins / containers at households (quality level depending on housing structure) and recycling centers (with presence of monitoring staff)
- Public containers for paper for recycling
- Single stream ("comingled") collection of all recyclables.

The better the quality is at the point of collection, the lower are the costs for post-sorting. Education and motivation of citizens help to further reduce post-treatment costs. Post-sorting isn't necessary at all in case of collection shops.

The key challenge to higher recycling rates and quality of paper for recycling lies in efficient municipal waste collection systems. The qualities of these waste streams are low and in general not well traced and documented. The systems are subject of the regional/local regulation and are also much more dependent on public awareness.

Through years of experience, a general awareness on the importance of recycling for more efficient raw material use by using recycled paper has developed within the population. Much less knowledge exists regarding conditions that determine the quality of paper for recycling.

Policy guidelines:

- Improvements in collection and sorting systems are proposed to be achieved by investing in awareness raising and promotion, development of additional recommendations and guidelines, rather than new bans and extended regulation.

- Requirements in relation to recyclability in eco-design and producer responsibility to inform and guide consumers for proper collection should be strengthened. Producer needs to communicate to the consumers and end-users information on the recyclability of the product in a simple and understandable manner so that they are informed enough to make the appropriate choice at discarding. Guidelines for proper collection and sorting at the consumer level are needed to maintain pure paper streams. Instructions must be available according to the local sorting systems and recycling technologies in use.

- "Smart« regulation is needed, combining regulatory and policy incentives to stimulate collection and recycling. Regulation should be designed based on the knowledge of the real market issues and stimulated through prices, paper stream should be market oriented.

2.4 Recommendation No 4

Promote eco-design and recyclability.

"Use product design to educate on the environment".

Policies are more focused on the waste stage of the paper life cycle; eco-design is not promoted and encouraged sufficiently. Schemes in support of extended producers' responsibility are missing both in relation to material and financial flows.

Eco-design is supported and encouraged by the new Waste Framework and Packaging and Packaging Waste Directives. The Eco-design Directive (2009/125/EC) does not address paper products and they are not included in the plan of products for which minimum criteria will be produced in the near future. The Eco-design Directive determines minimum environmental requirements while eco-label caters to the top 5% of products concerning environmental performance on the market. The Packaging and Packaging Waste Directive refers to EN standard 13430 which determines general requirements for packaging recoverable by material recycling, applicable to all recyclable packaging materials.

Eco-design of packaging is a trade-off with regard to many product requirements relevant to the packaged product. In view of this the final choice of packaging parameters is left to the packer. Extended producer responsibility and essential requirements defined in the packaging standards can improve packaging recyclability.

Various practices for extended producer responsibility exist in Europe, with different grades of producer responsibility limited to responsibility for final waste management or enhanced to include all stages of waste management with collection and sorting.

Policy guidelines:

- All stakeholders in the paper and waste paper value chain have the power to improve the quality of recycled paper. It is therefore appropriate that responsibilities of each stakeholder are clear and proportional to their range of influence to the quality of paper for recycling.

- General rules for eco-design in regulation on EU level are needed. Eco-design should be stimulated through waste and cost traceability of post-consumer waste management. Recommendations for product designers and producers should be available.

- Determination of recyclability, including evaluation methods and criteria for certification is of high importance. Recyclability tests should represent an umbrella and link to the existing standards and certifications.

- It is expected that a common approach to the operation of producer responsibility will be implemented. This should entail complete coverage of waste product management costs. For that, greater transparency of material flows and economic aspects within the producer responsibility need to be ensured.

- Encouragement of the use of ecolabels and purchase of products with eco certification that include recyclability criteria is important.

2.5 Recommendation No 5

Enforce use of recyclability criteria in green public procurement. "Recyclability of the product is more important than content of recycled fibres in paper products".

Common criteria for green public procurement in EU are defined, linked to eco-label recommend-dations. Though the product eco-label is proof of compliance with environmental criteria, it must not be requested per se from the supplier in the tender procedure.

Environmental criteria in public procurement procedures are more or less a legislative require-ment in all countries; with some countries prescribing exact environmental criteria and others re-lying more on the dissemination of good practice, contract templates and other softer tools.

On paper products the content of recycled fibres in the product has a high level of awareness. This aspect prevails too much, as the closed paper loop will only be established and maintained if ade-quate attention is also given to the recyclability of the product.

Policy guidelines:

- GPP should focus on sustainability. A shift needs to be made from the attention given in GPP to the share of recycled fibres contained in the product to the recyclability of the product.
- GPP is important tool to stimulate recycling, it represents one of few demand side measures and should therefore be imposed stronger. Common rules defined at the EU lev-el need to be clearly defined.
- Implementation is critical, therefore it should be strongly supported by the guidelines, ex-change of good practices and education of the users. Efforts are needed to increase the competence of civil servants performing GPP.
- GPP should be an obligation for public authorities and at the same time part of the general policy promoting eco-design and recycling. Measures are needed to stimulate private sec-tor to use the same principles and criteria in the procurement.

2.6 Recommendation No 6

Ensure access to quality paper for recycling in Europe.

It is estimated that a high quantity of reusable and recyclable paper for recycling is lost with export outside the EU borders. EUROSTAT reports the trade volume of paper for recycling in EU-27 according to trade flows. The EU-27 imports are small, but the exports exhibit strong growth till 2009, now remaining stable at nearly 15% of the amount of paper collected separately in the EU.

A recent proposal for changing the legal definition of end-of-waste for paper, aimed to allowing collected paper to cease being considered as waste earlier in the recycling process, has been rejected due to the fear of a potential negative effect on paper recycling in Europe. That could compromise the health and environmental standards contained in the Waste Directive and could reflect in even increased export of paper for recycling thus strongly effecting the European paper recycling sector (European Parliament, December 2013).

The waste shipment regulation provides a safeguard to prevent loss of resources. Amended regulation lays down requirements for shipments of waste within the EU and between the EU and third countries, containing stricter requirements for the member states to establish shipment inspection plans, based on risk assessment.

Policy guidelines:

- End-of-waste regulation and criteria already announced in a new directive should be discussed with the focus on sustainability and resource efficiency. Market and cost/benefit analyses should prevail.

- Strict implementation of the waste shipment regulation needs to be ensured, with more practical supervision of actual shipments of paper for recycling from EU.

- Paper and packaging waste traceability all along until recycling has to be enhanced.

3. Project partners' contribution and strategy

The overall results from our project clearly show that there is room to enhance the quality of paper for recycling implementing the already existing legislation as well as through strong voluntary commitments in the paper value chain.

It is clear that paper mills using paper for recycling as a major raw material are only partially satisfied by its quality. So far, the target of increasing the collection rate in all CE countries is prevailed versus the concept that quality of the secondary raw material is at least as important as the overall collection rate.

The project partners worked together for more than two years promoting the relevance of the quality of paper for recycling. During the project some relevant tools have been developed, and some of them already implemented. Nevertheless, in order to be more effective they will need to be adopted in the whole paper value chain in the near future.

Assessment of paper based packaging recyclability; the method has been developed, and presently four laboratories in CE region possess the right equipment and expertise to carry out the recyclability test thus assisting packaging designers in the development of new recycling oriented products.

Scorecard of paper based packaging products; a Scorecard proposal has been developed during the project time frame and preliminary discussed in a web based public consultation. Nonetheless, this instrument will require a deep discussion in the European Recovered Paper Council before being adopted. The project partners involved in this development will ensure their availability even after the end of the project to ensure a smooth adoption. Due to the complexity of paper recycling process and the huge variety of products present in the market, most likely, additional adjustments and methodological refining will be necessary to ensure the sustainability of the tool in the next future.

Ecolabels and green public procurement; recently, the recyclability criteria have been included into the ecolabel of printed and converted products. Similar criteria are present in the Blue Angel and Nordic Swan as well. In several CE countries the public administration is further developing the national plans for green purchasing. In this context, a clear message from the EcoPaperLoop project concerns the introduction of recyclability criteria for the products to complement the already existing criteria of a minimum amount of recycled products purchased by public authorities. In order to develop minimum environmental criteria, the project partners in their own countries commit themselves to support public authorities and local environmental agencies with the technical expertise gained in the project.

Sustainability tool for end-of-life performance; a sustainability tool has been developed during the project. Currently, this tool allow to translate the recyclability performance of graphic products tested according to ERPC score card into (i) energy consumption increase/decrease versus an average category product, (ii) chemicals consumption increase/decrease versus an average category product, (iii) CO_2 consumption/savings versus average category product. In the case of packaging products categories the tool has been set up, however, it will properly function once the data base will be fully completed. Project partners working on recyclability of packaging products in their own countries agreed to share future results. The lead partner will maintain and update this tool for at least five years after the end of the project.

Decision tree of paper for recycling collection systems; based on the analysis of CE situation, a decision tree has been developed to support local authorities in charge of waste management and collection. The decision tree allow decision makers to clarify what is the best strategy to follow in order to improve paper for recycling collection and quality compared to previous.

EcoPaperLoop Final Conference

Kraków, December 2nd, 2014

Conference Presentations

(Videos on the Conference Website www.ecopaperloop.eu)

EcoPaperLoop Project:

Sustainability of the paper value chain

Graziano Elegir

EcoPaperLoop project: sustainability of the paper value chain

Graziano Elegir, Final conference Ecopaperloop, Kracow 02/12/2014

Ecodesign for the Enhancement of Central Europe **Paper** Based Products Recycling **Loop**

Programme: Central Europe 2013

Priority 3.4: Using our environmental Responsibility - Supporting environmentally friendly technologies and activities

Lead Partner: Innovhub-SSI, Paper Division (Milan, Italy)
Project time frame: September 2012 – December 2014

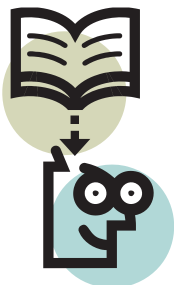
Mission

Improve the quality of paper for recycling

PROJECT PARTNERSHIP

Partnership	Country
Innovhub-Stazioni Sperimentali per l'Industria	Italy
Paper Technology Consulting GmbH	Germany
Technical University of Darmstadt	Germany
Technical University of Dresden	Germany
Pulp and Paper Institute Ljubljana	Slovenia
University of Ljubljana	Slovenia
University of West Hungary, Paper Research Institute	Hungary
Polish Packaging Research and Development Centre	Poland
COMIECO, National Consortium for the Recovery and Recycling of Cellulose-based Packaging	Italy
Lombardy Region	Italy

Collected paper for Recycling in CE



Country	Collection 2012 [1000 tonnes]
Austria	1.451
Czech Republic	807
Germany (CE region)*	7.416
Hungary	436
Italy (CE region)**	3.618
Poland	1.842
Slovakia	250
Slovenia	237
Total	**16.056**

Approximately 1/3 of the paper used by the European Paper Industry

* DE: *Estimated figures based on population in the CE region*
** IT: *Estimated figures based on Comieco's collection in the CE region*

Recycling rate in CE countries

Country	Recycling rate
Austria	70%
Czech Republic	56 %
Germany	76 %
Hungary	47 %
Italy	63%
Poland	39%
Slovenia	64 %
Slovakia	49 %
Average in CEPI countries	71,7 %

- paper recycling rates are still highly inhomogeneous
- paper recycling rates are still quite low in some countries

Trends in the paper sector

Recycling rates have constantly increased in the last 20 years *but have recently started to level out.*

The decline in newspapers consumption affects paper recycling rate since they are traditionally one of the best recycled paper products.

The increase of tissue and packaging share does not fully compensate for the decline of graphic paper

Potential for further increase does exist especially in those countries far below the average.

Focus on the Quality of Paper Recycling

- **Improper collection systems** can drastically reduce the amount & the quality of paper being recovered for recycling
  - *Avoid commingled collection with other materials*
  - *Promote the use of EN643 standard*
  - *Promote quality assessment of collected paper for recycling*
- **improper design of a graphic or packaging product** can create problems in the recycling process, lower the recycled paper quality and worsen the environmental impact.
  - *Need of a scientific approach to assess recyclability of paper based products*

Paper for Recycling in Central Europe

- **Paper for recycling** *is not recycled only in the country where it is produced.*
  - Recycling focused product design
  - Efficent paper collection systems (quality oriented)

  must be developed at a transnational level to increase the sustainability of the paper loop.

Stakeholders interaction in the paper for recycling value chain

Municipalities: quantity

Citizens:
waste management costs

Waste management : profitability

Converters: quality of the product

Paper mills: quality of paper for recycling

EcoPaperLoop – project structure

WP1: Project management

WP 3: Recyclability assessment

WP4: Eco-efficient collection systems

WP2: Communication platform

WP5: Sustainability assessment

WP6:Transnational policy development

Main project targets

- New standard method to assess packaging paper products recyclability.
- Regional database on printed and packaging products recyclability.
- Recommendation guidelines for reliable best practises on recovered paper collection.
- Pilot LCA case studies on the impact of recycling oriented eco-design of paper products.
- Roadmap for transnational policy strategy in the paper for recycling field.

EcoPaperLoop_ Recyclability tools developed

- **New Laboratory assessment method for paper based packaging products**
- **Created a large database on paper based product recyclabiliy**
- **Score card proposal for paper based packaging products**

EcoPaperLoop_ Sustainability tools developed

- Pilot LCA case studies: environmental impact of different product design
- Web-based sustainability recycling calculator

CENTRAL EUROPE COOPERATING FOR SUCCESS. EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND

EcoPaperLoop_ collection systems

- Deep analysis of the current situation in the Central Europe countries
- Recommendation guidelines and decision tree for paper collection systems

CENTRAL EUROPE COOPERATING FOR SUCCESS. EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND

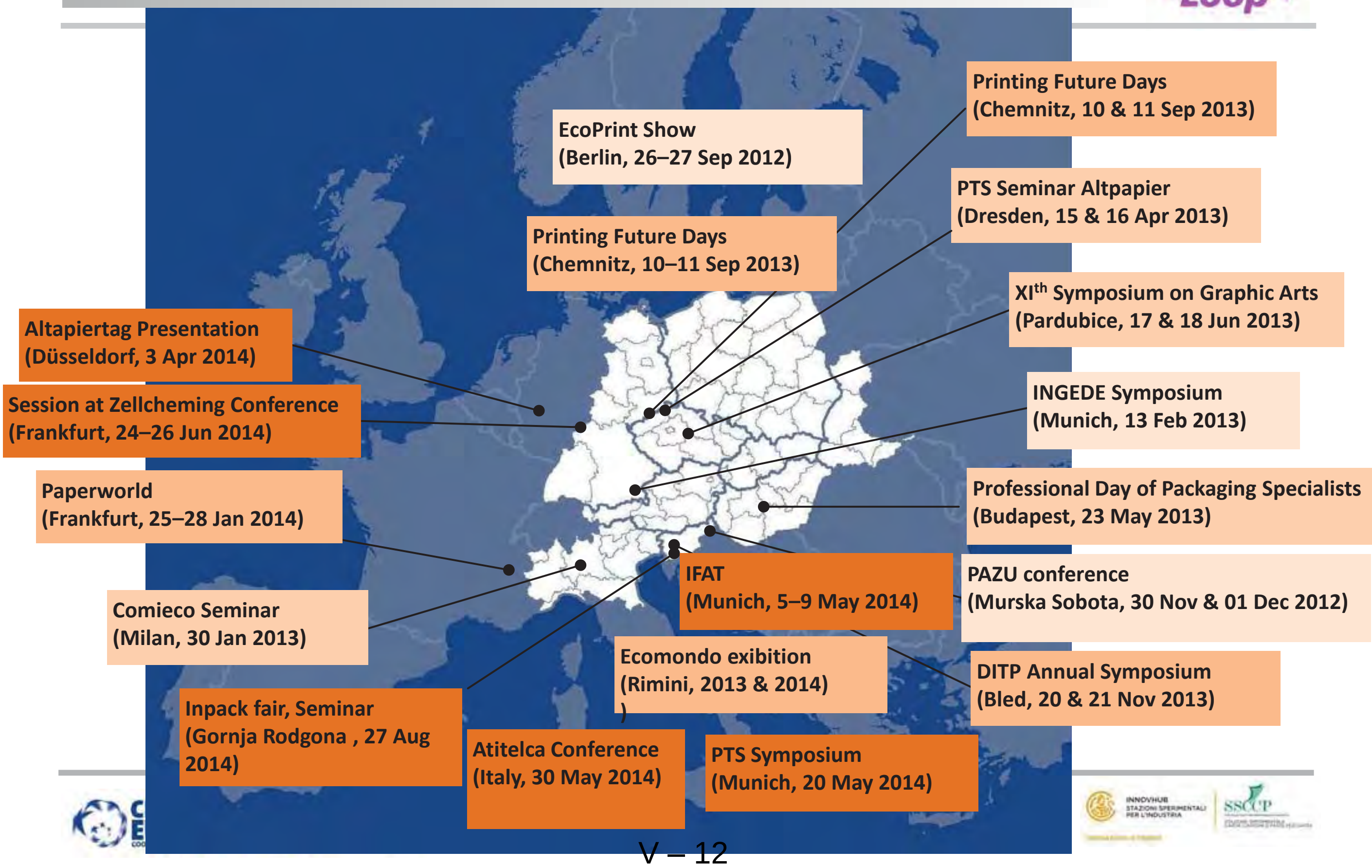
EcoPaperLoop_ regulatory framework

➢ Deep analysis of the current situation in five Central Europe countries

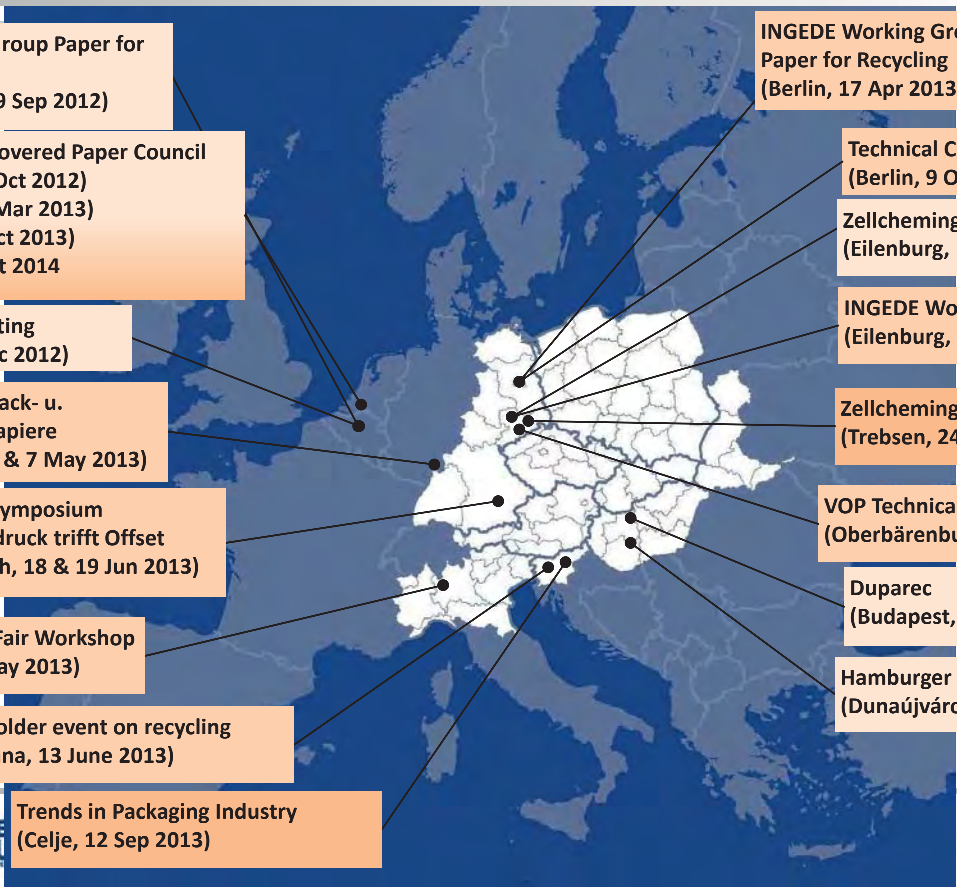
➢ Roadmap document: project position paper for a transnational strategy in CE

CENTRAL EUROPE COOPERATING FOR SUCCESS. EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND

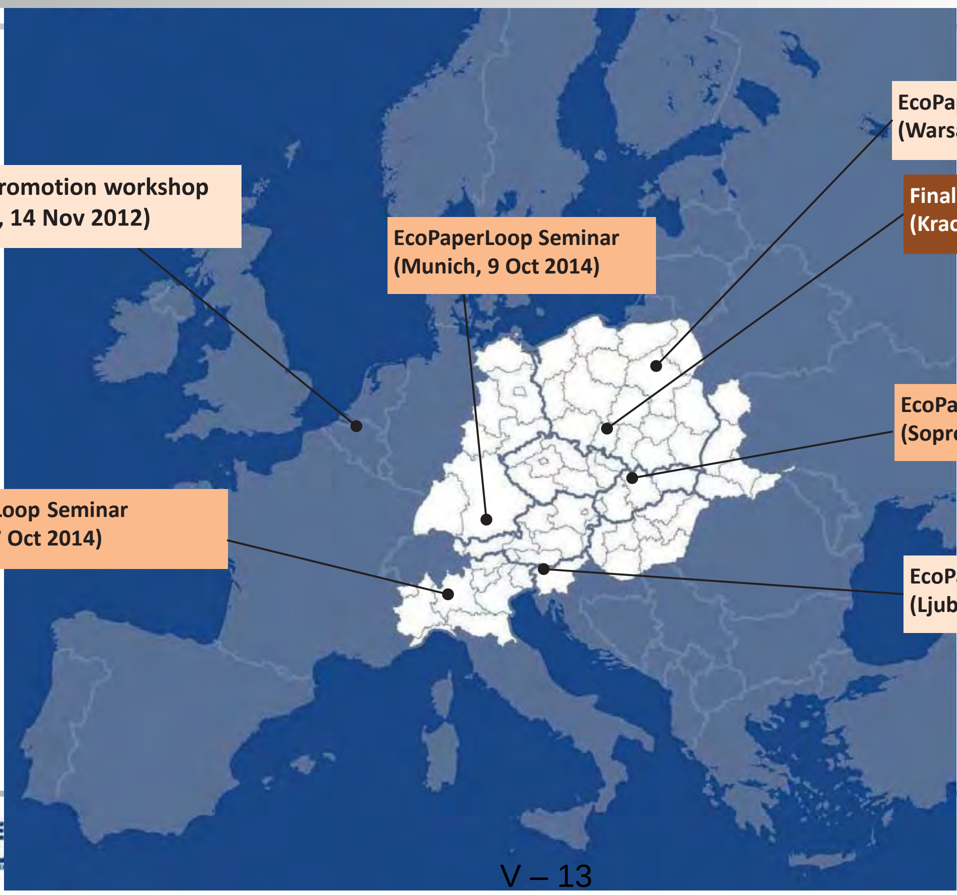
Communication in conferences and exibitions



Face-to-face stakeholder dialogues



Project promotion workshop & Promotion seminars in local language



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Inštitut za celulozo in papir

University of Ljubljana

COBRO

UNIVERSITY OF WEST HUNGARY

CENTRAL EUROPE COOPERATING FOR SUCCESS. EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND

This project is implemented through the CENTRAL EUROPE Programme
co-financed by the ERDF (European Regional Development Fund)

The waste collection in Poland – problems with the quality of paper for recycling

Katarzyna Godlewska

ZBIÓRKA ODPADÓW W POLSCE – PROBLEMY Z JAKOŚCIĄ MAKULATURY

Dr inż. Katarzyna Godlewska

Stowarzyszenie Papierników Polskich

ZBIÓRKA ODPADÓW - LEGISLACJA

Obowiązek selektywnej zbiórki w 2013 r. wprowadzono poprzez zapisy ustawy o czystości i porządku w gminach. W ustawie stwierdza się, że gminy ustanawiają selektywne zbieranie odpadów komunalnych obejmujące, co najmniej następujące frakcje odpadów: papieru, metalu, tworzywa sztucznego, szkła i opakowań wielomateriałowych oraz odpadów komunalnych ulegających biodegradacji, w tym odpadów opakowaniowych ulegających biodegradacji (art. 3 ust. 2 pkt 5).

ZBIÓRKA ODPADÓW- LEGISLACJA

Legislatorzy w ustawie o odpadach wyraźnie zdefiniowali, co należy rozumieć przez pojęcie zbiórki selektywnej (art.3 pkt 25) – jest to zbieranie, w ramach, którego dany strumień odpadów, w celu ułatwienia specyficznego przetwarzania, obejmuje jedynie odpady charakteryzujące się takimi samymi właściwościami i takimi samymi cechami.

MAKULATURA

Jednym z surowców, który powinien być zbierany selektywnie jest papier i tektura z odzyku.

Makulatura jest to: papier, tektura lub ich przetwory, które utraciły wartość użytkową albo w procesie produkcji nie uzyskały wartości użytkowej i kwalifikują się do ponownego rozwłókniania oraz zastosowania jako surowiec do produkcji papieru lub tektury (wg normy ISO 4046 : 1978 oraz PN 92/P - 50000 pt.: "Papier, tektura, masa włóknista i określenia związane - terminologia").

ZUŻYCIE I ODZYSK MAKULATURY W POLSCE W LATACH 2012 – 2013

Wyszczególnienie	2012	2013
Zużycie makulatury (tys. t)*	1.708,5	2.049,7
Import makulatury (tys. t)	393,1	457,7
Eksport makulatury (tys. t)	542,1	593,1
Odzysk makulatury (tys. t)	1.857,5	2.185,1
Wskaźnik zużycia (%)	44,7	49,9
Wskaźnik odzysku (%)**	44,7	48,9
Wskaźnik recyklingu (%)**	41,1	45,8

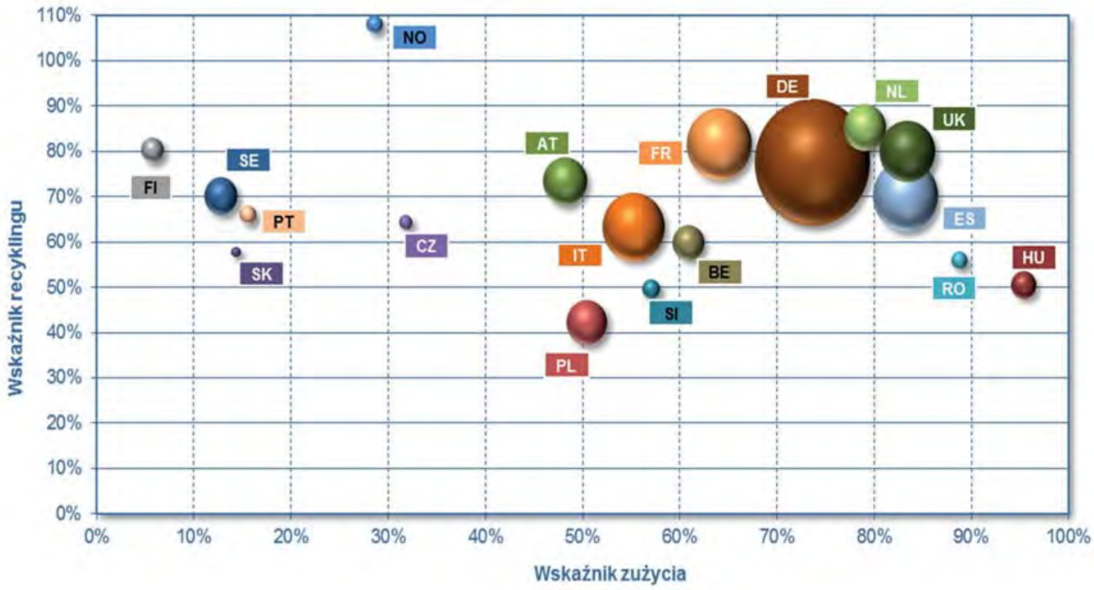
** wg SPP*
*** wskaźniki liczone w stosunku do całkowitego zużycia papieru i tektury uwzględniając saldo wymiany handlowej wyrobami z papieru i tektury oraz papierem zadrukowanym*

MAKULATURA- EUROPA

Dla porównania w 18 krajach CEPI zebrano łącznie 55,5 mln ton makulatury. Wskaźnik zbiórki – 72,7%, a wskaźnik recyklingu – 71,9%.

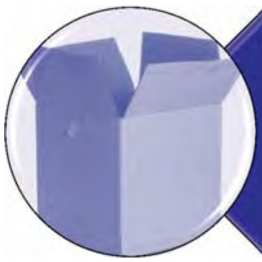
Najbardziej efektywne systemy zbiórki do recyklingu makulatury mają: Norwegia, Holandia, Francja, Finlandia, Wlk. Brytania, Niemcy, Austria, Hiszpania, Szwecja gdzie wskaźniki odzysku wynoszą powyżej 70%.

MAKULATURA - WSKAŹNIK RECYKLINGU, WSKAŹNIK ZUŻYCIA ORAZ ZUŻYCIE W KRAJACH CEPI – 2013 R.



Dane wg. CEPI

ŹRÓDŁA MAKULATURY



Zużyte opakowania i odpady z produkcji opakowań (opakowania jednostkowe, zbiorcze
i transportowe oraz „ścinki” z produkcji opakowań)

Odpady z zadrukowanego papieru i produkcji materiałów graficznych (przeczytane gazety, książki, broszury, ulotki, zapisane zeszyty, akta biurowe, zwroty gazet i czasopism itp.)

EUROPEJSKI WYKAZ ZNORMALIZOWANYCH ODMIAN PAPIERU I TEKTURY Z ODZYSKU

Podstawowym i najbardziej rozpowszechnionym narzędziem stosowanym do oceny jakości makulatury jest norma PN-EN 643: 2014-03E.

W normie tej zdefiniowano odmiany makulatury, stosowane jako surowiec do ponownego w produkcji wyrobów z papieru i tektury w przemyśle papierniczym. Zawiera ona również informacje dotyczące składu poszczególnych gatunków makulatury jak i poziomy tolerancji dla materiałów nie papierniczych i nieporządanych.

RODZAJE MAKULATURY

- odmiany słabe np. czasopisma niesprzedane z klejem lub bez kleju,
- odmiany średnie np. papier biurowy sortowany,
- odmiany lepsze np. ścinki drukarskie,
- odmiany mocne np. ścinki tektury falistej nowe,
- odmiany specjalne np. etykiety.

EUROPEJSKI WYKAZ ZNORMALIZOWANYCH ODMIAN PAPIERU I TEKTURY Z ODZYSKU

Niezwykle ważnym aspektem przygotowania odpowiedniej, jakości makulatury jest odsortowanie papierów i tektur nienadających się do przerobu w przemyśle papierniczym.

Norma PN-EN 643: 2014-03E definiuje pojęcia materiałów nieużytecznych (materiały zabronione i niepożądane), tak aby były zrozumiałe dla wszystkich osób zaangażowanych w problematykę gospodarki papierem i tekturą przeznaczoną do recyklingu.

- materiały zakazane - to każdy materiał, który stanowi zagrożenie dla zdrowia, bezpieczeństwa oraz środowiska takie jak odpady medyczne, zanieczyszczone produkty higieny osobistej, niebezpieczne odpady, odpady pochodzenia organicznego w tym odpady żywności, bitumen, toksyczne proszki itp.
- materiały niepożądanych (odpady) – są to materiały nienadające się do produkcji papieru i tektury np. materiały niepapierowe, papier i tektura niezgodny z definicją gatunku makulatury papier i tektura, papier i tektura nienadające się do wytwarzania papieru i tektury oraz papier nie nadający się do odbarwiania (jeżeli odnosi się do rozważanego przypadku).

MAKULATURA – RODZAJE ZANIECZYSZCZEŃ

Rodzaje zanieczyszczeń:

- mechaniczne np. metal, tworzywa sztuczne, szkło, tekstylia, drewno, piasek i materiały budowlane;
- chemiczne np. rozpuszczone cząstki klejów papierniczych, niektórych farb drukarskich, substancji impregnujących, pozostałości substancji chemicznych;
- mikrobiologiczne np. bakterie, pleśnie, grzyby.

ZANIECZYSZCZENIA – PROBLEMY TECHNOLOGICZNE

Zanieczyszczenia występujące w dostarczanej makulaturze mogą powodować:

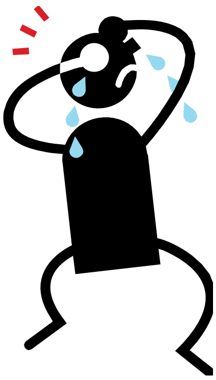
- utrudnienia w procesie produkcyjnym np. poprzez uszkodzenie maszyn lub też obniżenie jakości gotowego wyrobu.
- trudności z rozwłóknianiem,
- zaklejanie odzieży maszynowej (sita, filce),
- zapychanie sit sortowników,
- wady w papierze w postaci wtrąceń kleistych, parafinowych, smolistych (z papierów powlekanych itp.).

MAKULATURA

Powstaje pytanie z czego wynikają te duże rozbieżności pomiędzy efektywnością selektywnej zbiórki osiąganymi w innych krajach europejskich a Polską???

ZBIÓRKA ODPADÓW- PRAKTYKA

W praktyce niestety w wielu przypadkach gminy chętnie zastępują selektywną zbiórkę systemem dualnym, czyli tzw. zbiórką suche – mokre.



SYSTEM DUALNY SUCHE - MOKRE

Ogólnie zakłada się, że odpady mokre przeznaczone są do kompostowania, zaś suche do segregacji i dalszego zagospodarowania.

- frakcja sucha czyli opakowania po produktach spożywczych, chemii gospodarstwa domowego, środkach czystości, folia, opakowania wielomateriałowe, butelki PET, kubki i sztućce jednorazowe, papier kolorowy, suchy karton, guma, skóra, drewno (fragmenty mieszczące się w pojemniku) oraz opakowania metalowe,
- frakcja mokra czyli odpady kuchenne, resztki i obierki owoców i warzyw, fusy z kawy i herbaty, skorupki jajek, odpady tytoniowe (niedopałki), rośliny i ziemia kwiatowa, zużyte ręczniki papierowe, zużyte chusteczki higieniczne, pieluchy jednorazowe i inne środki higieny osobistej, mokry karton, woreczki i torebki papierowe, pozostałości po domowej „hodowli" zwierząt, skoszona trawa, liście, pocięte gałęzie,
- szkło

ZBIÓRKA ODPADÓW- PRAKTYKA

Zamiast 7 strumieni odpadów – mamy 3 strumienie nieselektywnie zebrane, co na pewno oznacza mniejsze koszty dla zbierającego, ale prowadzi do znacznego pogorszenia jakości potencjalnych surowców wtórnych!!!!

ZBIÓRKA ODPADÓW- PRAKTYKA

Ponadto dofinansowywane są instalacje do segregacji nieselektywnie zbieranych odpadów!!!!

ZBIÓRKA ODPADÓW
A
MAKULATURA

Selektywna zbiórka makulatury powinna odbywać się zgodnie z Rozporządzeniem Ministra Gospodarki z 2005 r w sprawie szczególnego postępowania z odpadami opakowaniowymi.

Dz.U.2005, nr 219, poz.1858

PODSUMOWANIE

W 2012 r. w Polsce jednostkowe zużycie papieru wynosiło 107,9 kg, a w 2013 r. odnotowano je na poziomie 116,1 kg papieru. Oznacza to, że zapotrzebowanie na papier i tekturę będzie wzrastało.

W efekcie popyt na makulaturę, stanowiącą jeden z podstawowych surowców do produkcji papieru, będzie wzrastać w nadchodzących latach.

Tym istotniejszy jest odpowiedni jej odzysk, a zwłaszcza makulatury opakowaniowej.

PODSUMOWANIE

W ostatnich latach miały miejsce inwestycje, w efekcie których zwiększyła się produkcja papierów w 100% produkowanych z makulatury.

Polski przemysł papierniczy, wprowadzając nowe, innowacyjne rozwiązania przyczynia się do wypełniania przez Polskę nałożonych przez UE obowiązków w zakresie osiągania odpowiednich wskaźników recyklingu.

PODSUMOWANIE

Przy odpowiedniej edukacji jak i odpowiedniej praktyce w zakresie zbiórki selektywnej możemy poprawić jakość odzyskiwanych surowców wtórnych i osiągnąć wskaźniki stawiane przed Polską przez UE.

Dziękuję za uwagę.

Strategies for the collection of paper for recycling

Harald Großmann

WP 4 – Improve Collection Strategies

Harald Grossmann, Roland Zelm, Anja Groß, Sofia Guerrero Mercado, Nguyen Trung Cong

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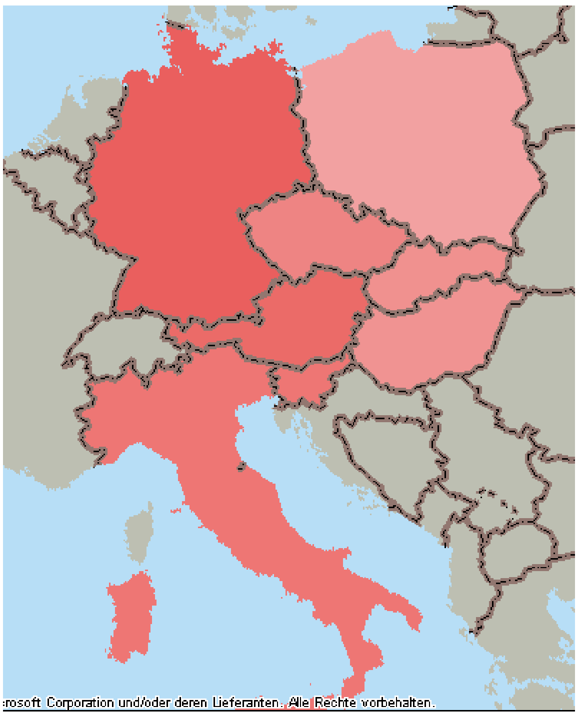
Paper Based Products Recycling Loop

Grant No: 4CE555P3

Current p&b recycling rates in CE



recycling rate in %

80

40

0

$$\text{recycling rate \%} = \frac{\text{pfr* collection}}{\text{p\&b** consumption}} \times 100\ \%$$

*p&b = paper & board

**pfr = paper for recycling

WP 4 – Improve Collection Strategies

The focus of WP4 was on pfr collection from households

The objective

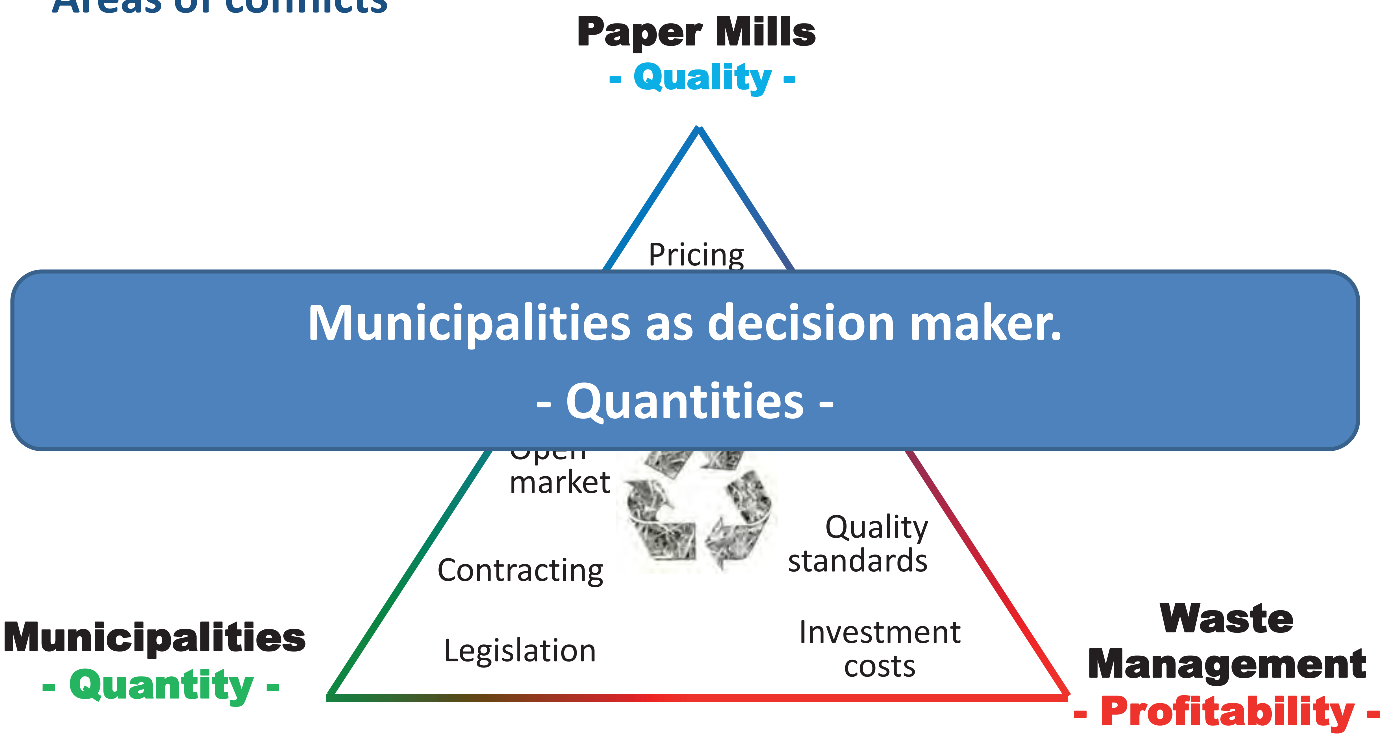
was to develop recommendations for improving existing or initially installing collections systems taking into account all major local and regional principal variables crucial for the success of the effort.

Content

- **Stakeholders' areas of conflict**
- **Conclusions for better collection strategies**
- **Recommendations**
- **Tool for decision finding**

Stakeholders' areas of conflict

Areas of conflicts

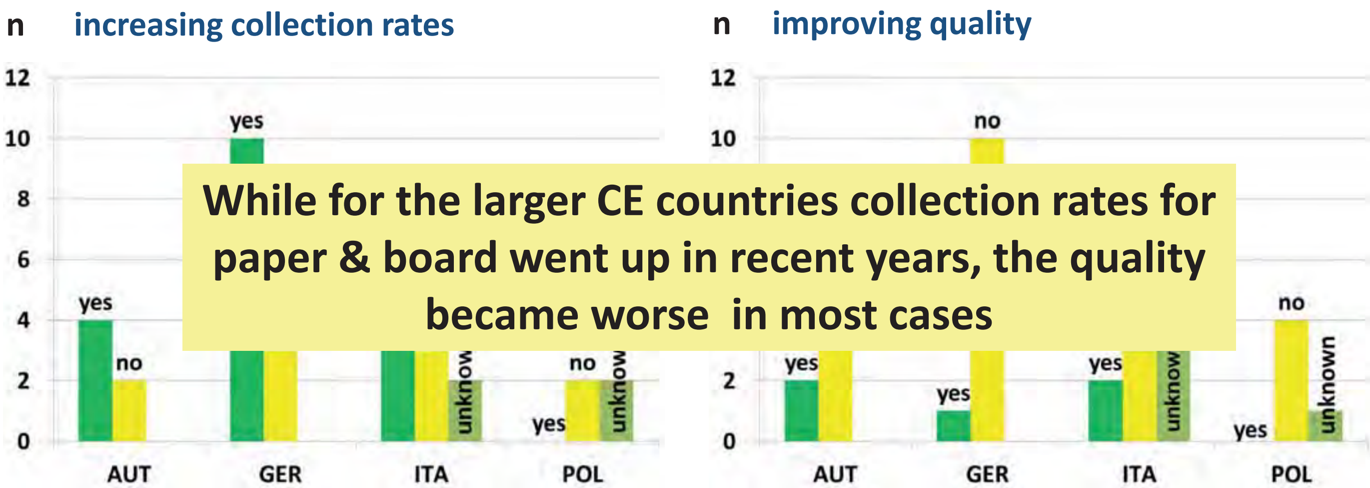


Municipalities as decision maker.

- Quantities -

Survey on Collection Strategies: Changes observed in recent years

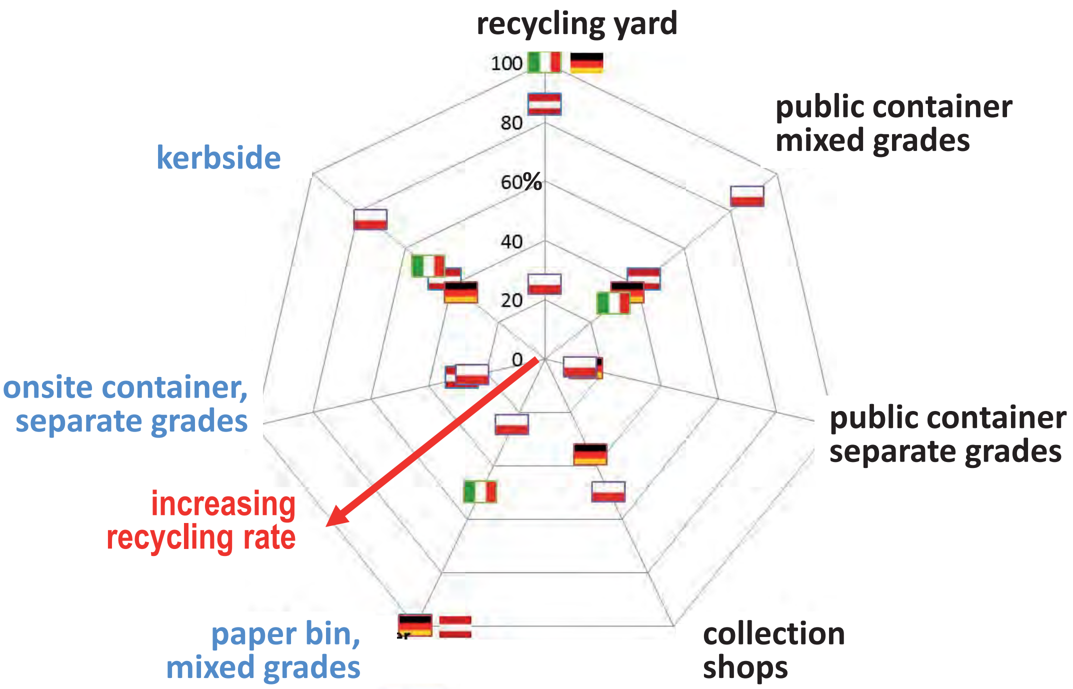
n = number of answers from local authorities

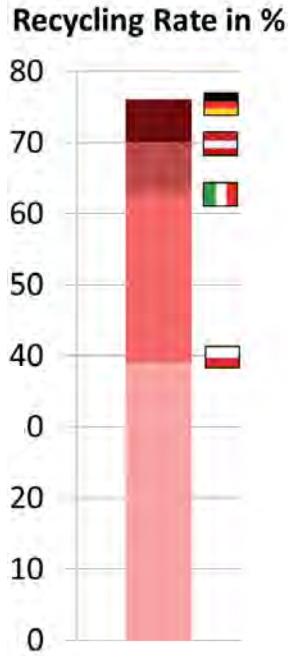


While for the larger CE countries collection rates for paper & board went up in recent years, the quality became worse in most cases

Correlation between collection system and recycling rate

39 responding authorities, data from AUT + GER + ITA + POL





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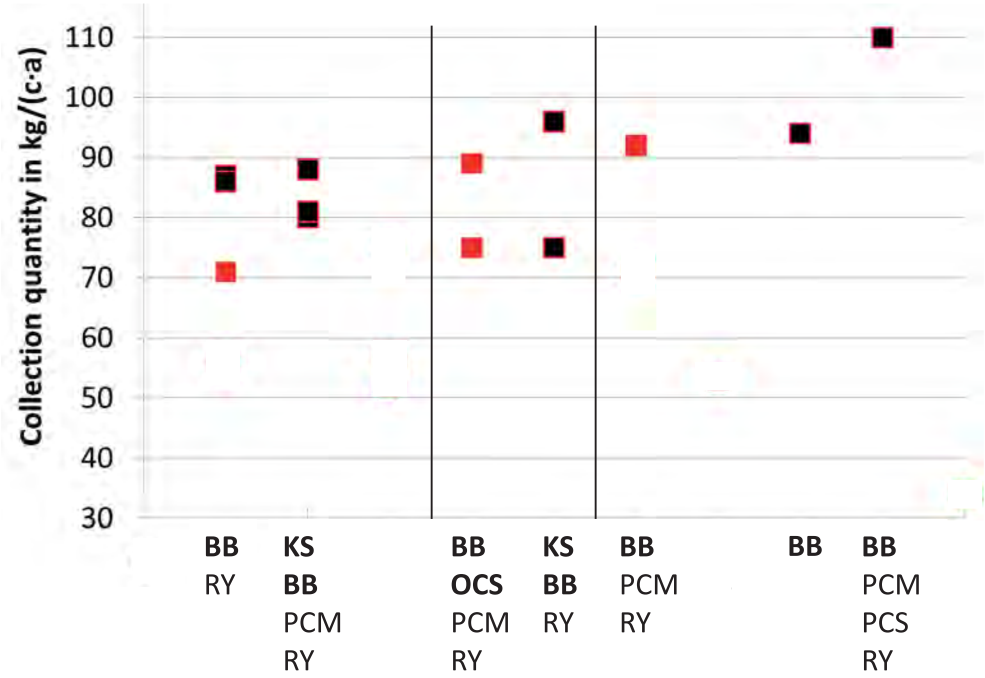
Correlation between type of collection systems and quantity

20 responding authorities, data from AUT + GER

Correlation between type of collection systems versus quantity

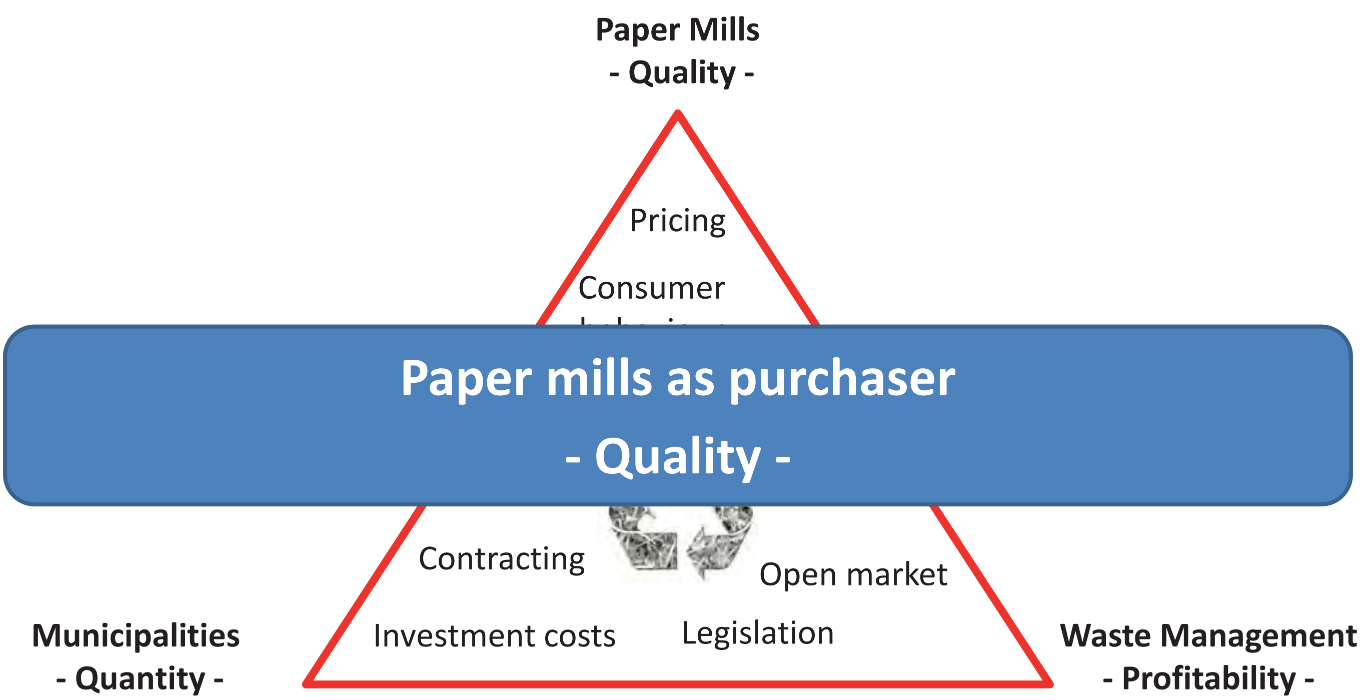
elimination of collection shops and low GDP, data from AUT + GER



urban
rural

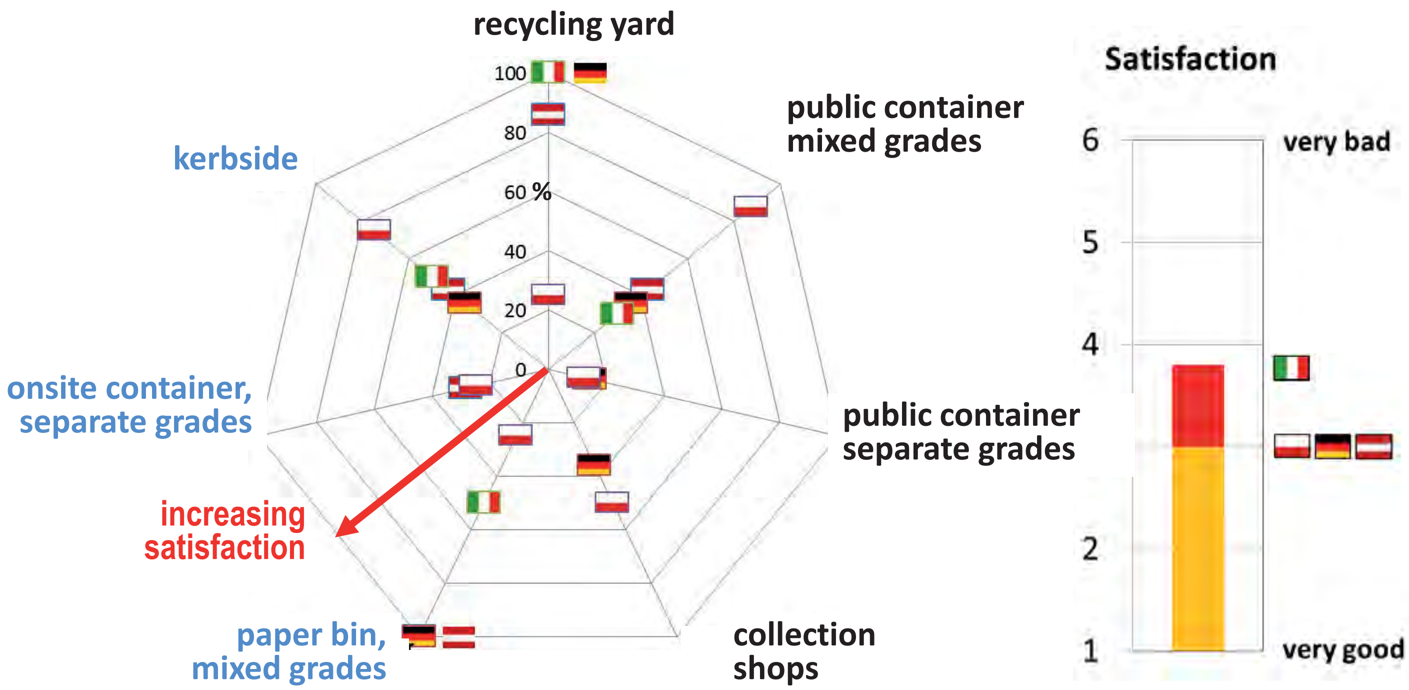
KS	kerbside
BB	blue/red bin
OCS	onsite container separate grades
PCM	public container mixes grades
PCS	public container separate grades
RY	recycling yard

Areas of conflicts



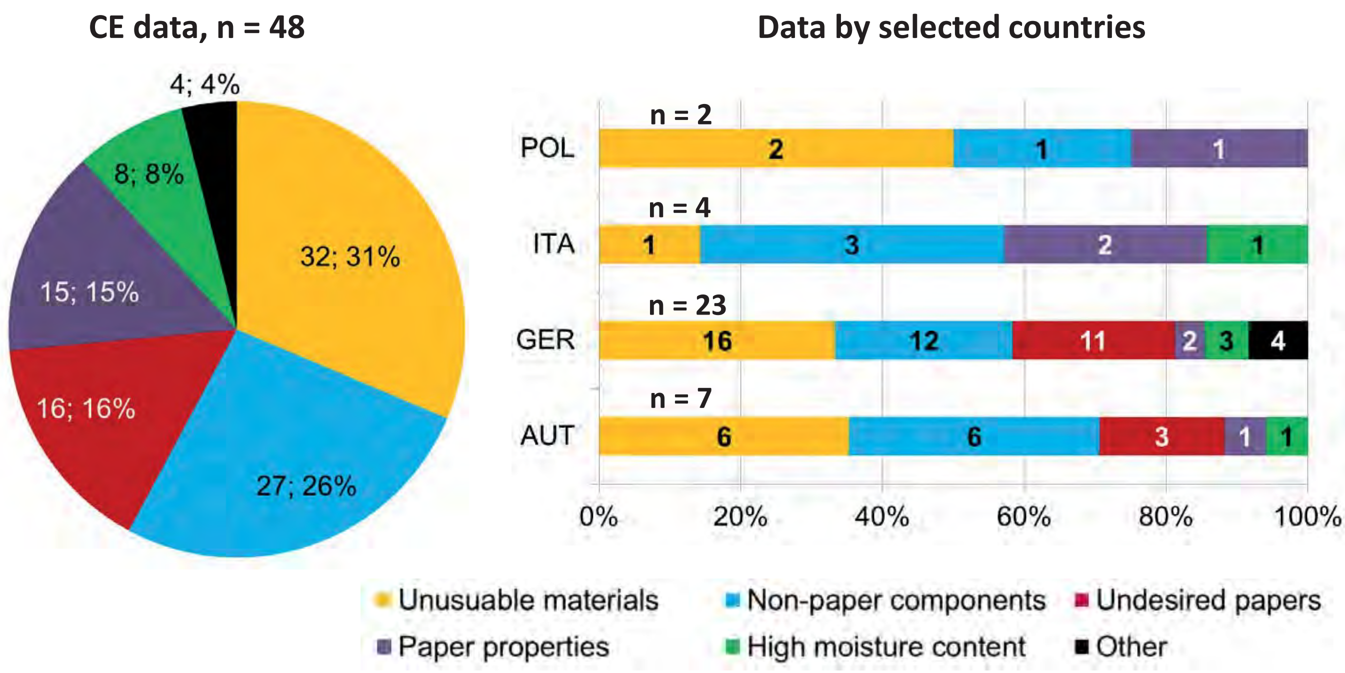
Type of collection system versus satisfaction of paper mills

39 responding authorities, 41 responding paper mills, data from AUT + GER + ITA + POL

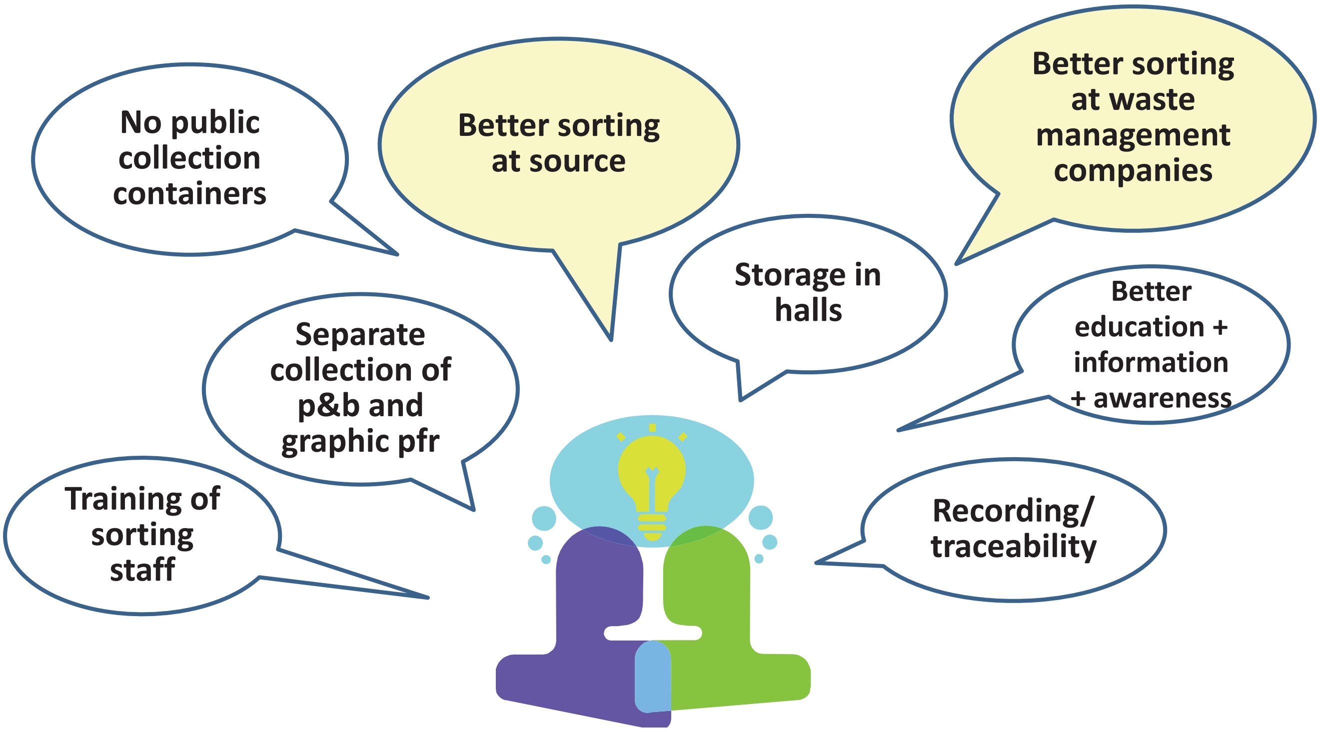


Type of problems with pfr

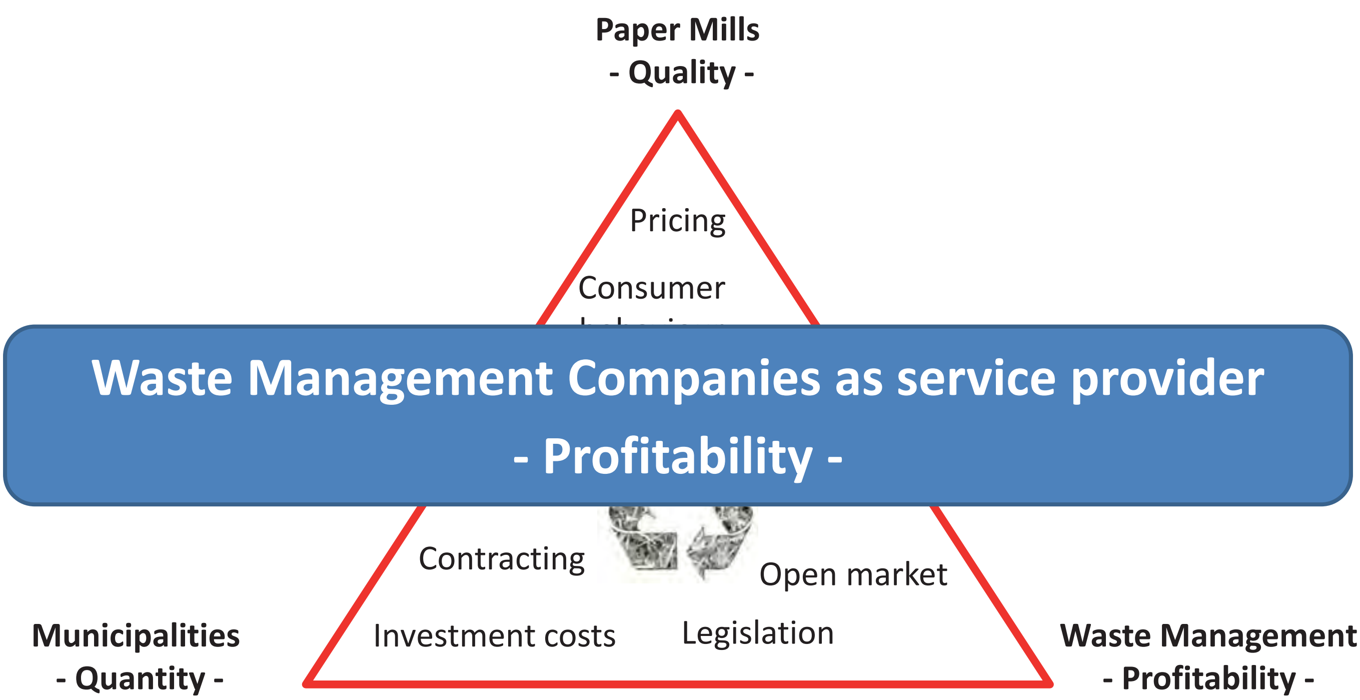
n = number of responding paper mills, multiple answers possible



Ideas from paper mills to improve pfr collection



Areas of conflicts



Statements concerning economic aspects of collection & sorting, Germany

	 * + 
Examples from:	Berlin, **automatic sorting plant** (state of the art)
Collection	area determined by costs for logistics
Profit-ability	largely depending on external factors
Quality	little undesired material sorted pfr: visual good quality for paper mills

*Source: http://www.mario-czaja.de/2014/03/gemeinsam-am-blaue-tonnen-problem-arbeiten/

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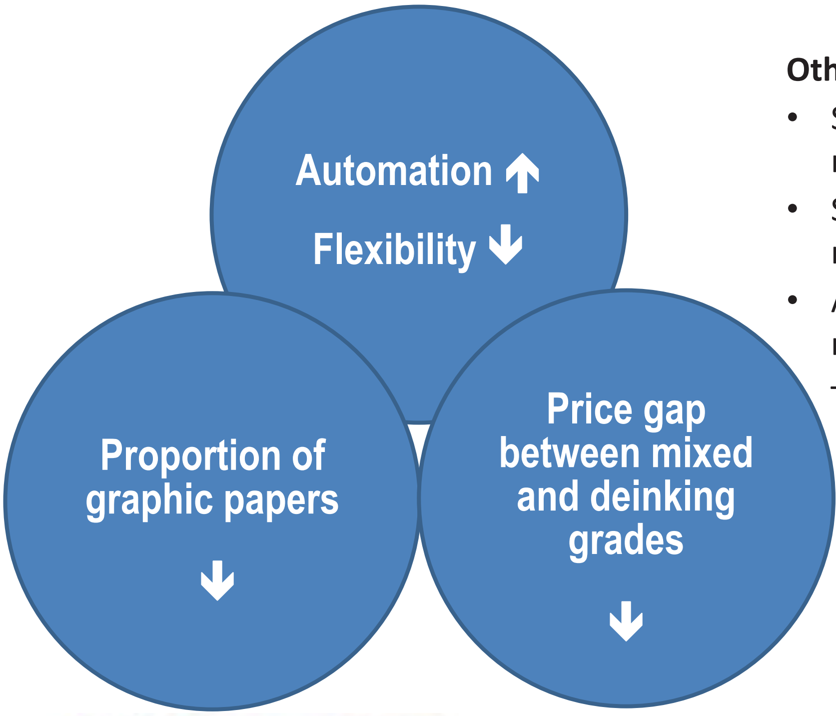
Challenges for waste management industry in Germany



Other facts:

- Short contract durations with municipalities
- Strong competition results in small margins
- Additional competition by paper mills (contracts between paper mills – local authorities)
  - (Increasing thefts and frauds)

=> Poor to non existing planning security

Challenges for waste management industry in Poland

Source: Rethink, Stora Enso 3/2012

Focus on organisational challenges/problems:

- Municipalities are free to decide about level of waste separation
- Often no sorting at point of collection
  => low quality of pfr
  => unconscious ignorance of requirements by municipalities?
- No effective control of waste management streams by authorities
- Often low technical standard of sorting plants
- Relatively low environmental awareness & too little incentives for citizens to separate recyclable fractions

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Paper Based Products Recycling Loop

Grant No: 4CE555P3

Conclusions for a better pfr collection

Differences and competing objectives make the identification of ideal solutions difficult

separation + control → **Recycling yard, collection shop**

Quantity

Quality
(grades, impurities)

- public containers separate grades
- public containers mixed grades
- on-site container mixed grades
- kerbside collection

high comfort → **Paper bin**

- **No clear indication from data and other sources that certain collection systems offer overwhelming effects.**
- **Assessment depends upon particular stakeholder group.**

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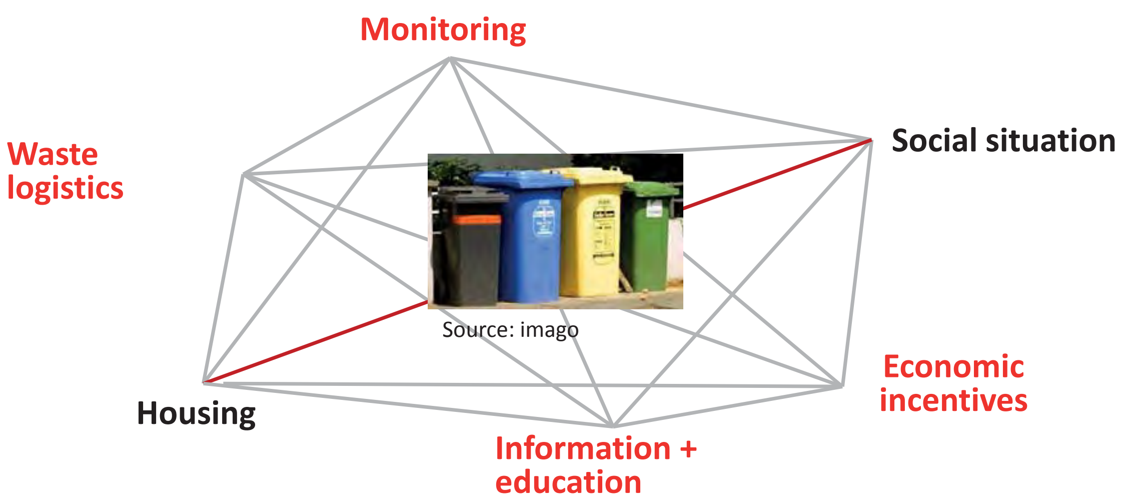
More important: socio-economic factors influence success of collection systems <u>on a very local level</u>

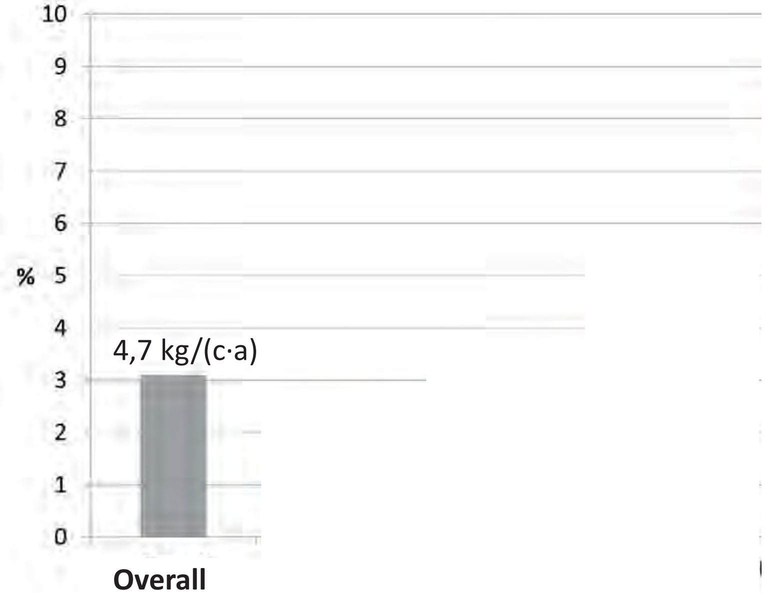
Relevant factors for waste separation apart from legal framework:



Source: imago

E. g. potential pfr from households depending on urbanisation/housing conditions, example from Germany

Study from Southern Lower Saxony, 2012: Recyclable fraction of p&b in residual waste[1)]



=> Comprehensive approach including all waste streams needed

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Recommendations

=

Reduction of areas of conflicts

+

Improvement of waste management

Reducing the area of conflict (1)

Contracting and concepts:

- **Long-term contracts** between communities and waste management companies of preferably 10 years
  => to support willingness to invest
- **Tripartite agreement** between local authorities, paper mills, waste management companies
  => to balance interests
- **Transparent contract design**
  => separation of collection and distribution (sales)
- **Rethink public private partnerships** for sorting plants especially for urban/metropolitan areas
  => waste management companies profit from technical equipment of municipalities, municipalities profit from know how of waste management companies

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Reducing the area of conflict (2)

Contracting and concepts:

- **Inclusion of regional industries** in waste management concepts of municipalities
  => ensure that pfr collection strategies consider requirements of the local paper industry and existence + capacity of sorting plants, e. g. separate collection if there are paper mills producing graphic paper in the area.
- CEPI Best Practice Specifications for tendering the collection of pfr
- **Communication and education:**
- **PR activities for local use of pfr** by municipalities
  => rise awareness of importance of regional recycling loops, e. g. publication of recycling ways on municipalities websites

Source: www.abfallwirtschaft.steiermark.at

Reducing the areas of conflict (3)

Communication and education:

- **Enhance the dialogue between all major stakeholders**
  => Install a forum with meetings on a regular basis to discuss requirements and to find appropriate solutions fairly balancing diverse interests

- **Education of other stakeholders**

  => for waste management companies/municipalities: use of same pfr quality standards, e. g. INGEDE methods

=> for municipalities: inclusion of requirements of recycling industry especially in countries with softer legal standards

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Reducing the area of conflict (4)

Legislation and other aspects:

- **Obligation for implementation of recycling target rates** adjusted according to waste streams (no overall target rate) on national level
  => more specific targets considering recyclability and technical possibilities for different materials

- **Clear rules concerning responsibility** for collection from households
  => to guarantee collection independent from market price
  => to cover costs/investments for infrastructure
  => to mind lengthy litigation

- Evaluate **take-back systems for packaging** (dual systems) according to their suitability for pfr (separate collection for pure paper products is good praxis)
  => minimisation of organisational efforts

Reduction of areas of conflicts (5)

Legislation and other aspects:

- **Countrywide/Europe-wide standardised minimum waste separation**
  => no decision making on municipalities level for a low grade of separate collection
  => separate collection of pfr (clear guidelines)

- **Support of development of useful waste management technologies** helping to meet recycling rates, e. g. through tax incentives or payment to sorting plants by authorities if commingled material is delivered
  => incentives for innovation

- **Stricter control (monitoring) of waste/recyclable fraction flows** by authorities in countries with lower recycling rates

Improvement of waste management (1)

Waste logistics:

- **No commingled collection** for pfr with other recyclable fractions
- Adjustment of collection **intervals and/or container size** for residual waste/recyclable fractions
  => measurement of filling level by municipalities
- Most **user-friendly collection system** for available space
  => short ways
- **Mixture of pick up and bring** system
  => bring systems better for bulky materials and pre-sorting
- **Locked or fenced containers** for problematic collection points with public access
  => to reduce unauthorised use, thievery and contamination
- Separate collection of laminated materials (liquid packaging)

Source: private photography, Wrocław

Improvement of waste management (2)

Waste logistics:

- Location of **bring systems at highly frequented facilities**, e. g. shopping center (especially in rural areas)
- **Underground containers** for urban areas with limited space
  => Ljubljana example:
  - evenly distributed collection points within less than 150 m
  - separation of residual waste, paper, packaging, glass, organic
  - emptied on a weekly basis
  - chip cards per household
  - weighting and charging of residual waste

Source: www.ljubljana.si

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Improvement of waste management (3)

Economic incentives:

- **Reward citizens** for good quality pfr
  => e. g. credits for mixed grades from paper bins by weight and property
  => incentives for pre-collected pfr (graphic, board) at municipal recycling yards

- Separate pfr collection should be offered **free of charge**
- **Credits** for citizens offering usable space for public **collection on private property** and care for **cleaning**
- **Personalisation of disposal fees**
  => Pay-as-you-throw for residual waste (paying per bag, by weight, by volume)
- Adjustment of **fees for residual waste**
  => motivate better waste separation with higher fees

Improvement of waste management (4)

Information and education:

- Waste separation campaigns and **communication of benefits and results**
- **Multichannel marketing** by authorities
  => information phone (especially after changes), poster, written information, customer magazine, social media, promotional messages on collection trucks …)
- Municipal **waste management consultants**
  => on-site consultancy of owners, housing associations, kindergartens, businesses …
- Recognition effect through a **countrywide consistent layout** of collection systems (uniform colour scheme and pictograms for specific collection systems)
- Consideration of **language aspects**
- **Environmental education** in kindergardens and schools, e. g. excursion to sorting plant and paper mills, collection of pfr at schools and kindergardens

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Recommendations: Waste management issues (5)

uniform label scheme in Czech Republic

source: presentation by Mr. Grolmus (EKO-KOM) at workshop on collection strategies in Sopron, 9.7.14 –

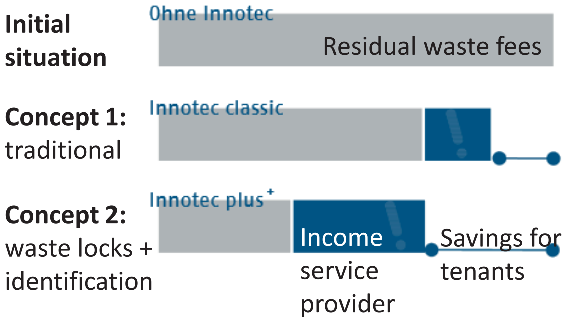
Announcement of a new collection scheme

source: public information in Ostrołęka, Poland

Improvement of waste management (7)

Special solutions for large housing estates:

- **Personalised costs** especially important for motivation (high anonymity)
  => lock and identification systems (fair waste management)
- Example from Germany: use of **specialised** private or public **service partners** with closed concepts and performance contracting
  => services: analysis, consultancy, layout, information of tenants,
  management of collection points, clearing
  => financed by saving waste fees
- **Educational offerings** by local authoritities for housing associations

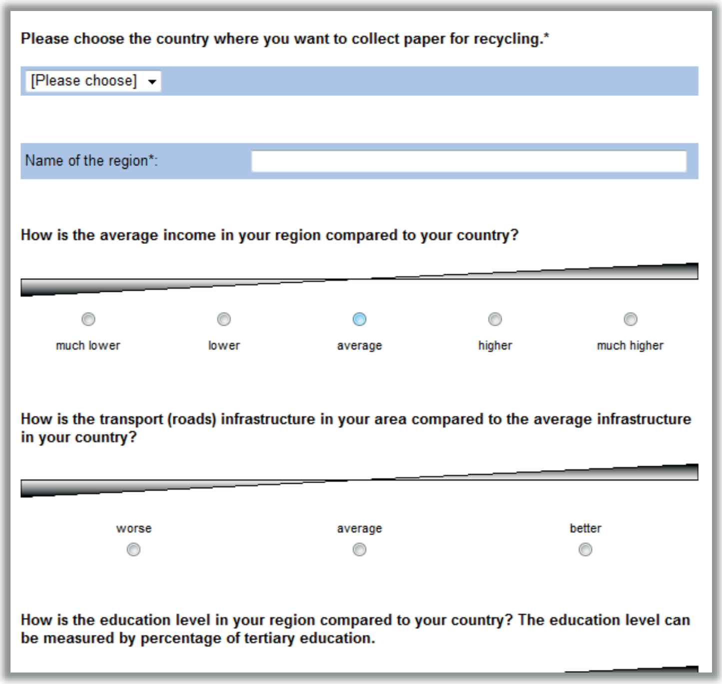


Source: Image brochure of innotec abfall-management GmbH, example of reduction for waste fees and performance contracting

Tool for decision finding

Online based tool

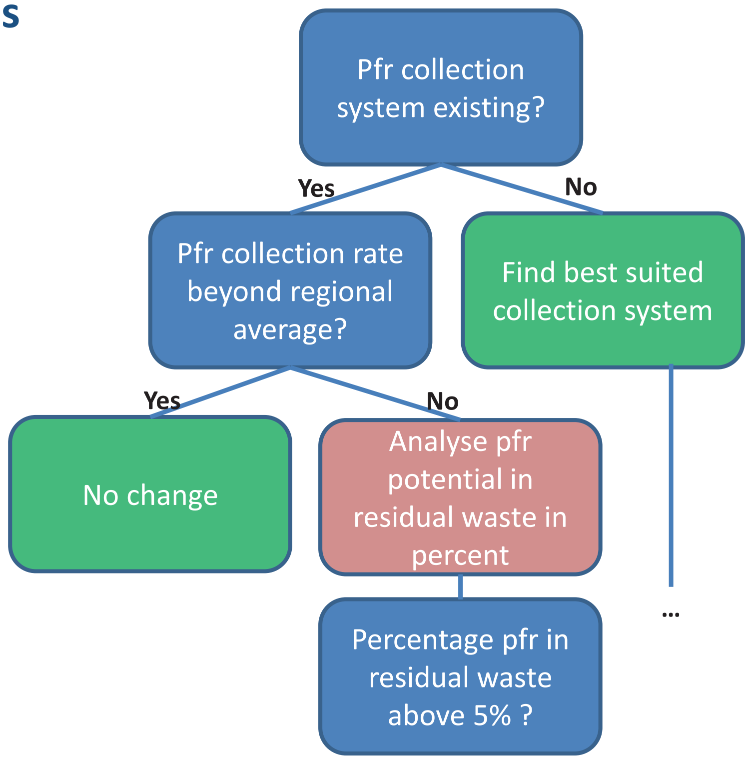
1. Request of local conditions and specification of area
2. Decision tree:
   - decision if change of collection systems is useful
   - including recommendations
3. Suggestions for adequate collection systems on basis of local conditions (descending priority):
   - Building structure
   - Infrastructure
   - Mobility
   - Income
   - Average age of population
   - Education



Example: Request for local conditions

Inclusion of recommendations

- E. g. target rates for collection
- E. g. limit for pfr in residual waste
- E. g. waste management issues



Recommended target rates for collection of pfr

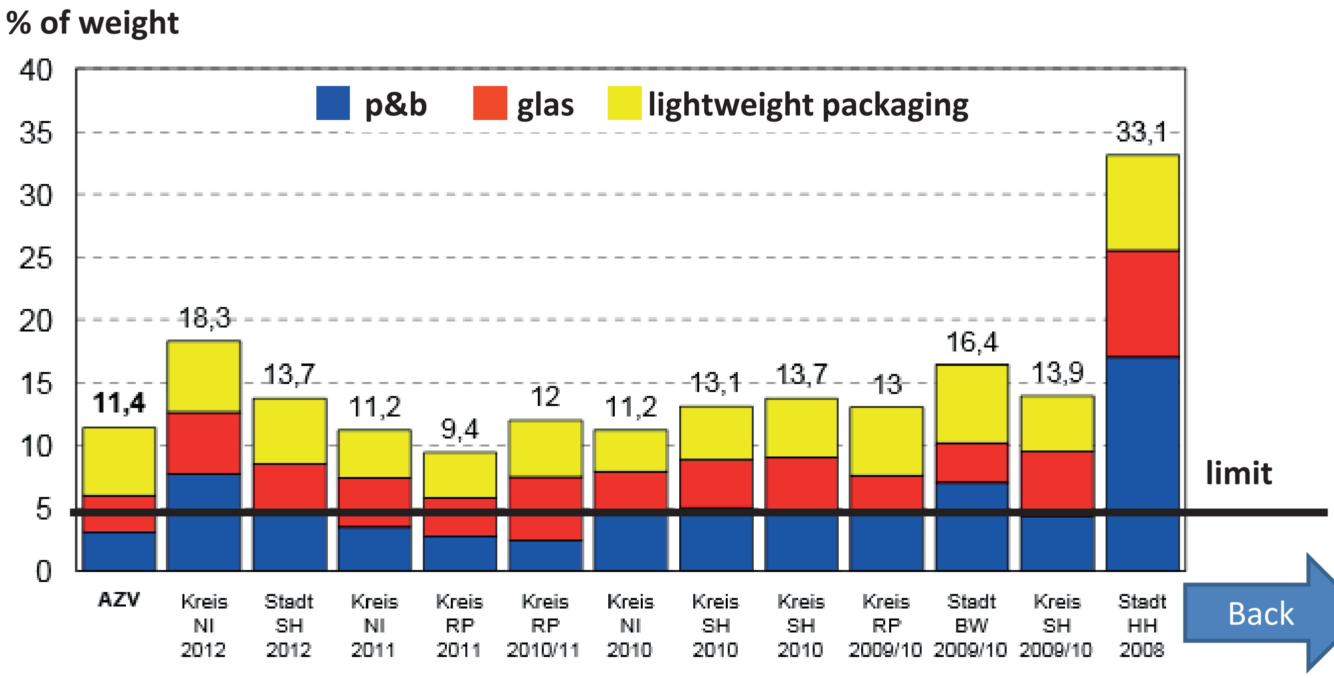
Country	Recycling rate	Target rate
Austria	70%	70%
Czech Republic	56%	63%
Germany	76%	76%
Hungary	47%	58%
Italy	63%	66%
Poland	39%	54%
Slovenia	64%	64%
Slovakia	49%	59%
European Union 28	69%	

Back

Presumption: collection rate = target rate

$$\text{Recycling rate} = \frac{\text{pfr* collection}}{\text{p\&b** consumption}} \times 100\ \%$$

Recommended limit for recyclable fraction of p&b in residual waste



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Example for results

Dresden Neustadt:

- **Building structure:** detached, semi-detached, **rented flats in apartment buildings**, owned flats in apartment buildings, high-risers
- **Transport infrastructure:** much worse, **average**, better
- **Mobility per 1000 inh.:** < 300 cars, **300-500 cars**, > 500 cars
- **Income:** much lower, lower, **average**, higher, much higher
- **Age:** **< 38**, 38–46, > 46
- **Education:** lower, average, **higher**

Suitable collection systems for your situation

Based on your given answers these are recommended collection systems for your region/area. They are listed in descending order, beginning with the most suitable.

Container or Underground Container

Containers or underground containers are placed on public ground at a place where they are reachable for citizens. Underground containers where, in contrast to normal containers, the container-body is placed underground to save space on public streets, integrate into the townscape better but have higher investment costs due to the pit that needs to be dug and the concrete casing that needs to be built. For the collection a special garbage truck is needed that can lift the containers up and for separate paper grade collection a special truck with 2 compartments or an extra collection tour is needed. The different collection points should not be further away than 500 m from the inhabitants of the area to ensure they use them.

Blue Bin

One or two bins are positioned at the citizens' property. If the goal is to collect mixed pfr, one bin is sufficient and if separate sorts are required two bins (one for graphic and the other for board) should be positioned. A collection truck is needed to collect the full bins in a reasonable interval. If there are two bins, either two collection tours or a collection truck with two compartments is needed. The blue bin concept is very comfortable for citizens and collects a good quality of pfr with few impurities.

Kerbside

The term kerbside collection system means door-to-door collection systems, where household is asked to leave their recyclable wastes on the kerbside on specified dates to be separately collected for recycling. Concerning paper and board kerbside collection, it has to be properly prepared (without plastic wrappings and inserts, the cardboard flattened) and packed (some countries demand use of special bags or the municipality might provide a special container (bin) or the public are asked to secure papers (with string) for collection). Kerbside collection for pfr leads to few impurities and good pfr quality.

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Thank you for your attention.

Der Leitfaden der Umweltdirektion der Europäischen Kommission sei an ein zweites Abfallende-Maßnahmen-Paket gekoppelt, erklärt die Confederation of European Paper Industries (CEPI). Dieses betreffe Papier, Kupfer und Glaß und werde vermutlich am 9. Juli vom Regelungsausschuss abgesegnet.

Im Leitfaden zur AbfRRL schreibt die Kommission, dass „der Zeitpunkt, zu dem ein Material oder eine Substanz das Abfallende erreicht, gleichzusetzen ist mit der Vollendung des Rückgewinnungs- und Recyclingprozesses“. CEPI meint, dass im Fall von Papier die Kommission nicht die Erfüllung der End-of-Life-Kriterien als Equivalent zum Recycling bezeichnen sollte.

Das Problem für Abfallentsorgungsunternehmen und Abfallhändlern sei, dass sie durch die neue Interpretation zu „Recyclern“ würden, ohne wesentliche Vorteile daraus ziehen zu können. Im Gegenzuge jedoch wären sie gesetzlich als „Produzenten“ für das Output-Material verantwortlich. Den Entsorgungsunternehmen eine derartige Verantwortung aufzubürden, würde nur die lange Liste der schlecht umgesetzten EU-Umweltmaßnahmen verlängern und nichts zu einem grünen Wachstum in Europa beitrage, übt CEPI Kritik.

Life cycle analysis of paper products

Grzegorz Ganczewski, Daniele Bussini

Life Cycle Assessment(LCA)

of paper packaging products

EcoPaperLoop - Final Conference
2nd December 2014, Krakow
Poland

Greg Ganczewski

COBRO – Packaging Research Institute

What is LCA ??

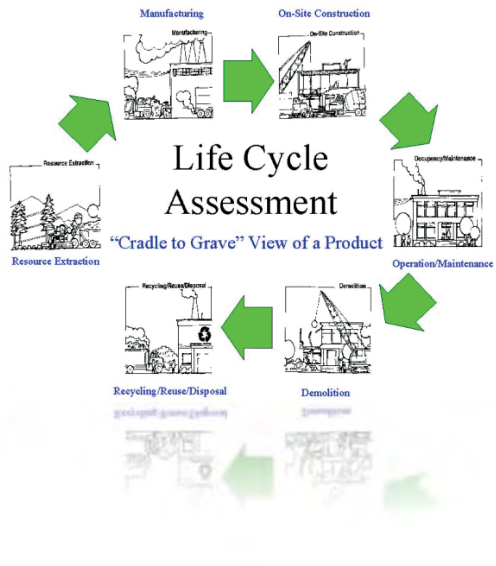
Input: What we have taken from the environment

Life: Detailed Biography and Family Tree of our product

Output: What we are leaving behind - emissions

What is LCA ??

- LCA = Life Cycle Assessment
- Probably the most popular standardised sustainability and environmental assessment methods
- Can be used to assess products, value chains, processes, whole companies, economy and even socio-cultural implications
- Its main goal is to assess the aspects of environmental impacts in whole life cycle of selected subject matter.

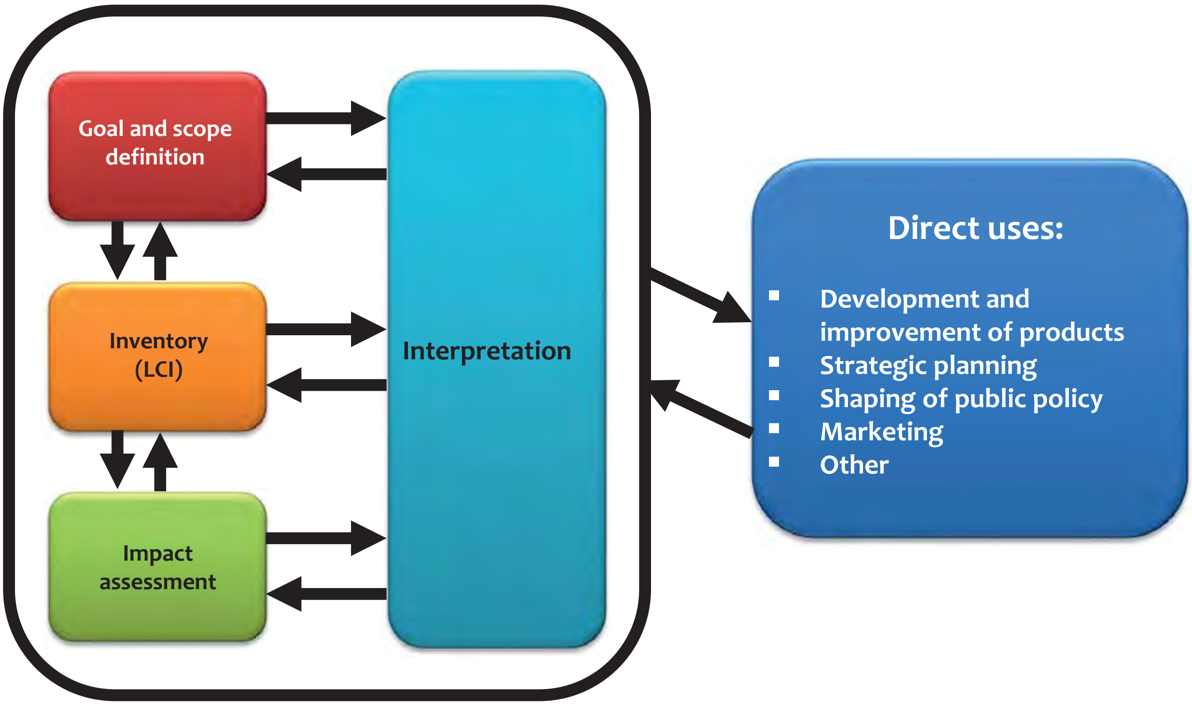


What is LCA ??

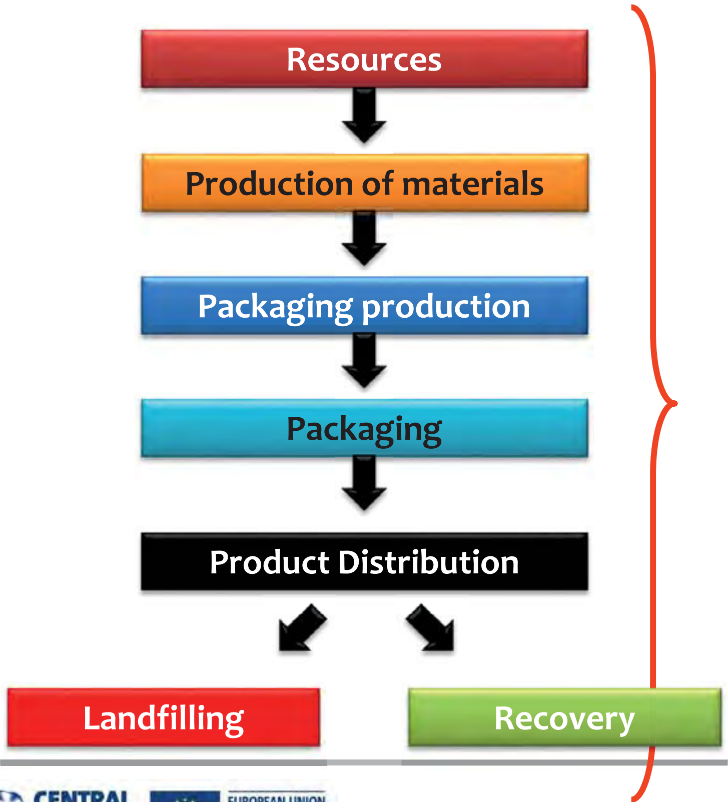
LCA method can be used to rate and compare a product with another products of similar function.

- LCA method consists of different criteria of evaluation in all life cycle stages of a selected product.
- Potential environmental influence of every life cycle process of a chosen product is quantitatively recorded in different impact categories

LCA in 4 steps



LCA of Packaging



- Natural resources utilisation
- Environmental damage
- Energy utilisation
- Gas emissions
- Liquid waste
- Solid waste
- etc

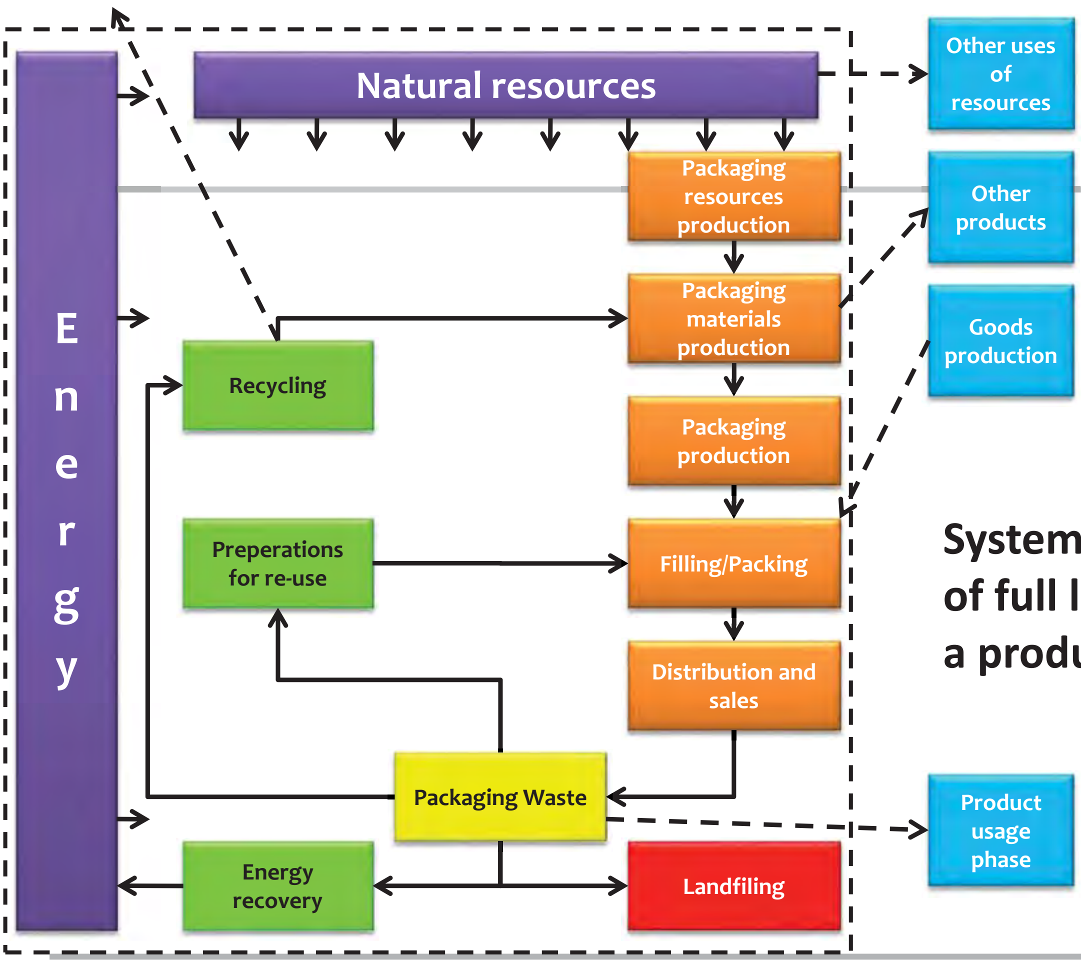
WP5 - Eco-design for recycling

In ECOPAPERLOOP we look at the end of life of paper products – especially the step of recycling.

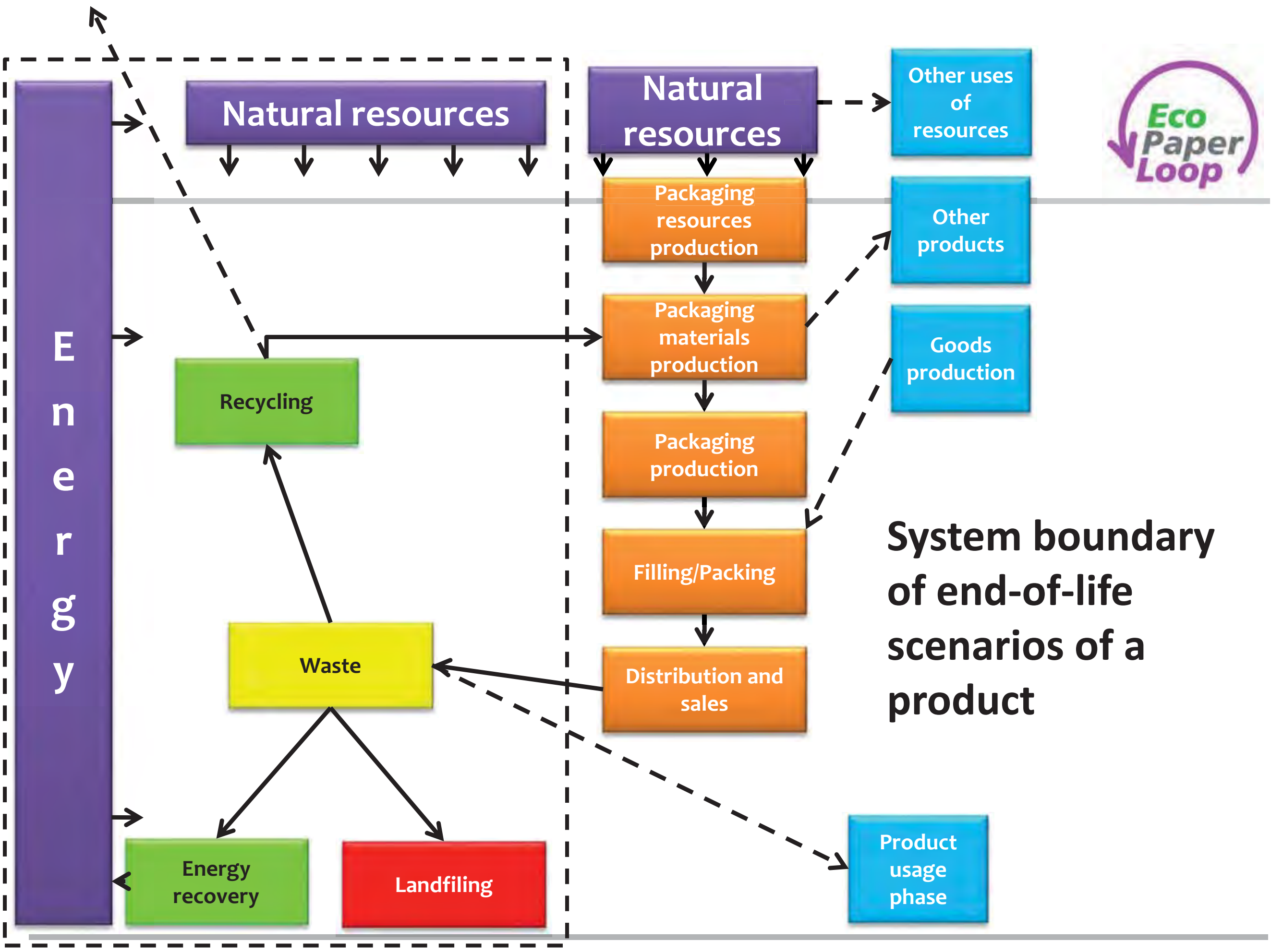
LCA will allow us to compare eco-design environmental impacts in recycling.

Assumptions:

- **For better clarification and comparison potential LCA results will be shown in 2 modes:**
  - Full life cycle of the product
  - Focus on the end-of-life processes – showing only emissions in end-of-life scenarios



System boundary of full life cycle of a product



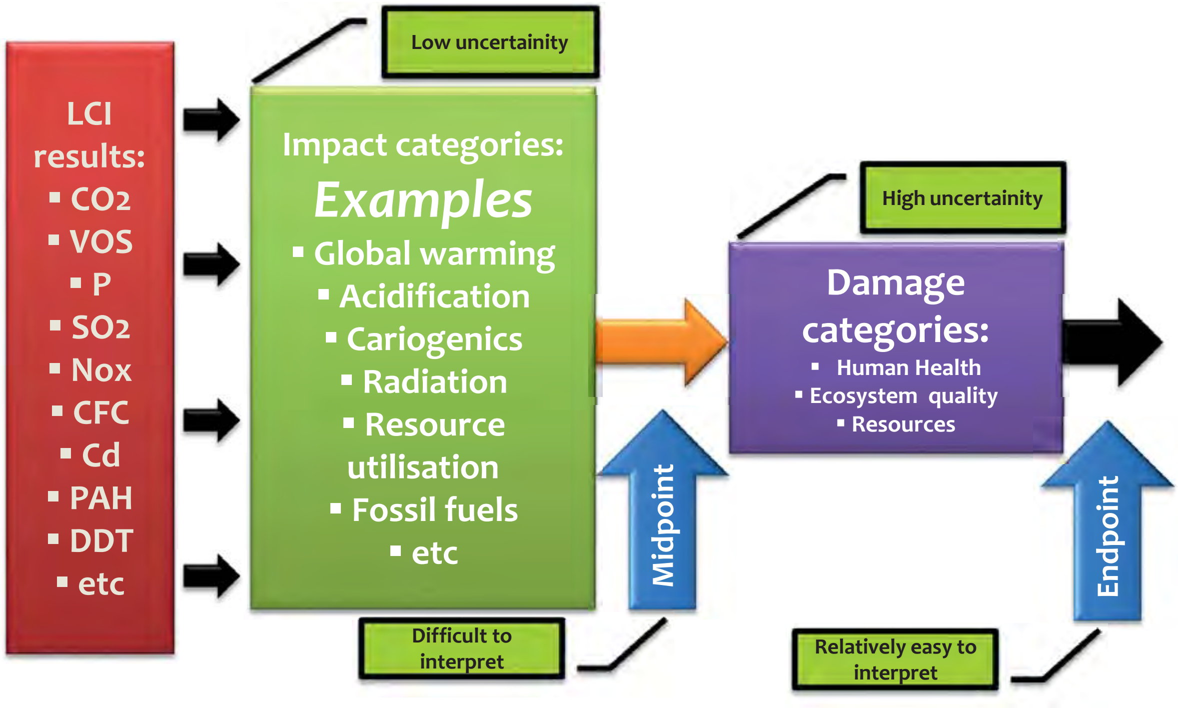
System boundary of end-of-life scenarios of a product

Choice of products for LCA

Total of 4 LCA's – 2 for packaging and 2 for graphic products:

- Two general packaging and graphic products demonstrating issues easy to understand by all project stakeholders
  - *Comparison of flexo and offset newsprint*
  - *Comparison of pure paper bag and laminated paper bag*
- Two technical LCA's – specific packaging and graphic products demonstrating particularities of paper and direct linkage of recyclability benchmark score to environmental impacts
  - *LCA of Italian magazines*
  - *LCA of Polish paper packaging*

Impact Assessment Method



Impact Assessment Method

Proposed method

- **ReCiPe**
  - **ReCiPe** is an impact assessment method which comprises harmonized category indicators at the midpoint and the endpoint level.
  - It is an improvement on CML 2000 and Eco-indicator 99. The main contributors to this project are **PRé consultants**, **CML** and **RIVM**, **Radboud University**.
  - ReCiPe allows the environmental load of a product to be expressed in a single score.

Impact Assessment Method

Relevant impact categories – mid-point:

- **Agricultural and urban land occupation** (in particular for Paper Production process) - The amount of either agricultural land or urban land occupied for a certain time. The unit is m2*yr.
- **Climate change** - The characterization factor of climate change is the global warming potential. The unit is yr/kg CO_2 equivalents.
- **Fossil fuel and minerals depletion** (for all the processes) The characterization factor of fossil depletion is the amount of extracted fossil fuel extracted, based on the lower heating value. The unit is kg oil equivalent (1 kg of oil equivalent has a lower heating value of 42 MJ).

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Impact Assessment Method

Relevant impact categories – end-point:

- **Human Health**, expressed as the number of year life lost and the number of years lived disabled. These are combined as Disability Adjusted Life Years (DALYs), an index that is also used by the World bank and WHO. The unit is years.
- **Ecosystems**, expressed as the loss of species over a certain area, during a certain time. The unit is years.
- **Resources** surplus costs, expressed as the surplus costs of future resource production over an infinitive timeframe (assuming constant annual production), considering a 3% discount rate. The unit is 2000US$.

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LCA – Paper Bags

Comparison of pure paper and plastic laminated shopping bag.

- **The scope:** to assess the full life cycle of shopping bags:
  - pure paper bag
  - paper plus plastic lamination

- **End-of-Life scenarios:**
  - **Pure Paper Bag:** Recycling of pure paper bag in a standard recycling plant
  - **Laminated Paper Bag Scenario A:** Recycling of laminated paper bag in a standard recycling plant
  - **Laminated Paper Bag Scenario B:** Recycling of laminated paper bag in a specialized plant for the treatment of composite and laminated paper grades
  - **Laminated Paper Bag Scenario C:** Disposal without recycling.

LCA – Paper Bags

Methodology:

A typical product with standard properties and typical conditions of printing and recycling.

- Calculatated with **SimaPro version 8.0.3**
- **ReCiPe Endpoint V1.10** was used as an impact assessment method
- Most of the processes and data for the calculation were taken from **Ecoinvent v.3 Database**.

LCA – Paper Bags

Assumptions:

- **Paper**: Same paper grade was considered for both pure paper bags and plastic laminated bags:
  - **50% kraft bleached** cellulose from wood and,
  - **50% recycled fibres**.

- The functional unit for the calculation is **1 kg** of ready to use bags.

LCA – Paper Bags

Assumptions:

- **Lamination:** 20% w/w of polypropylene.

  The case of 20% plastic lamination can be considered as the maximum level of plastic fraction normally used in high quality bags available on the market.

  Reference: Information from contacted laminated bags producers.

- **Total mass** of the bag and all the other packaging elements (like adhesive application, handles and finishing) are supposed to be the same for both pure paper bag and laminated bag

End-of-life scenarios assumptions:

- **Pure Paper Bag**
  - all the product is recycled back to the same packaging paper stream, for manufacturing of the same paper grade.
  - The recycling yield is assumed to be 100%, that mean no coarse reject is generated in the recycling.
- **Laminated Paper Bag - Scenario A**
  - the end of life option is recycling as mixed packaging paper for recycling in a standard plant, not specifically equipped for managing high amount of composite materials.
  - It is supposed that the coarse reject after the pulping stage is 50%, because not all the cellulose fibres can be recovered and an important part of them is rejected together with plastic.

LCA – Paper Bags

End-of-life scenarios assumptions:

- **Laminated Paper Bag - Scenario B**
  - The end of life option is recycling as selected packaging paper for recycling in a specialized plant, equipped for managing high amount of composite materials.
  - An average transport distance of **500 km** by truck from the place where the paper is collected to the mill where it is recycled is assumed.
  - It is supposed that the coarse reject after the pulping stage is 25%, some fibres are rejected together with the plastic but most of the paper fraction can be recovered (75%).
  - Part of the plastic waste (50%) is supposed to be recycled.

LCA – Paper Bags

End-of-life scenarios assumptions:

- **Laminated Paper Bag - Scenario C**
  - the end of life option is **final disposal** of the used product, for instance if the local regulation doesn't allow recycling for this kind of products in the paper fraction.

- **Laminated Paper Bag – coarse pulping reject waste**
  - The coarse pulping reject is supposed to be disposed as for the MSW, **60% landfill** and **40% incineration**.
  - There are no specific data available at EU level for the disposal of recycling waste, so it is considered the same ratio as for MSW.

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LCA – Paper Bags

End-of-life scenarios assumptions:

- **Closed Loop Approach:** The recycled fibres obtained are supposed to replace the raw material used for bags manufacturing:
  - 50% of recycled fibres replace the recycled raw material,
  - 50% of recycled fibres avoid the usage of virgin cellulose pulp.

- **Quality Factor:** quality of recycled fibres is normally lower than virgin cellulose fibres.
  - The quality factor was set to 75%, which means that only 75% of the original quality and properties can be obtained by using recycled fibres.
  - In order to include this reducing quality factor in the LCA calculation, it was considered that only 75% of available recycled pulp is used back into the loop for replacing the virgin pulp fraction
  - The determination of the most suitable value for the quality factor need to be studied more precisely, taking into account new developments of the Product Environmental Footprint rules under discussion in Europe.

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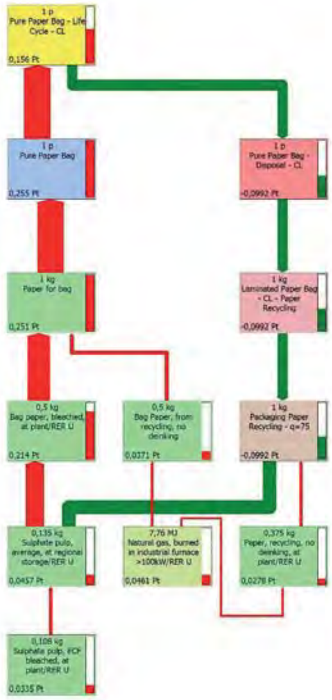
LCA – Paper Bags – Process Tree

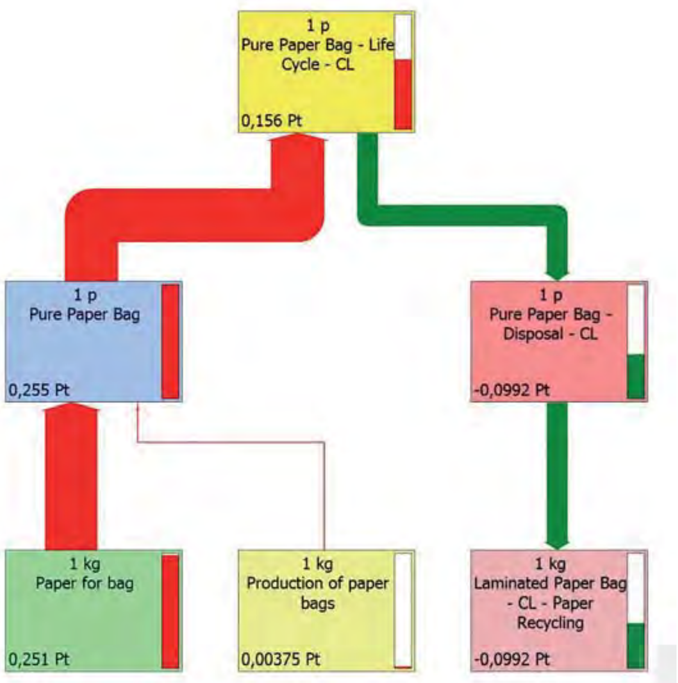


Pure Paper Bag: The green arrow shows the benefit of recycling into the same loop.

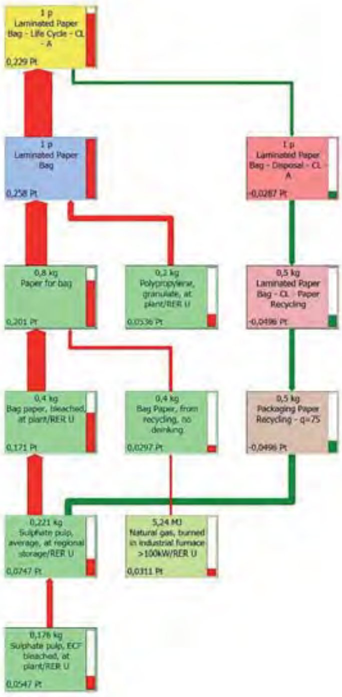
- The arrow is linking to the sulphate pulp which production could be avoided with recycling into the same loop.

Recycling can avoid the major impact of pulp production from virgin wood, but the environmental impacts of the recycling process and paper formation are still accounted.

LCA – Paper Bags - Process Tree



LCA – Paper Bags - Process Tree



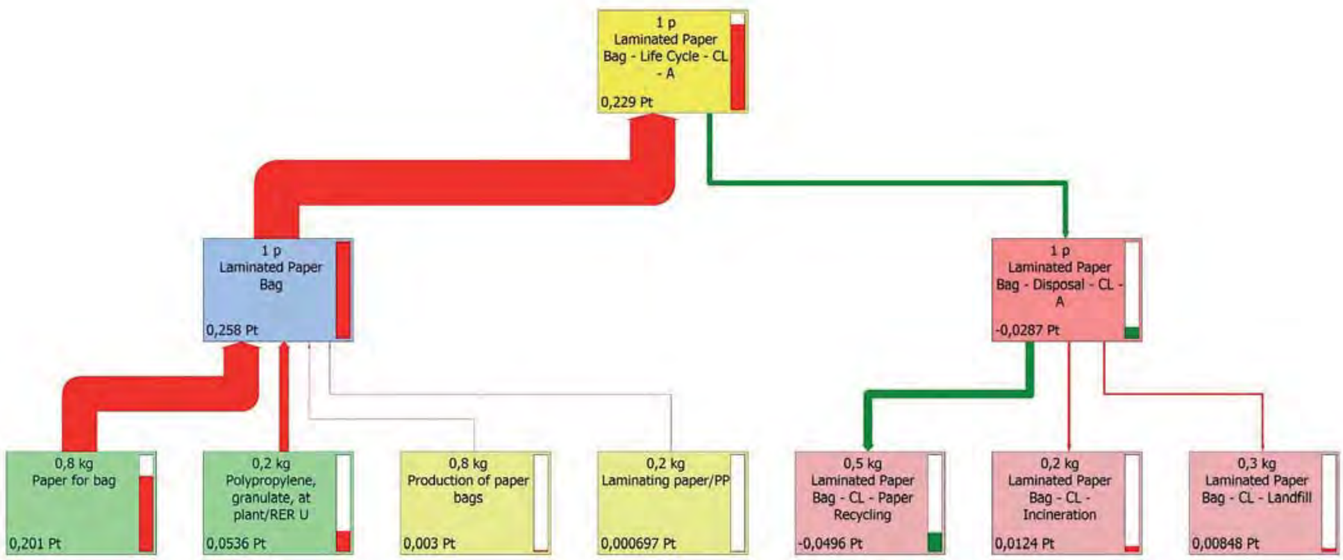
Laminated Paper Bag - Scenario A: The green arrow shows the benefit of recycling into the same loop.

- The arrow is linking to the sulphate pulp which production could be avoided with recycling into the same loop.

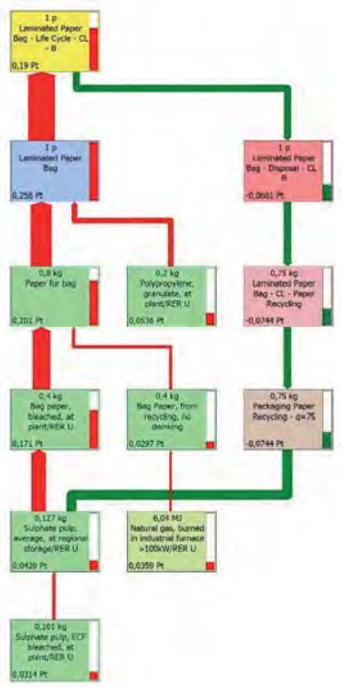
Recycling benefit is smaller than in **Pure Paper Bag** due to smaller amount of paper being recycled

- The amount of paper recycled is equivalent to 50% of the overall bag mass.

LCA – Paper Bags - Process Tree



LCA – Paper Bags - Process Tree



Laminated Paper Bag - Scenario B: The green arrow shows the benefit of recycling into the same loop.

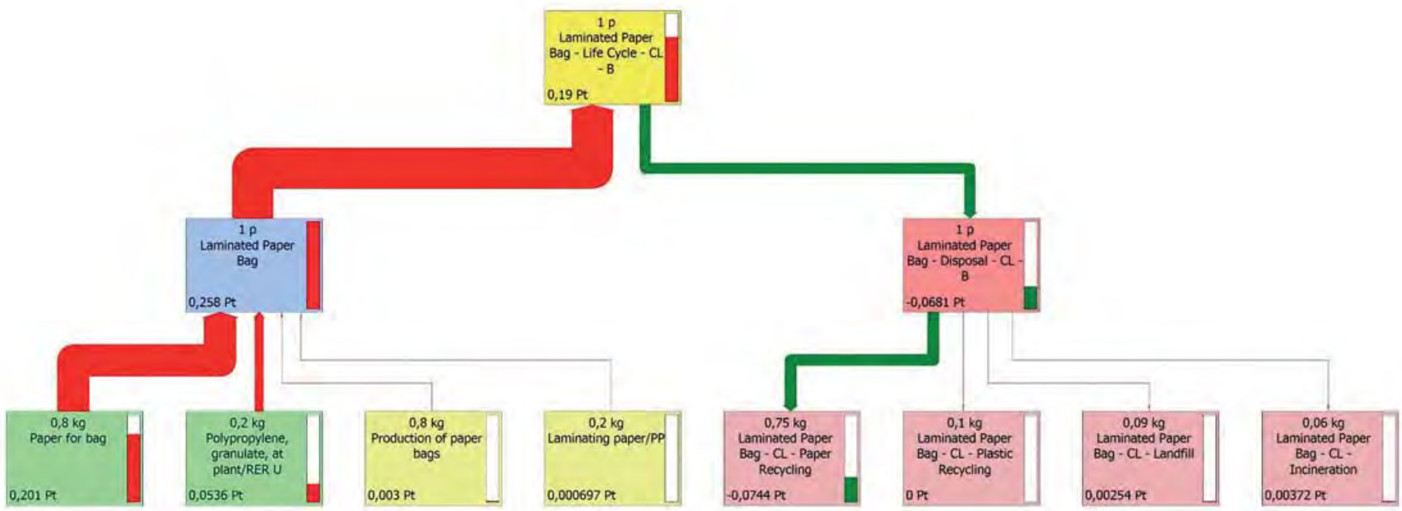
- The arrow is linking to the sulphate pulp which production could be avoided with recycling into the same loop.

Recycling benefit is bigger than in **Laminated Paper Bag - Scenario A** due to larger amount of paper being recycled.

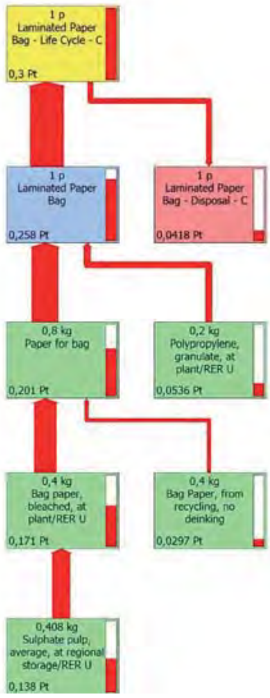
- The amount of paper recycled is equivalent to 75% of the overall bag weight.

Note: The recycling process also includes bigger transport environmental costs, due to the fact that there are not many specialised recycling plants in Europe that can successfully recycle laminated paper bags with high efficiency.

LCA – Paper Bags - Process Tree



LCA – Paper Bags - Process Tree

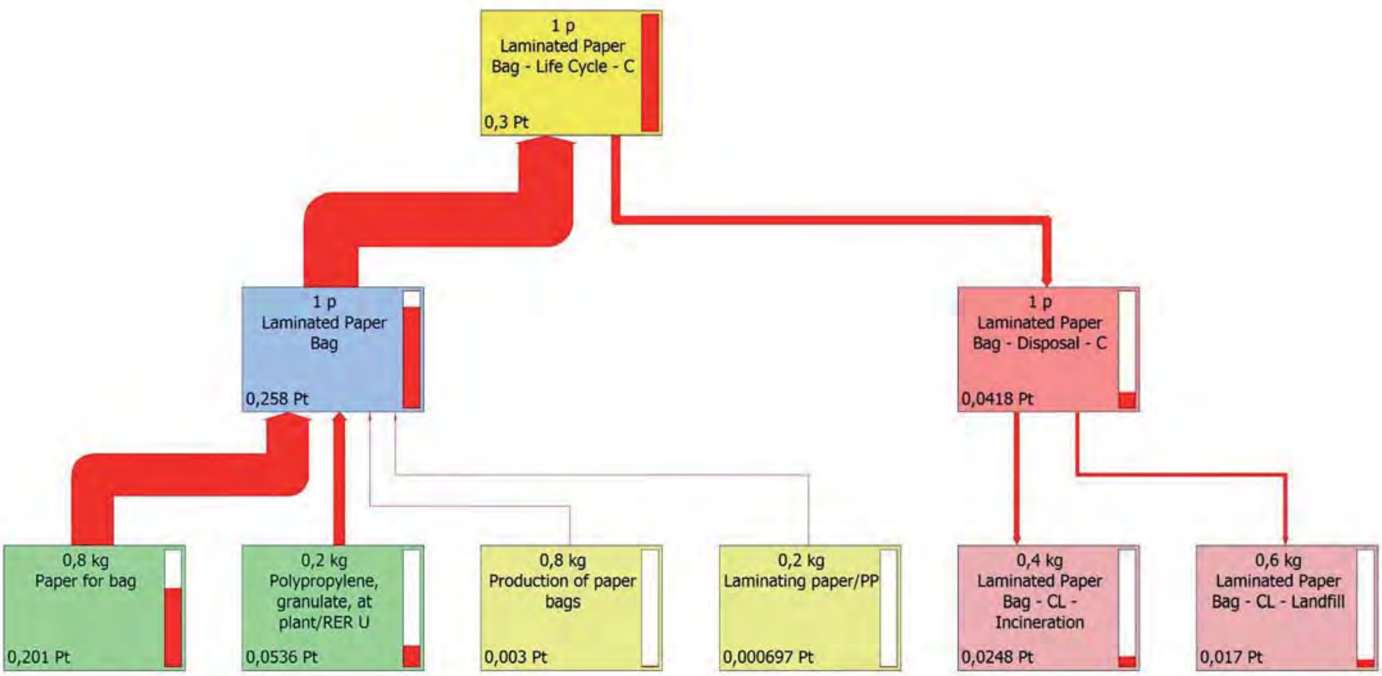


Laminated Paper Bag - Scenario C:

no recycling is taking place - all of the laminated paper bag is considered as a waste and is disposed in landfill and incineration

- This is a scenario specific to countries where laminated paper bags usually do not go to any recycling plant.

LCA – Paper Bags - Process Tree



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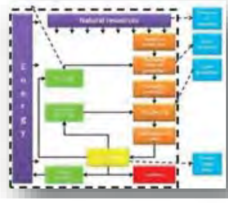
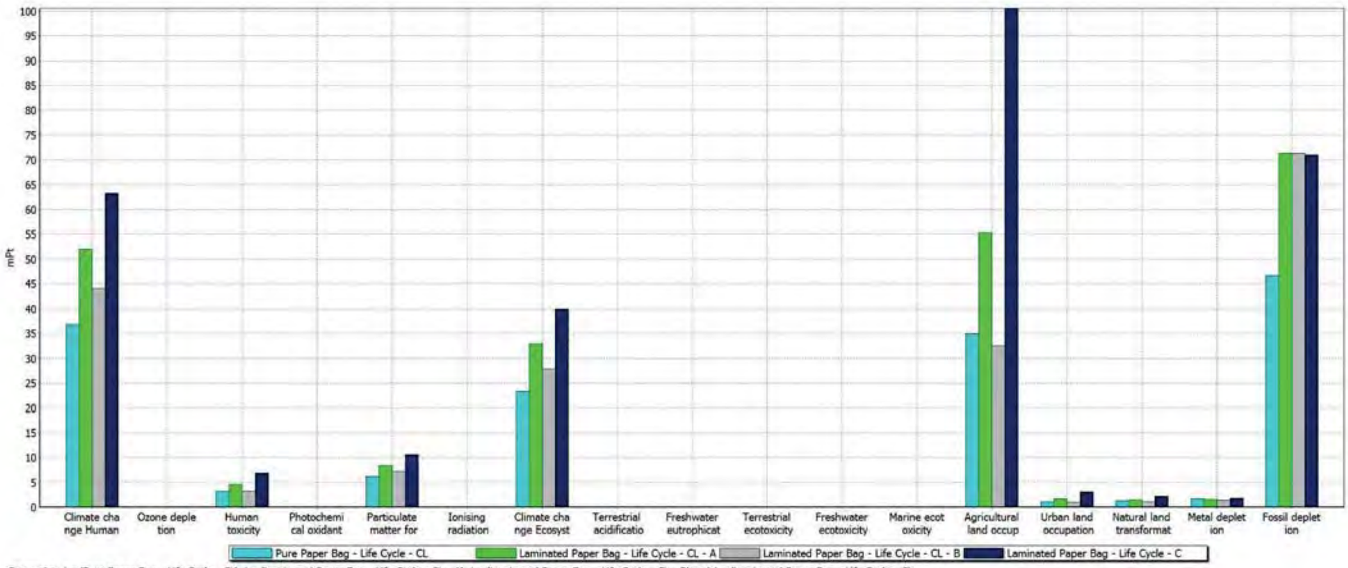
LCA – Paper Bags – Impact Assessment



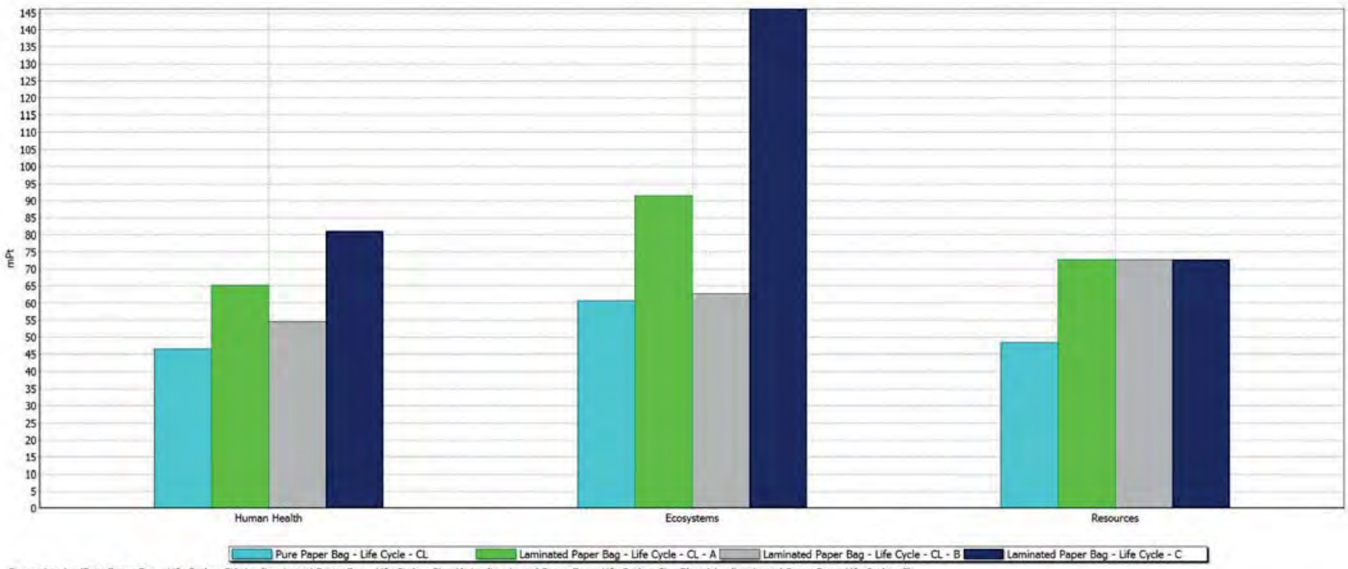
Full life cycle – Mid-Point Results



Comparing 1 p 'Pure Paper Bag - Life Cycle - CL', 1 p 'Laminated Paper Bag - Life Cycle - CL - A', 1 p 'Laminated Paper Bag - Life Cycle - CL - B' and 1 p 'Laminated Paper Bag - Life Cycle - C';
Method: ReCiPe Endpoint (H) V1.10 / Europe ReCiPe H/A / Weighting

LCA – Paper Bags – Impact Assessment

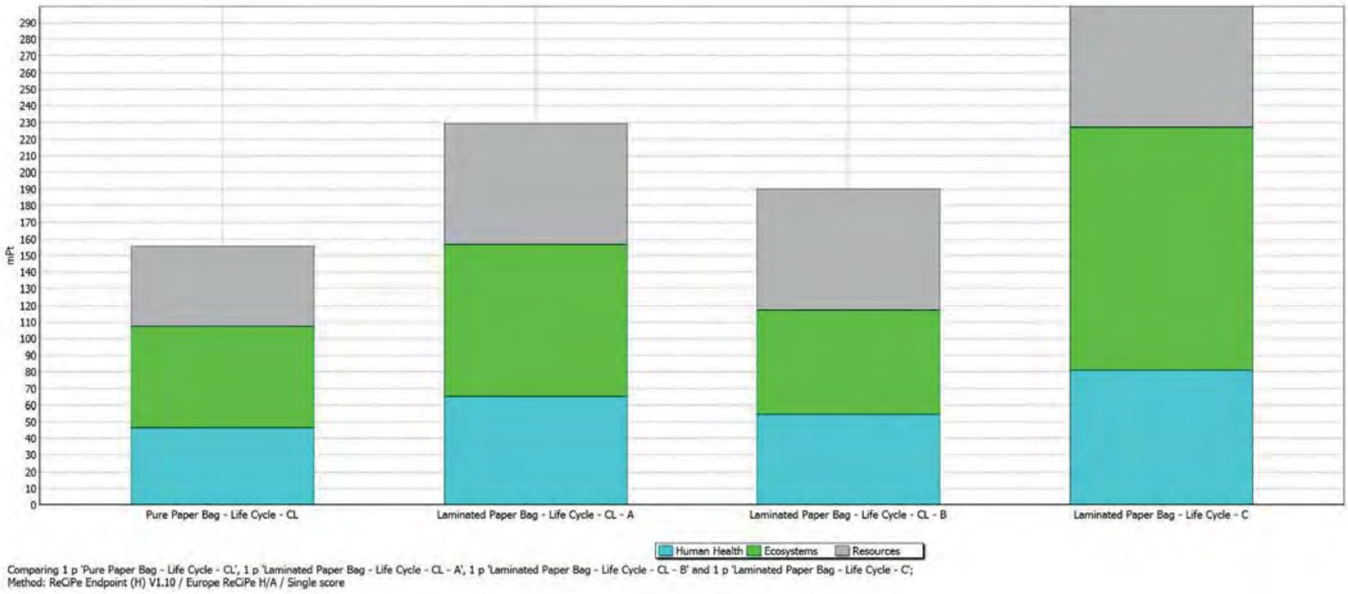
Full life cycle – End-Point Results



Comparing 1 p 'Pure Paper Bag - Life Cycle - CL', 1 p 'Laminated Paper Bag - Life Cycle - CL - A', 1 p 'Laminated Paper Bag - Life Cycle - CL - B' and 1 p 'Laminated Paper Bag - Life Cycle - C';
Method: ReCiPe Endpoint (H) V1.10 / Europe ReCiPe H/A / Weighting

LCA – Paper Bags – Impact Assessment

Full life cycle – Single Score Results

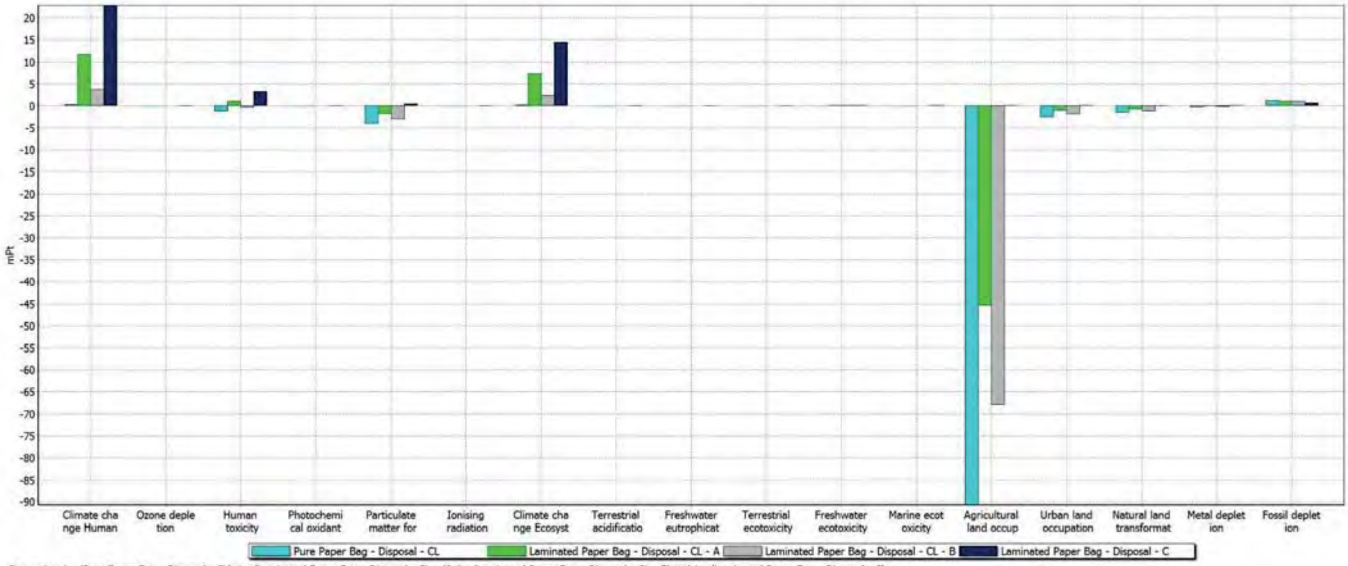


LCA – Paper Bags - Impact Assessment

- **Pure paper bag** shows the lowest environmental impacts in all categories, as 100% of the material is recycled.
- In **scenarios A** the level of recycling is 50% and in **scenario B** raise up to 75%.
- For all these scenarios the recycled fibres are used for replacing the cellulose pulp with a **quality factor of 75%.**
- Scenario C assumes no recycling at all – all the material goes to waste.
- The benefit of recycling is especially prevalent in agricultural land occupation impact category, which is directly linked to the feedstock material of pulp and paper production.

LCA – Paper Bags – Impact Assessment

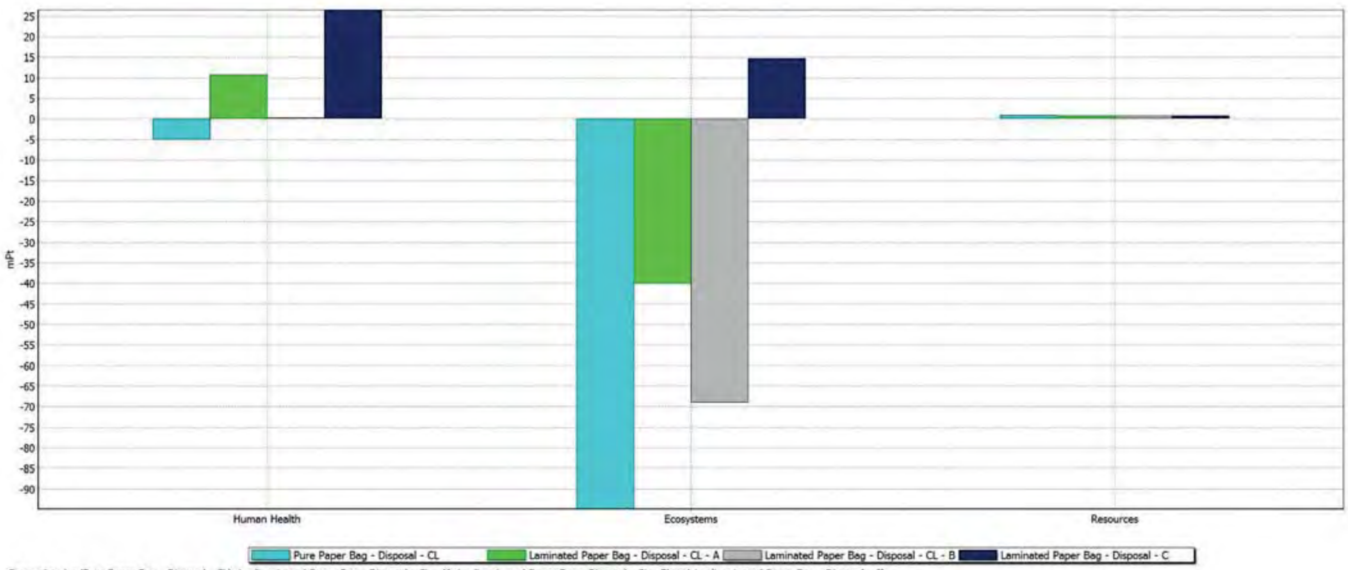
Disposal only – Mid-Point Results



Comparing 1 p 'Pure Paper Bag - Disposal - CL', 1 p 'Laminated Paper Bag - Disposal - CL - A', 1 p 'Laminated Paper Bag - Disposal - CL - B' and 1 p 'Laminated Paper Bag - Disposal - C';
Method: ReCiPe Endpoint (H) V1.10 / Europe ReCiPe H/A / Weighting

LCA – Paper Bags – Impact Assessment

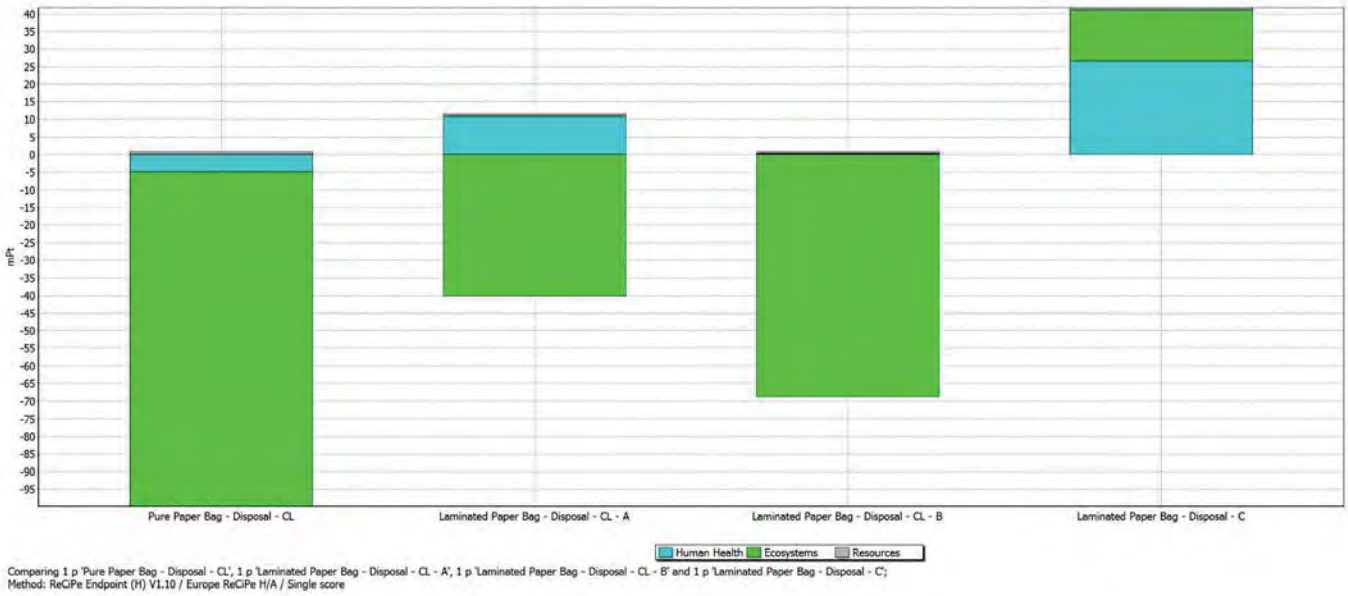
Disposal only – End-Point Results



Comparing 1 p 'Pure Paper Bag - Disposal - CL', 1 p 'Laminated Paper Bag - Disposal - CL - A', 1 p 'Laminated Paper Bag - Disposal - CL - B' and 1 p 'Laminated Paper Bag - Disposal - C';
Method: ReCiPe Endpoint (H) V1.10 / Europe ReCiPe H/A / Weighting

LCA – Paper Bags – Impact Assessment

Disposal only – Single Score Results



LCA – Paper Bags - Impact Assessment

- The impact of disposal scenario in the category of agricultural land occupation is negative for **pure paper bag** and **scenario A** and **B** of **laminated paper bag** due to recycling processes present, constituting an environmental benefit.
- This category in weighted presentation shows that recycling is most relevant and crucial process in the considerations of disposal scenario processes.
- **Laminated Paper Bag Scenario C** – as there is no recycling present – the impact of this category is zero. All impacts of **scenario C**, are related to landfilling of laminated paper bag.

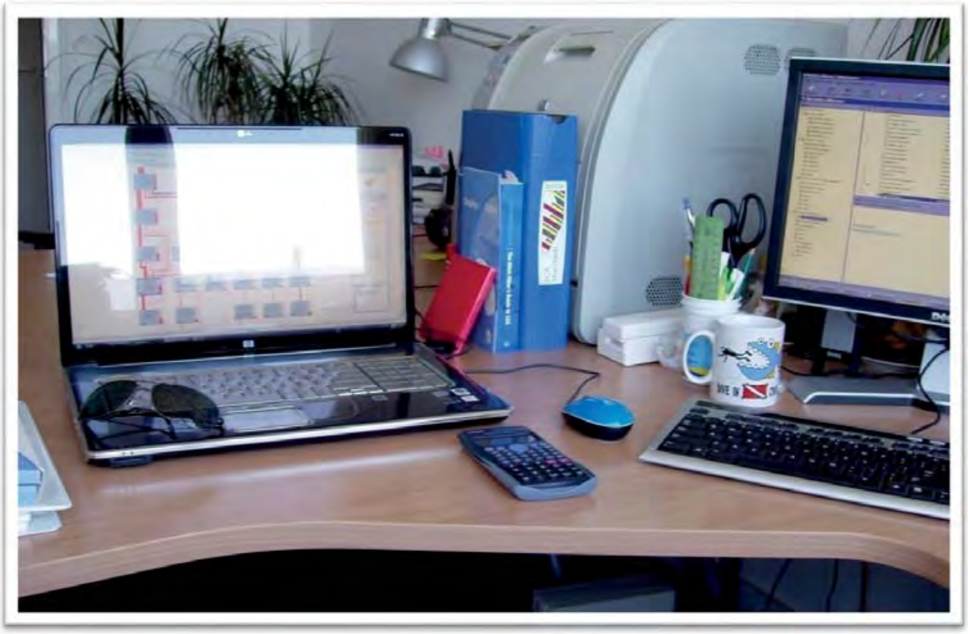
LCA – Paper Bags - Conclusions

- The main impact for the manufacturing of all bags is due to the **pulp and paper production** from virgin cellulose fibres.
- The polypropylene accounts for 27 % of the total weighted environmental costs for the **laminated paper bag**.
- the most important environmental advantage is the possibility of **recycling** the paper at the end of life in the **same production loop**, for producing the same paper grade used for the bag.
- This option enable to reduce the amount of virgin raw material pulp for the manufacturing of the bags, although taking into consideration a reducing **quality factor of 75%.**
- In the case of laminated **paper bag** - **Scenario C** , the lack of recycling make it necessary to supply all virgin fibres for the production and to dispose the product at the end of life.

LCA – Paper Bags - Conclusions

- The case of **pure paper bag** with complete recycling in the same paper cycle has the best behaviour in all impact categories.
- **Laminated paper bag – Scenario A** is worse than the **pure paper bag**, because of the impact of polypropylene and the low amount of recycling rate, 50% of the total bag mass.
- In **Scenario B** the results for most of the impact categories are better than **Scenario A.**
- The **Scenario C** is generally the worse one, especially for agricultural land occupation which is directly linked to the pulp feedstock supply.
- The determination of the most suitable **quality factor** value need further investigation in the future, taking into account new developments of the Product Environmental Footprint rules under discussion in the EU.

Thank you!!



LCA Workstation

Life Cycle Assessment of printed paper products and Sustainability Calculator.

Daniele Bussini, Final conference EcoPaperLoop, Kracow 02/12/2014

LCA of printed products.
EcoPaperLoop approach

EcoPaperLoop approach to sustainability:

➢ **Focus on the end of life phase of LCA, environmental sustainabiltiy of the recycling / deinking process.**

➢**LCA OF NEWSPAPERS.**
Comparison between average products of different categories.
Assessment of different recycling options, different recycling loops.

➢ **STUDY OF THE MOST IMPORTANT END OF LIFE PARAMETERS, AFFECTING THE SUSTAINABILITY OF RECYCLING.**

➢ **SUSTAINABILITY CALCULATOR. Software tool for the calculation of environmental impacts and sustainability of recycling.**

LCA of newspapers

CASE STUDY: Standard Offset and flexographic printing of newspapers.

- **THE SCOPE OF THE STUDY is to assess the life cycle of newspapers printed with standard offset and flexographic technology, taking into account the most important phases from the production of the paper to the end of life options.**

- **Offset newspapers are considered recyclable within the graphic paper loop, by flotation deinking process.**
Flexo newspapers are considered undeinkable under standard flotation deinking and could not be recycled in the graphic paper loop.
Possible recycling in other paper loop, for instance packaging paper loop.

LCA Inventory – Impact Assessment

Inventory:

Database Ecoinvent V3 (update September 2014).

✓Average Category Data

✓Literature Data

Functional Unit is 1kg printed product.

Software for LCA
SimaPro, Version 8.0.3 (update September 2014).

Impact Assessment Method:
ReCiPe Endpoint V1.10

LCA Impact Assessment

Most Relevant Impact Categories – midpoint:

✓**Agricultural and urban land occupation** (in particular for paper production process)

✓**Climate change** (in particular for production and recycling, where a lot of energy is required) – Expressed as global warming potential.

✓**Fossil fuel and minerals depletion** (in particular for the production of chemicals).

Damage Categories – endpoint:

Human Health, Ecosystems, Resources.

Assumptions for the study – product and process:

➢ **The same paper grade used for offset and flexo printed products. Newsprint made of DIP containing pulp. About 77% DIP (DeInked Pulp) and 23% virgin cellulose fibres. Source: Ecoinvent.**

➢ **Energy consumption and general impact of web offset printing and flexographic printing are considered the same. Differences are not significant with respect to overall life cycle.**

➢ **Flexo ink is supposed to have the same pigments as the offset ink, without the light weight oils fraction and solvents, which represent 47,5% of the offset ink. Source: Ecoinvent.**

➢ **Ink consumption is 2,5% of the paper weight for the offset printing and double for the flexographic printing. Source: Best Available Tecniques in the printing industry, Okopol, Germany.**

Assumptions for the study – end of life, general:

End of life: 90% of used newspapers (all types) are collected and recycled in the paper loop, municipal collection plus shops return.

The remaining amount is disposed 6% landfill and 4% incineration with energy recovery, as for mixed Municipal Solid Waste (MSW). Source: Cepi / Eurostat.

Assumptions for the study – end of life, specific:

OFFSET:

-Recycling within the same loop, graphic paper production loop.

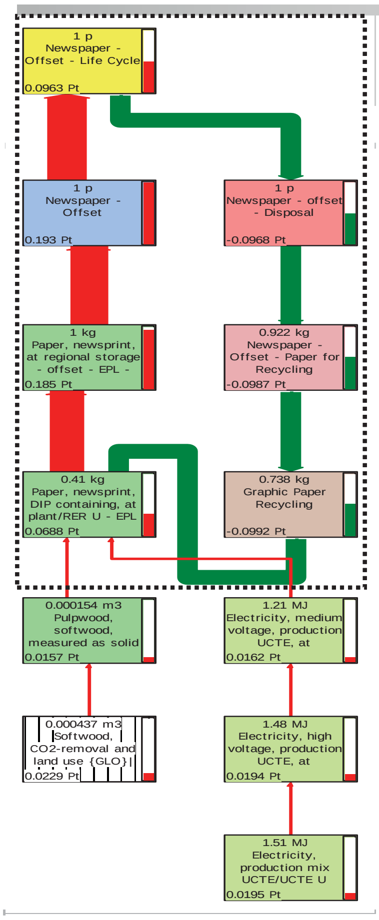
- Deinking process with standard flotation technology. (2 loop flotation plant with process yield of 80%).

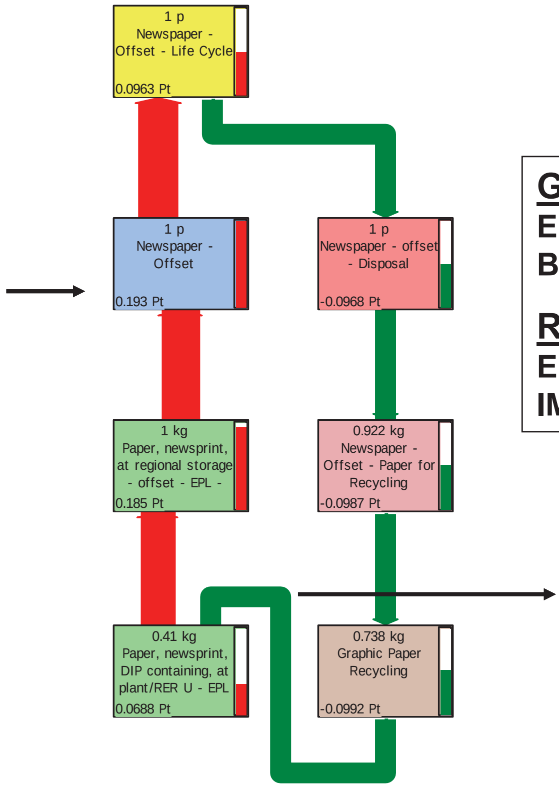
- Deinking sludge of 20% is disposed as landfill and incineration.

FLEXO:

-Newspapers are not deinkable by using a standard flotation technology, because the water based ink is dissolved in the pulp suspension.

- Products can be recycled in other loops, like packaging paper loop. This means recycling for the production of a different product, with lower quality fibers (downgrading). The benefit of recycling in this case is out of the system boundaries of the study.





Process tree

Green arrows: ENVIRONMENTAL BENEFIT.

Red arrows: ENVIRONMENTAL IMPACTS

CLOSED LOOP APPROACH, recycling

Recycled fibres replace raw material (DIP containing pulp)

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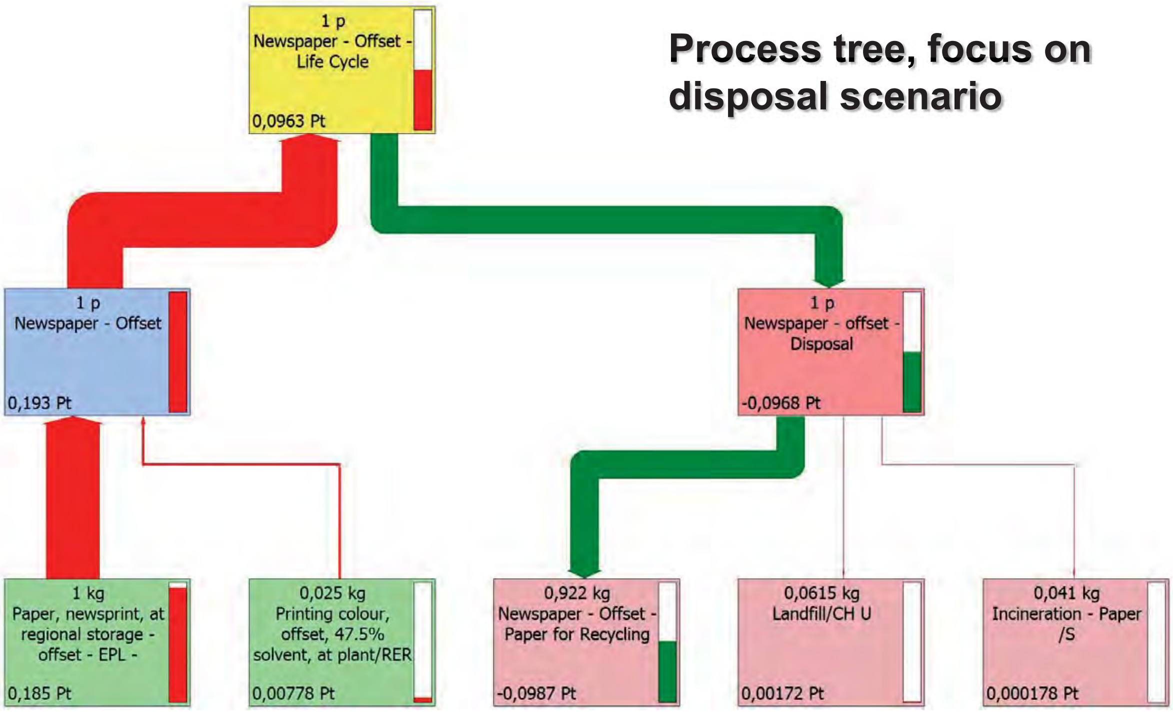
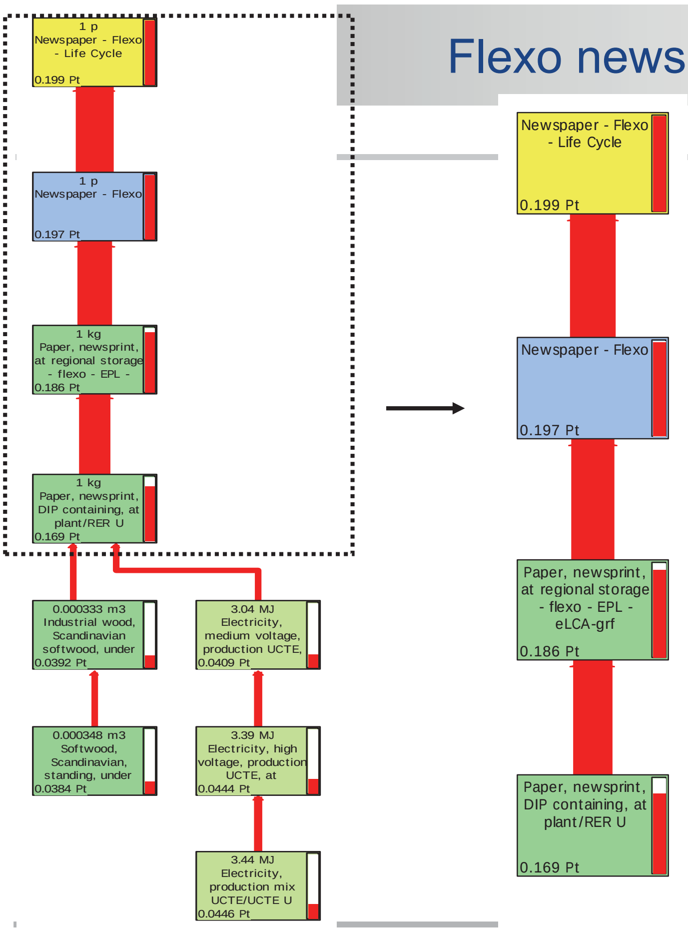
Offset newspaper

EcoPaperLoop

Process tree, focus on disposal scenario



Flexo newspaper



Process tree

Recycling in a different paper loop (packaging).

Raw material (DIP containing pulp) can not be replaced by recycled fibres.

It can not be accounted any benefit nor impact for the recycling (out of system boundaries).

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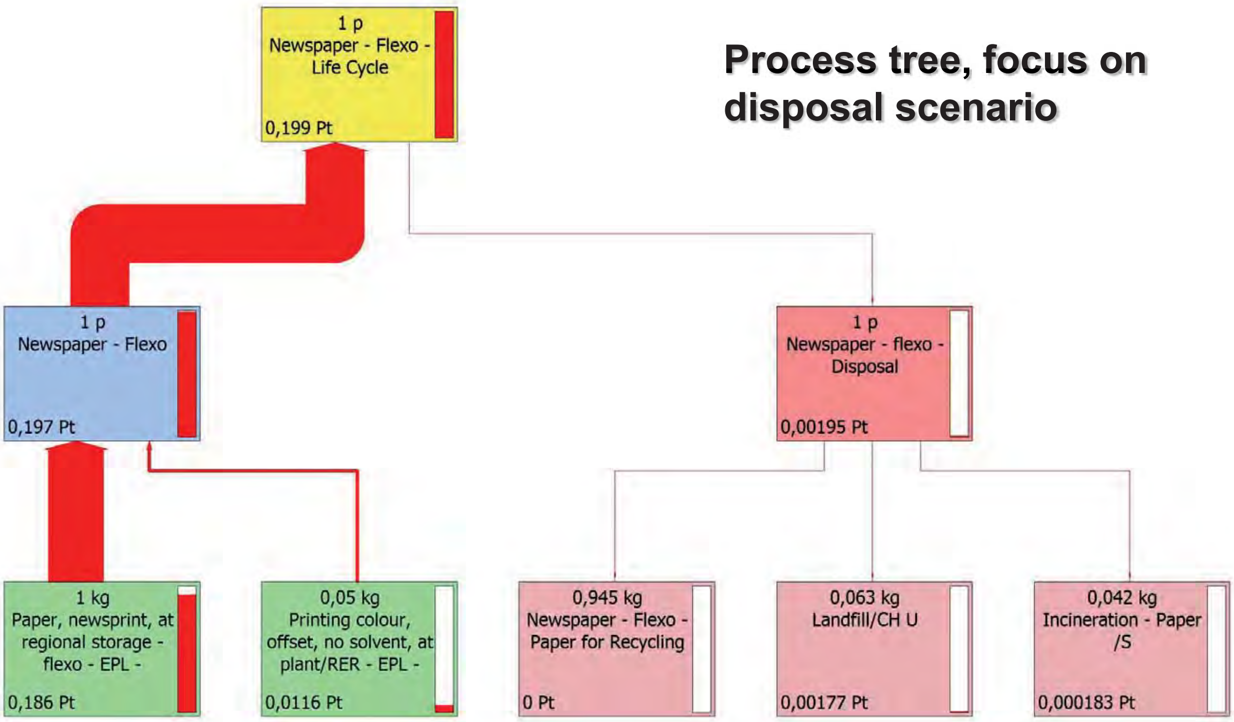
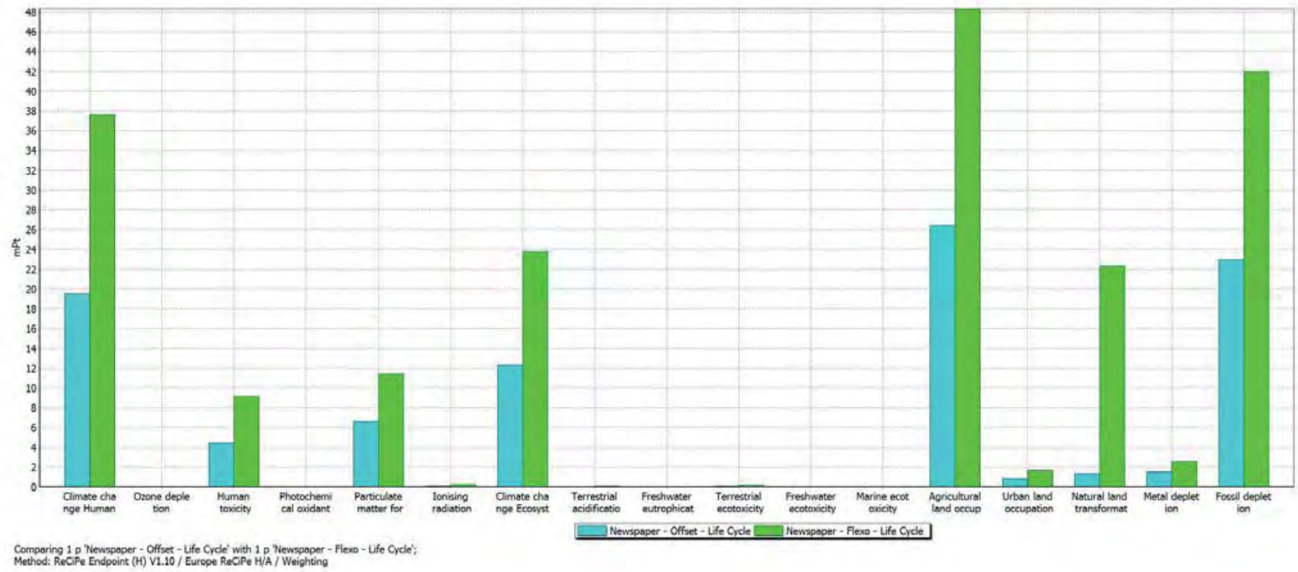
Flexo newspaper

Process tree, focus on disposal scenario



Newspapers – Full Life Cycle



Mid point results – Impact Categories

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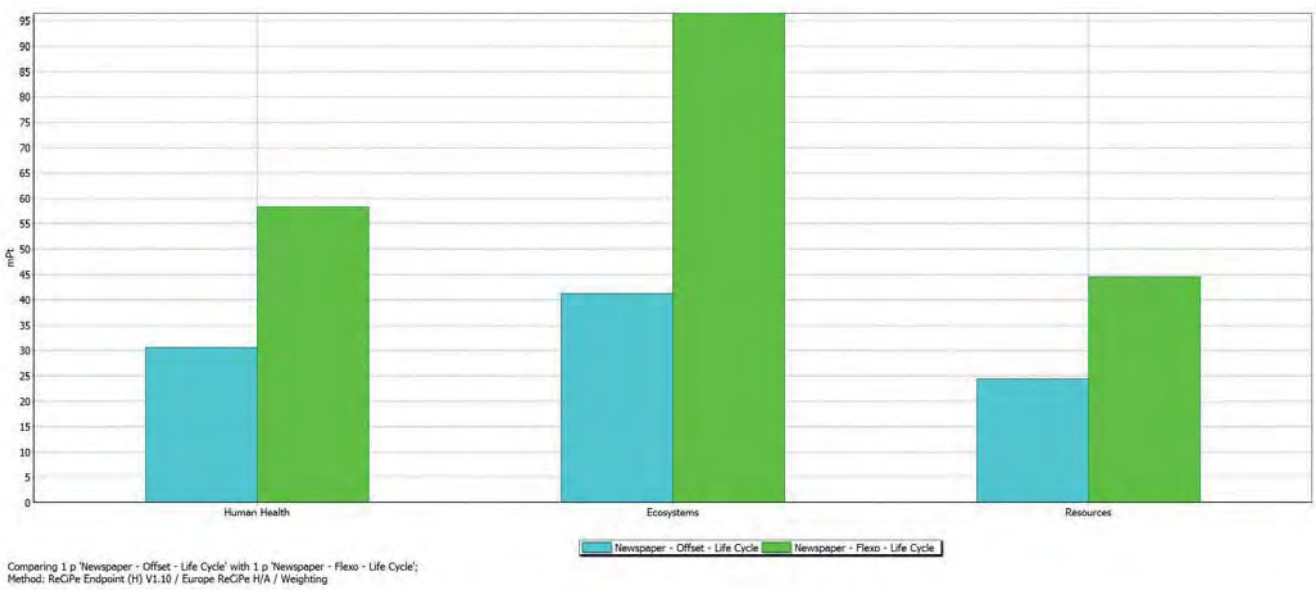
Newspapers – Full Life Cycle



End Point Results – Damage Categories

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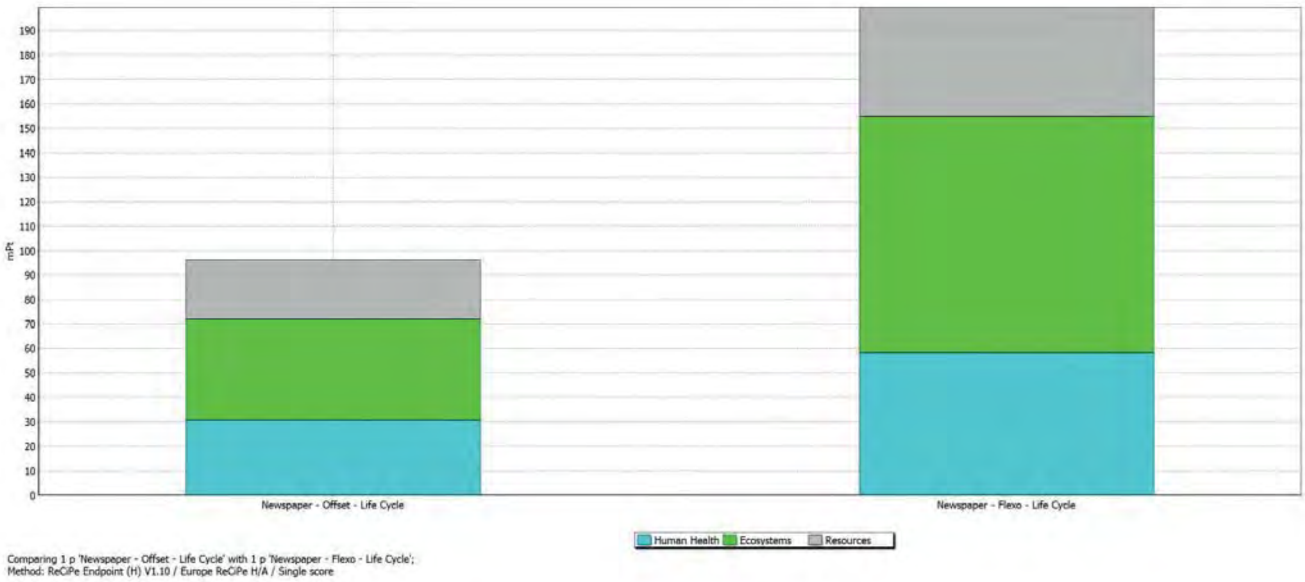
Newspapers – Full Life Cycle



Single Score Results

Newspapers – Results

✓**<u>The process with the highest impact</u> is the pulp production for paper manufacturing, because of the recycling process for DIP production and the chemi-mechanical process for cellulose production.**

✓**<u>The printing process</u> accounts about 5% of the overall impact in the case of offset newspaper and about 4,2% for flexo newspaper (lack of light fuel oils and solvents in the ink composition). However the difference is very small with respect of full life cycle of newspapers.**

✓**<u>The most important environmental advantage</u> is the possibility of recycling the material within the same production loop, reducing the amount of raw material required.**

✓**<u>Recycling has a positive effect in all the impact categories</u> and mainly in the categories where the impact of pulp production is more evident (agricultural land transformation, natural land trasnformation, climate change, fossil resources).**

Research study focused on the End of Life phase of printed products, to be implemented in the LCA:

- **Which are the most important environmental emissions in recycling?**
- **What are the most important deinking parameters affecting environmental emissions of recycling?**
- **How are they connected?**
- **How to evaluate the environmental performances of the recycling process depending of deinking parameters?**

End of Life parameters and Sustainability

Three Product categories considered in details:
Newspapers – Uncoated Magazines – Coated Magazines

Example: Newspapers category

OFFSET NEWSPAPERS (including Flyers)	luminosity Y, %			Dirt Speckes A_{50}, mm^2/m^2		
	Low limit: 33,5	Average: 53,0	High limit: 72,5	Low limit: 0	Average: 630	High limit: 3000
energy consumption, electricity, kWh/kg pulp	constant = 0,300	0,300	0,270	constant = 0,300	0,300	0,340
deinking chemicals consumption, g/kg pulp	13 g/kg NaOH 40 g/kg silicate	5 g/kg NaOH 10 g/kg silicate	constant= 5 g/kg NaOH 10 g/kg Silicate	-	-	-

- Agerage and Limits of Luminosity and Dirt Specks refers to laboratory tests results, considering hundreds of tests performed on market products. Acknowledge: Ingede.
- Data about chemicals and electricity consumption consider a typical 2 loop flotation deinking technology for the production of newsprint paper. Data from literature and Industry.

Sustainability Calculator

WEB based SOFTWARE TOOL:

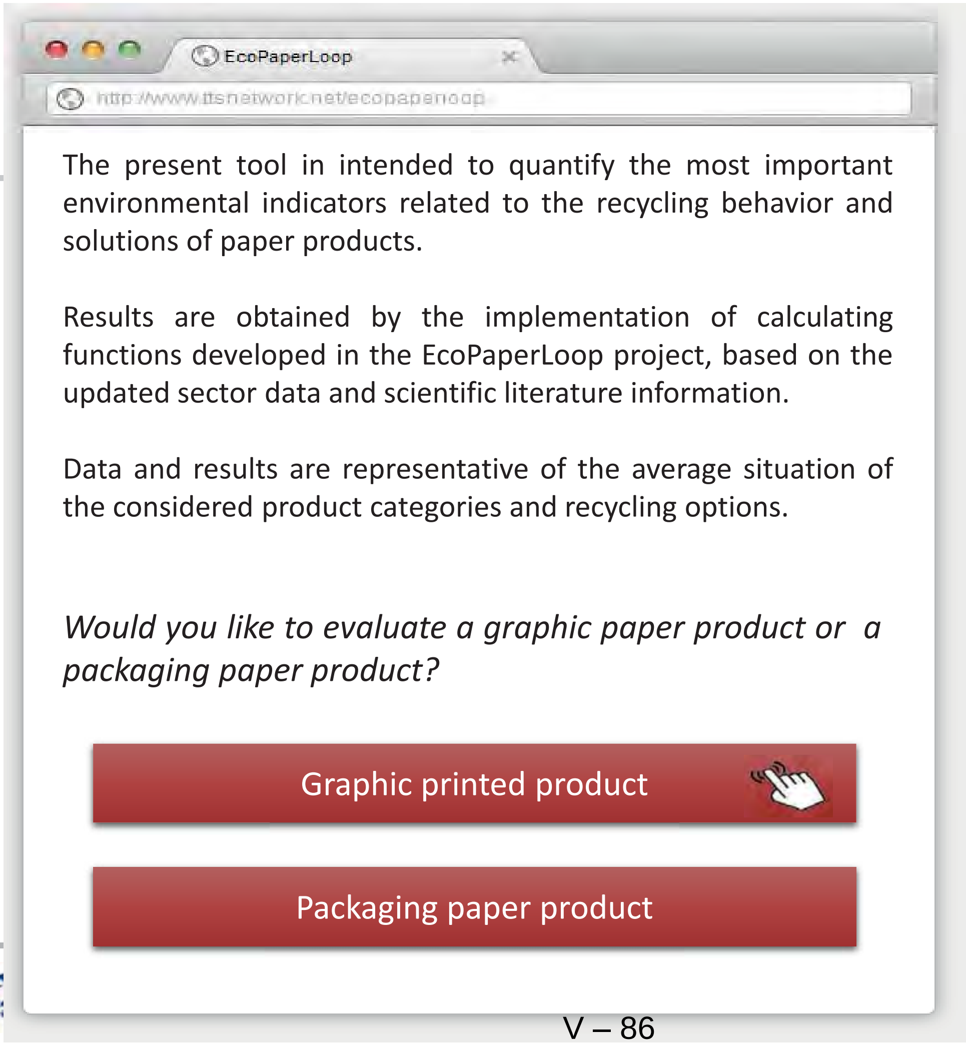
✓**Simplified calculation of environmental sustainability of printed products**
✓**LCA approach, focused on the end of life recycling phase**

INPUTS

✓**Deinkability parameters (Luminosity Y and Dirt Specks) of a <u>specific product</u> (according to Ingede Method 11 if available)**
✓**Average deinkability parameters for the <u>product category</u> (if specific results according to Ingede Method 11 are not available)**

OUTPUTS

✓**Chemicals and electricity consumption, average values**
✓**CO_2 emission**



Graphic printed product

A specific printed product was tested according to Ingede method 11 and related results are available.

Yes

No

The Sustainability Recycling Calculator is intended as a tool for paper and packaging producers, converters, brand-owners and final users of paper and packagnig products. The scope is to enhance the environmental sustainability of paper base products, by the analysis of the recycling performances.

Graphic printed product

Please select the Product Category

Offset Newspapers

Uncoated Magazines

Coated Magazines

Graphic printed product

OFFSET NEWSPAPER

Please insert the result values for Luminosity Y and Dirt Specks A50

Y VALUE	
A_{50} VALUE	

OK

Graphic printed product

OFFSET NEWSPAPER

Results of the most important environmental indicators of the recycling process:

NaOH (g/kg pulp)	
Silicate (g/kg pulp)	
Electricity (kWh/kg pulp)	
CO_2 Equivalent GWP100	

Go back to the beginning

EcoPaperLoop

The present tool in intended to quantify the most important environmental indicators related to the recycling behavior and solutions of paper products.

Results are obtained by the implementation of calculating functions developed in the EcoPaperLoop project, based on the updated sector data and scientific literature information.

Data and results are representative of the average situation of the considered product categories and recycling options.

Would you like to evaluate a graphic paper product or a packaging paper product?

Graphic printed product

Packaging paper product

EcoPaperLoop

Graphic printed product

A specific printed product was tested according to Ingede method 11 and related results are available.

Yes

No

The Sustainability Recycling Calculator is intended as a tool for paper and packaging producers, converters, brand-owners and final users of paper and packagnig products. The scope is to enhance the environmental sustainability of paper base products, by the analysis of the recycling performances.

EcoPaperLoop

http://www.itsnetwork.net/ecopaperloop

Graphic printed product

Please select the Product Category

Newspapers Offset
(including flyers of similar type)

Flyers Offset

Newspapers Flexographic

Newspapers Inkjet Digital

Uncoated Magazines
(Including flyers of similar type)

Coated Magazines
(including flyers of similar type)

EcoPaperLoop

http://www.itsnetwork.net/ecopaperloop

Graphic printed product

NEWSPAPERS OFFSER
(including flyers of similar type)

Average values of Luminosity Y and Dirt Specks parameters for the selected category are reported.

Luminosity Y	
Dirt Specks A_{50}, mm^2/m^2	
Dirt Specks A_{250}, mm^2/m^2	

Average values in the table can be used to calculate environmental indicators of the recycling process: deinking chemicals, electricity consumption, CO2 emissions.

Calculate Environmental performances

Go back to the beginning

Graphic printed product

NEWSPAPERS OFFSER
(including flyers of similar type)

Results of the most important environmental indicators of the recycling process:

NaOH (g/kg pulp)	
Silicate (g/kg pulp)	
Electricity (kWh/kg pulp)	
CO_2 Equivalent GWP100	

Go back to the beginning

Thank you

Daniele Bussini
daniele.bussini@mi.camcom.it

Recommendations for a regulatory framework

Mateja Mešl

Final Conference

EcoPaperLoop Project
2nd December 2014 in Krakow, Poland

Recommendations for a regulatory framework

Mateja Mešl
Pulp and Paper Institute Ljubljana, Slovenia

Presentation

Policy guidelines to improve common strategy and framework on paper recycling loop to reach recycling targets and high quality raw material for the industry.

- **Starting point**
  - **Present body of rules**
  - **Strategic objectives**
- **Consultation process**
- **Guidelines and recommendations.**

Starting point

- **Present body of rules**
  - Overview of legislative requirements with regard to paper recycling
  - Comparative study on implementation of the waste legislation in the CE Region

- **Community strategic objectives (EU circular economy targets)**
  - Resource efficiency: reducing demand for scarce resources and thus contributing to the competitiveness of the economy
  - Community targets: legislative proposal to review recycling and other waste-related targets in the EU (ambitious targets, landfill ban, high quality recycling,..)

- **Industry perspective (CEPI, The Road to 2050, Position Paper)**
  - Long term sustainability of paper loop; ambitious recycling targets, improving collection and thus quality of paper for recycling
  - Ensuring quality fibre for the industry in Europe.

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Pulp and paper Institute

Consultation process

- **Common questionnaire**
  - Paper recycling policy and goals
  - Legislation regarding paper recycling
  - Proposals for paper recycling policy.

113 responses from Austria, Germany, Hungary, Italy, Poland, Slovenia.

All relevant stakeholders, producers, waste management, authorities, civil society groups.

- **Intl brainstorming sessions**
  - World Coffee Ljubljana, Slovenia
  - Stakeholders 'Workshop Sopron, Hungary

Topics:
- Recyclability
- Collection strategies
- Public awareness
- Legislation.

- **Stakeholders' dialog**
- National conferences and seminars in partners' countries
- Dialog with project advisory and supporting institutions

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Recommendations

1. Change of focus of the overall policy regarding paper recycling is needed, prioritizing recycling and sustainability.
2. There is room for improvement in present regulation on paper products but no new bans or expand of legislation is expected. Education and promotion is more important and efficient to reach the targets.
3. Improved collection strategies are needed to ensure quality of paper for recycling.
4. Promote eco-design and recyclability - „Use product design to educate on the environment“.
5. Enforce use of recyclability criteria in green public procurement – „Recyclability of the product is more important than the content of recycled fibre in paper products“.
6. Ensure access to quality fibre for recycling in Europe.

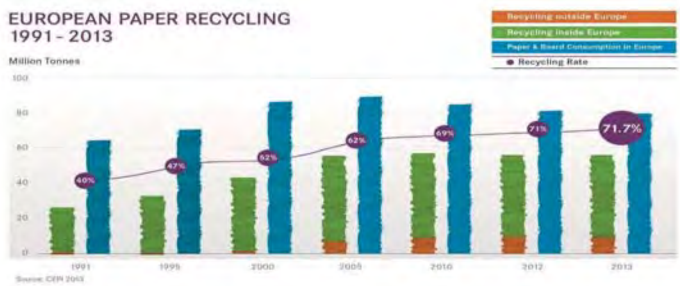
Recommendation No 1

Change of focus of the overall policy regarding paper recycling is needed, prioritizing recycling and sustainability.

- Ambitious targets are achievable only if a comprehensive approach to policy design and implementation is ensured, following the objective to maintain the quality of paper for recycling and thus focusing on the key preconditions, being eco-design, better collection and sorting.

CEPI, Key Statistics 2013

- EU reaching limits regarding recycling rates
- New consumption patterns and market trends



Recommendation No 2

There is room for improvement in present regulation on paper products but no new bans or expand of legislation is expected.

Education, promotion and stimulation of all actors in the value chain is more important and efficient.

- Recycling is adequately placed in the waste hierarchy, but clear definitions and quality standards for determination of recyclability are needed at EU level, including certification methods and guidelines.
- Legislation is lacking comprehensiveness; more emphasis on the closed loop recycling management is needed with clear responsibilities of all actors involved.
- Better material flow traceability is to be ensured to stimulate improvement of the environmental performance of the products.

Recommendation No 2

- Ensuring implementation of existing legislation in all countries and consistency between EU and national/regional regulation shall be priority: higher transparency in the legislation is needed to ease the implementation at all levels.
- Higher awareness of the recyclability issues shall be achieved with more investment in promotion and education:
  - Improvement of general knowledge on the whole paper loop, most important preconditions for the quality of paper for recycling.
  - A more „life-cycle thinking“ approach, promoting sustainability targets among all actors involved, eco-design, higher collection and sorting levels.
  - Stimulating actors in the paper loop for more efficient recycling, strengthening policy measures i.e. rewarding schemes, market development initiatives, support for technological development.

Recommendation No 3

Improved collection strategies are needed to maintain and ensure the quality of paper for recycling.

- The key challenge to higher recycling rates and quality of paper for recycling lies in efficient collection systems.

Uniform collection strategies do not and cannot exist. Communal collection streams are subject of local regulation and also much more dependent on public awareness.

- EU legislation should lay out the basis for the common orientation to clean waste streams, efficient sorting and traceability.

Promoting separate collection, more investment in awareness raising and development of additional recommendations and guidelines is essential.

- Strengthening requirements in relation to recyclability in eco-design and producers responsibility to inform and guide consumers for proper collection.

Recommendation No 4

Promote eco-design and recyclability
"Use product design to educate on the environment"

- Policies are more focused on the waste stage of the paper life cycle; eco-design is not promoted and encouraged sufficiently.

General rules for eco-design in regulation on EU level are needed. Eco-design should be stimulated and recommendations for product designers and producers developed.

- Determination of recyclability, including evaluation methods and criteria for certification is of high importance.

Recyclability tests should represent the umbrella and link to the existing standards and certifications. Use of eco-label and purchase of products with eco certification that include recyclability criteria should be encouraged stronger.

- Clear responsibilities of each stakeholder in the paper loop proportional to their range of influence on the quality of recycled paper.

Common approach to the operation of producer responsibility shall be implemented, with no disproportionate burden on the producers, covering aspects beyond their control.

Recommendation No 5

Enforce use of recyclability criteria in green public procurement.

"Recyclability of the product is more important than content of recycled fibre in paper products"

- GPP is important tool to stimulate recycling and should be imposed stronger.

The criteria of the content of recycled fibre in the product prevails too much.

GPP should focus on sustainability with more attention given to the recyclability of the product.

Clearly defined common rules at the EU level, supported with the guidelines, exchange of good practices and education of the users is needed.

- GPP should be obligation for public authorities and at the same time part of the general policy promoting eco-design and recycling.

Measures are needed to stimulate private sector to use the same principles and criteria.

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Recommendation No 6

Ensure access to quality paper for recycling in Europe.

- End-of-waste regulation and criteria already announced in a new directive should also be discussed with the focus on sustainability and resource efficiency.
- Strict implementation of the waste shipment regulation needs to be ensured, with more practical supervision of actual shipments of paper for recycling from EU.
- Paper and packaging waste traceability all along until recycling has to be enhanced.

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Eco
Paper
Loop
THANK YOU FOR YOUR ATTENTION!

The future quality of paper for recycling and its impacts on paper sorting and paper making

Johannes Kappen

Final Conference - EcoPaperLoop Project
2nd December 2014 in Krakow, Poland

The future quality of paper for recycling and its impacts on paper sorting and paper making

Johannes Kappen, Constanze Seidemann - PTS

Overview

- **Paper for Recycling: What will it look like in future?**
- **Any options?**
- **Sorting as one key to success**

Quality of Paper for Recycling?
Take a look at the paper products produced!

Consumer

Paper products

News
Magazines
Office
Folding boxes
Corrugated boxes
Compound
…

→

Waste management industry

Collected Paper for Recycling

Gradelist EN 643

Collection system
Sorting effort
Composition
No Paper componets
Printing in coverage
…

→

Paper industry

Secondary fibre stock

Value of fibre stock

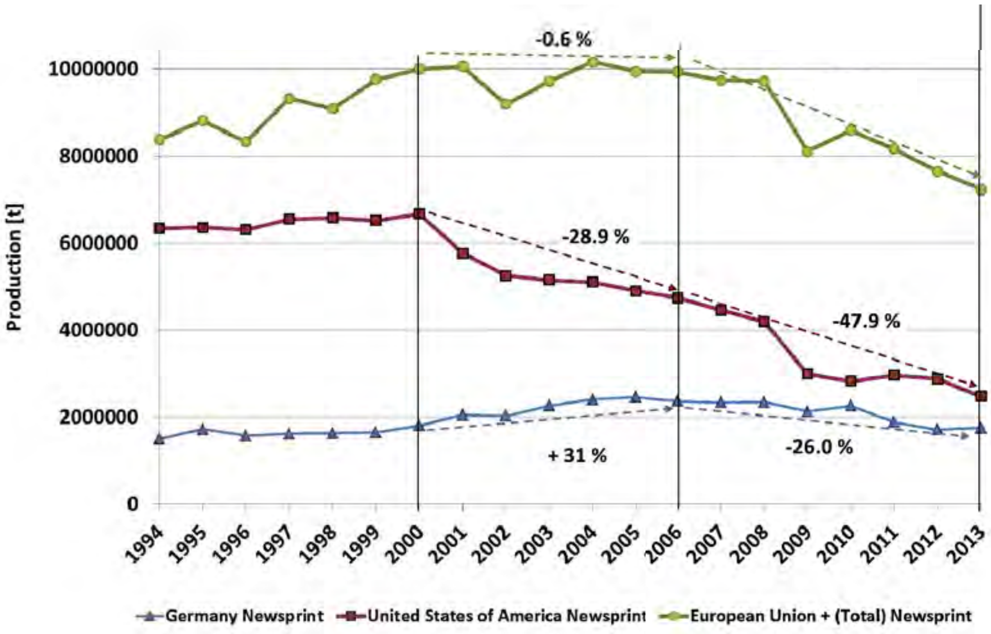
Strength
Optical properties
Impurities
Dewaterability
Deinkability
…

Consumption and Production of Newsprint

Consumption: USA: Reduction in newsprint from 1992 until 2011 by 54 %
Forecast USA. Down 47% from 2010 until 2020 (Source: Pulp and Printing Papers Forecast 2010–2020)

Forecast Europe: Down 56% from 2008 until 2020 (Source: The Future of Paper and Print in Europe 2008-2020)

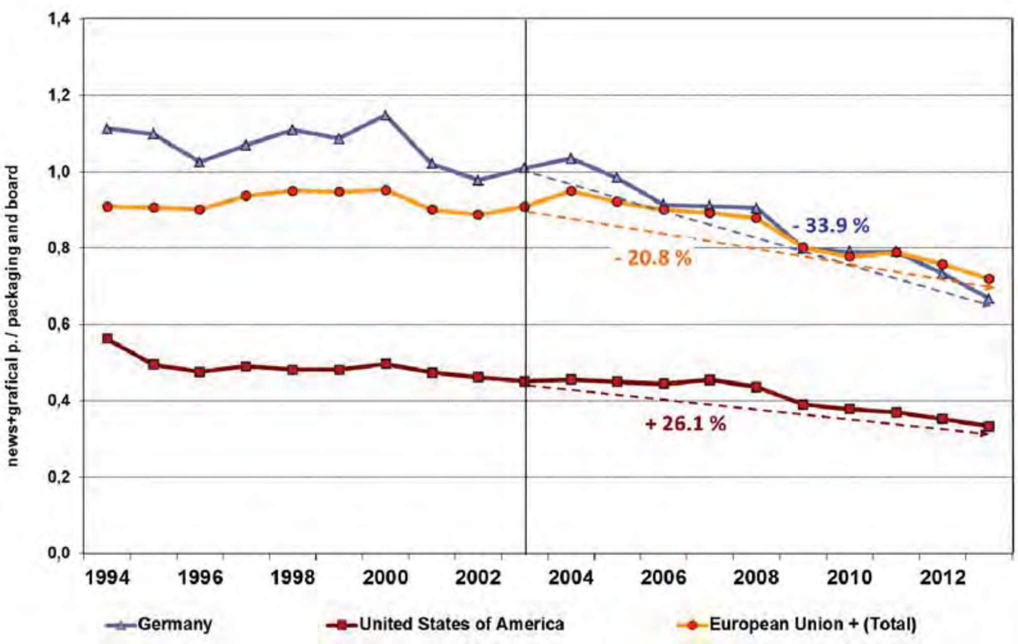
Production does react:



Source: Data from http://faostat.fao.org, 12-10-14)

The structure of grades is undergoing significant change

Production of newsprint and graphical paper in relation to packaging an board significantly reduced during last 10 years.



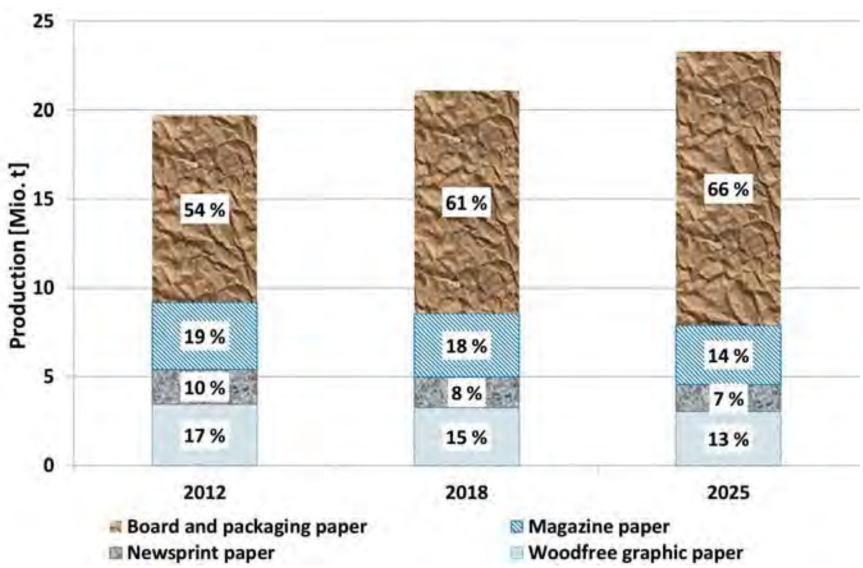
Source: Calculated based on Data from http://faostat.fao.org, 12-10-14)

Megatrends and their impacts on the paper industry

Megatrend	Impact on the paper sector
Increasing awareness of sustainability, quality and health in society	- Growing demand for packaging paper and board - More stringent requirements on the contents of health-related substances
Increasing scarcity of energy and raw materials (wood, etc.)	- Increasing use of paper for recycling - Substitution of fibre pulp by minerals (fillers)
Digitalisation of information and communication	- Decline in consumption/production of graphic paper
Price and cost orientation of consumers and industry	- Increasing pressure to implement cost reduction measures (yield improvement, formula optimisation, etc.)

Source: C. Seidemann et. al INFOR 171 R

A look into the future – Change in grade structure of the industry: Supply of PfR continues to change (GER)



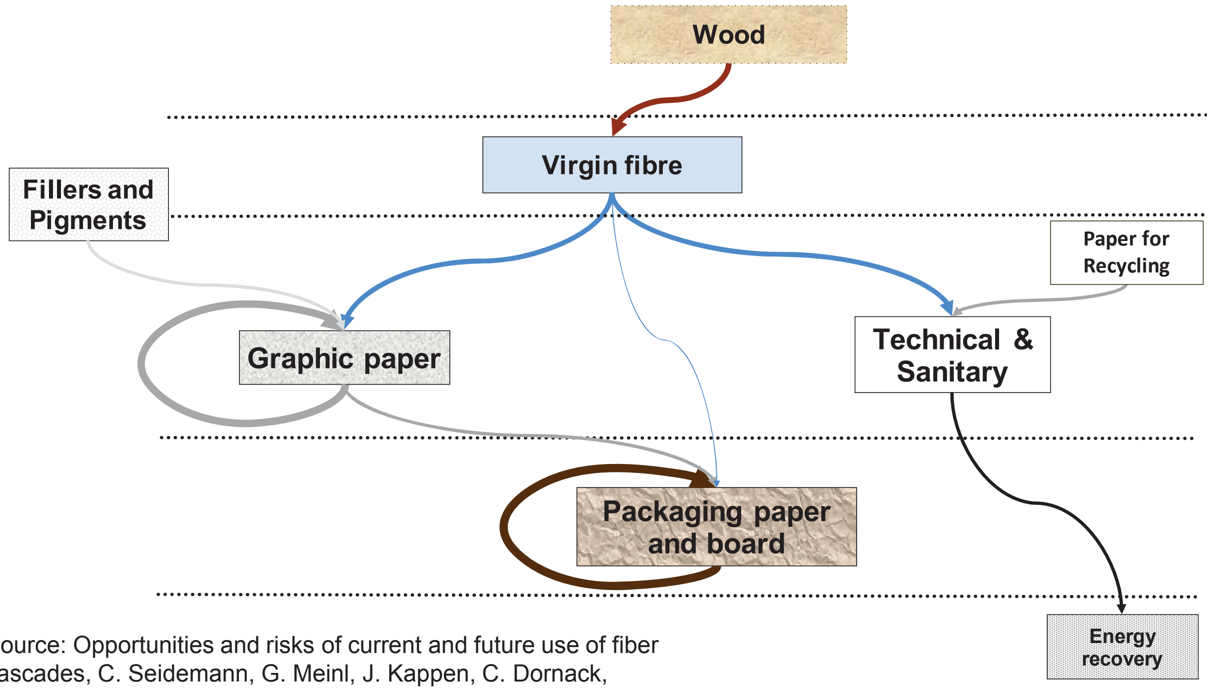
- Forecast based on actual trends

Source: C. Seidemann et. al INFOR 171 R

Predictions here and in coming slides based on a research project combining market expectations and comprehensive balancing and model based quality calculations.

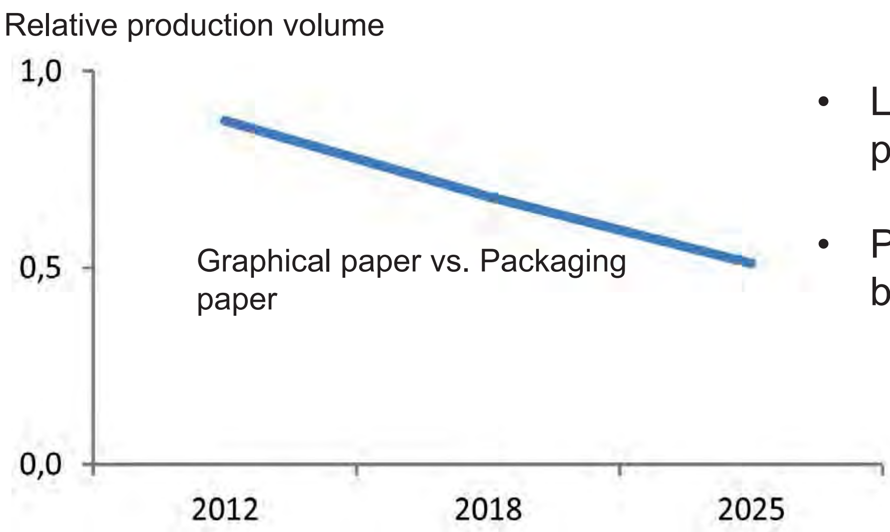
Current structure of the fiber cascades

Virgin fibre used mainly in the area of graphic production



Source: Opportunities and risks of current and future use of fiber cascades, C. Seidemann, G. Meinl, J. Kappen, C. Dornack, Deinking Symposium 2014

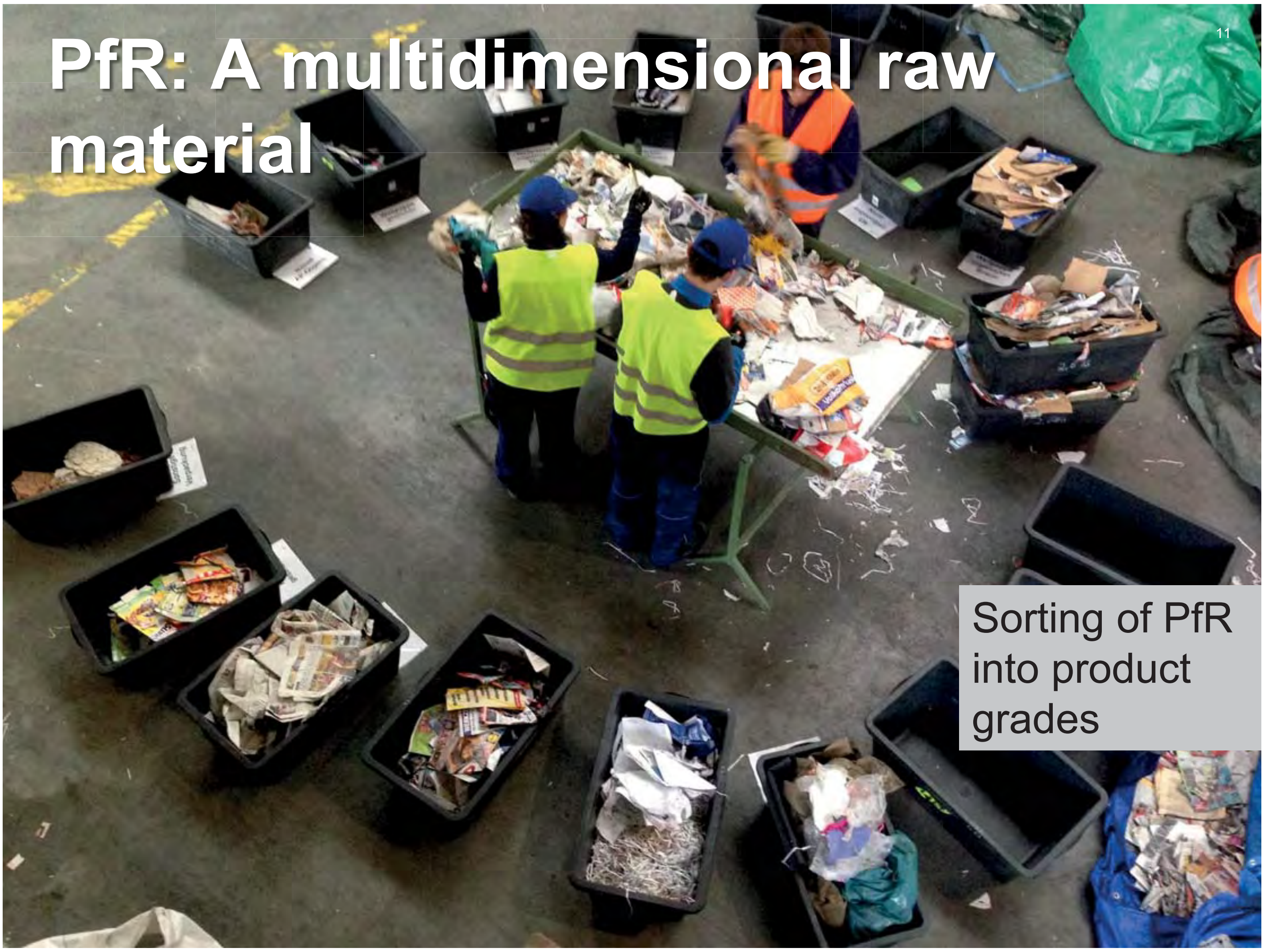
A look into the future – Change in grade structure of the industry: Supply of PfR continues to change (GER)



- Less graphical paper will be produced.
- Packaging grades will become more important

Source: based on C. Seidemann et. al INFOR 171 R

PfR: A multidimensional raw material



Sorting of PfR into product grades

Composition of 1.11 – How could it change? (GER)

1.11 is not a „natural grade, but refined due to sorting

Some of the impact will only „reach“ the PfR sorter

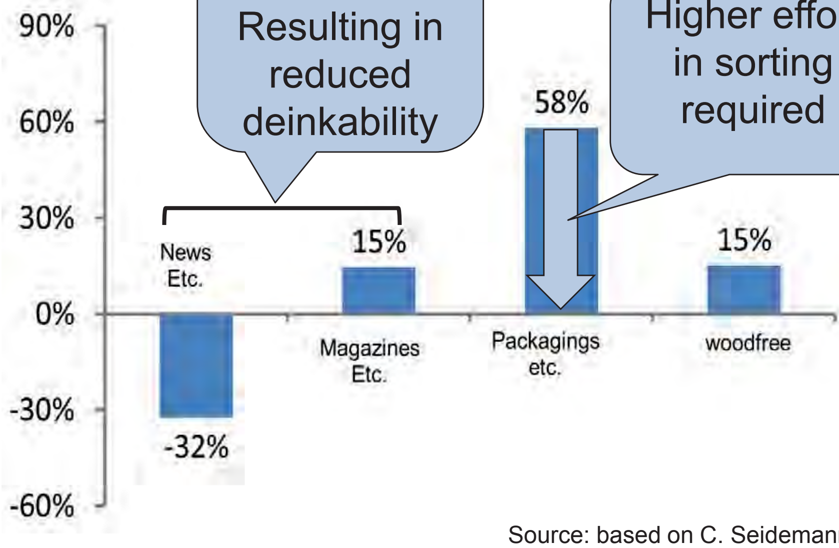
Trend between news and mag‘s reverted in last 12 months

Change in Mass fraction

2025 vs. 2012

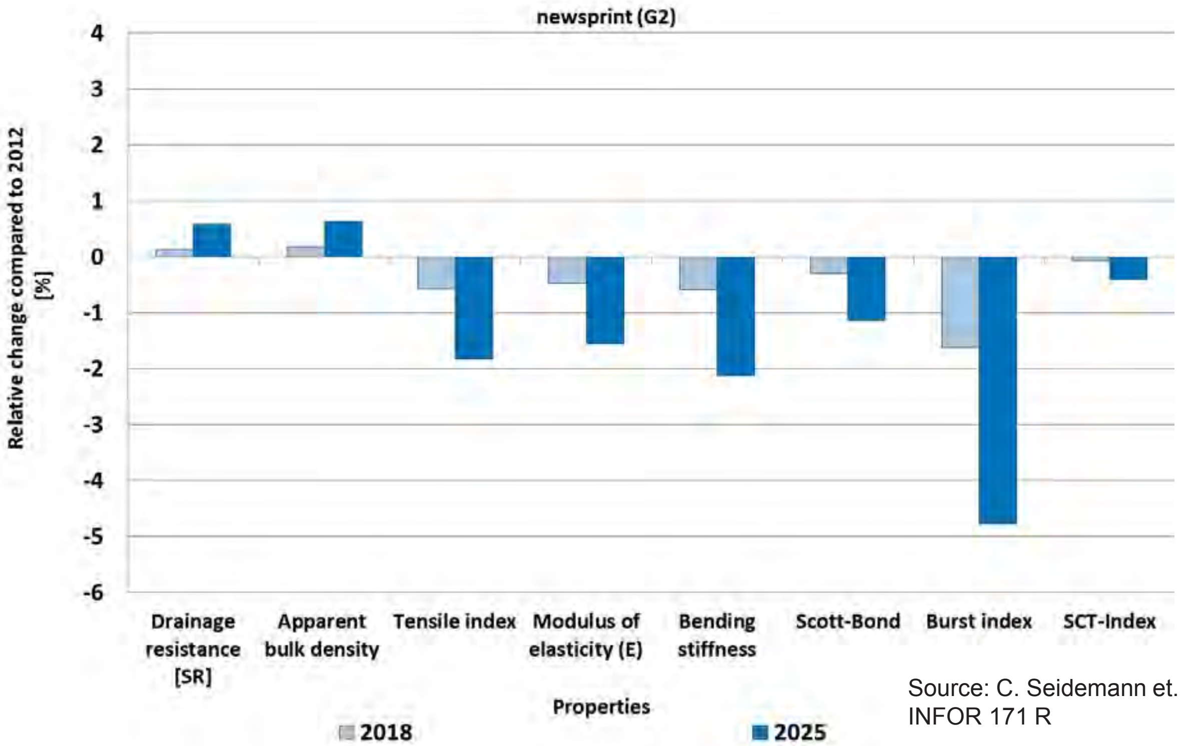
Current trend: vice versa! Resulting in reduced deinkability

Higher effort in sorting required



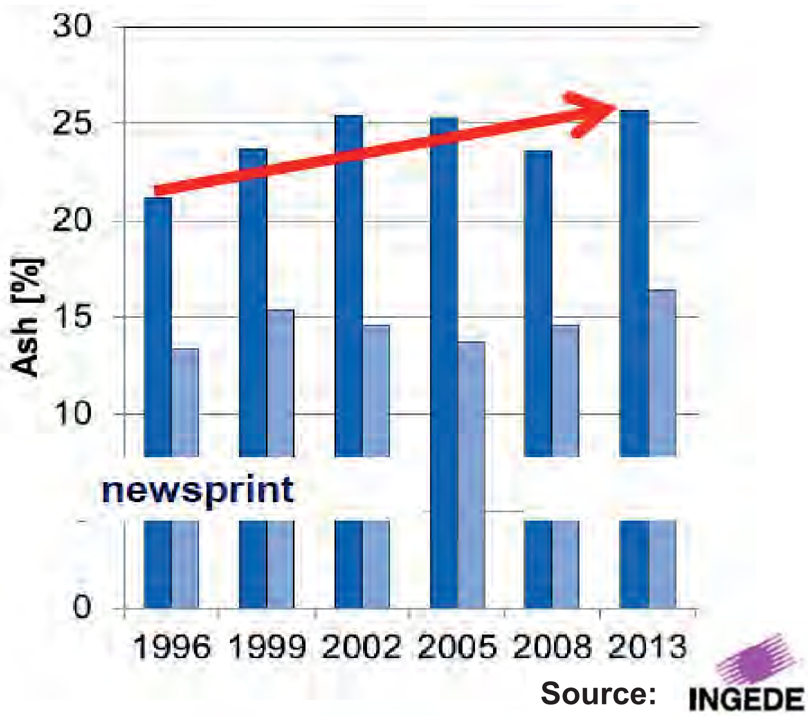
Source: based on C. Seidemann et. al INFOR 171 R

Impact on Newsprint produced (predicted values, GER)



Source: C. Seidemann et. al
INFOR 171 R

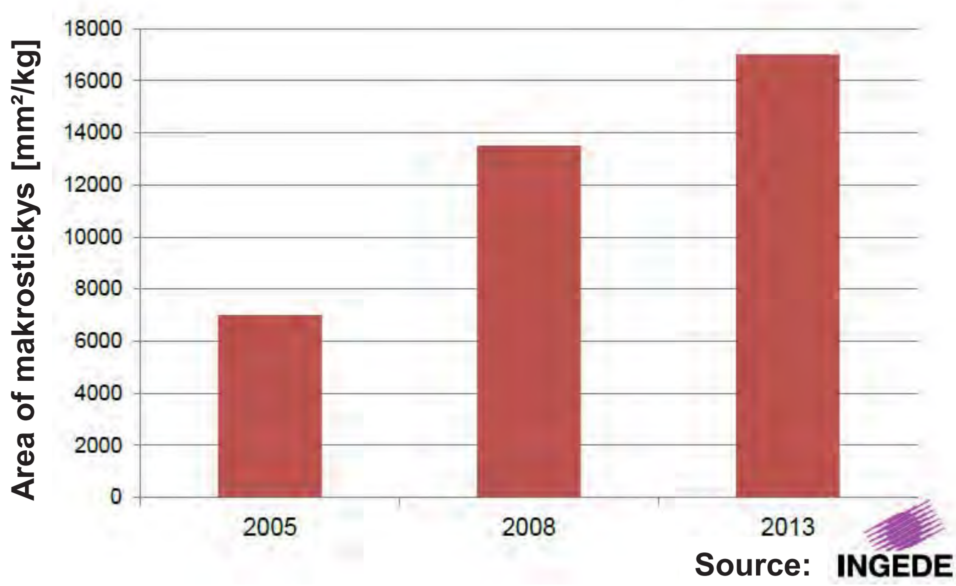
Change in graphical PfR quality: ash content



This trend to some extend depends on the ration between news and mag's

A reverted last 12 months does not mean that it will be so on the long run!

Change in graphical PfR quality: makrostickys area (INGEDE members)



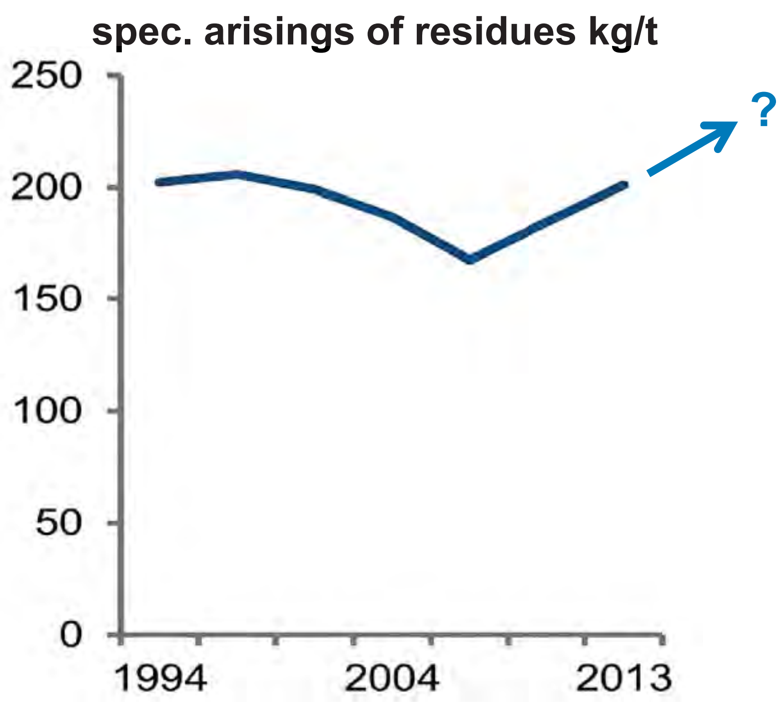
More complex finishing and converting leave its footmarks in PfR (1.11, undeinked pulp)

Further increase expected

Residue arising: A clear indicator on PfR quality

The waste arisings in paper making are increasing (Germany)

Most probably a result of the downturn of the quality of PfR



Source: INFOR 172,
(PTS-VDP-residues monitoring)

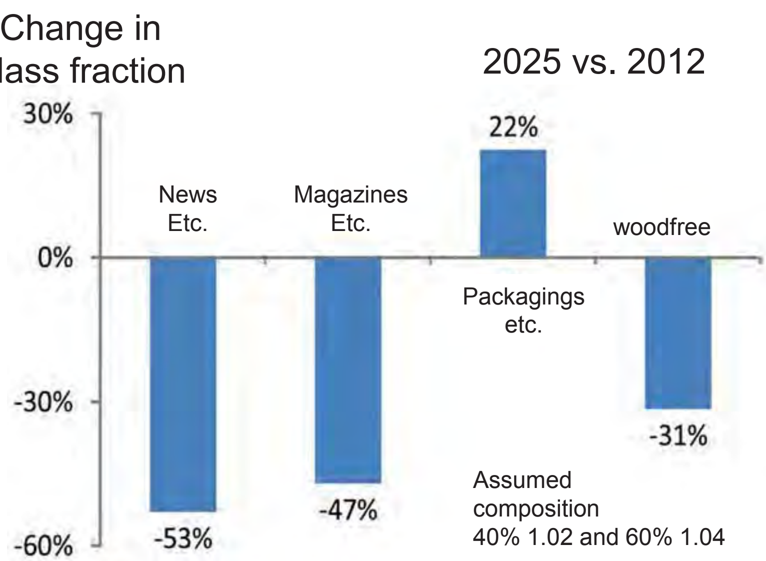
Quality of PfR for packaging – How will it change? (GER)

Forecast:

Dramatic change in the composition of PfR

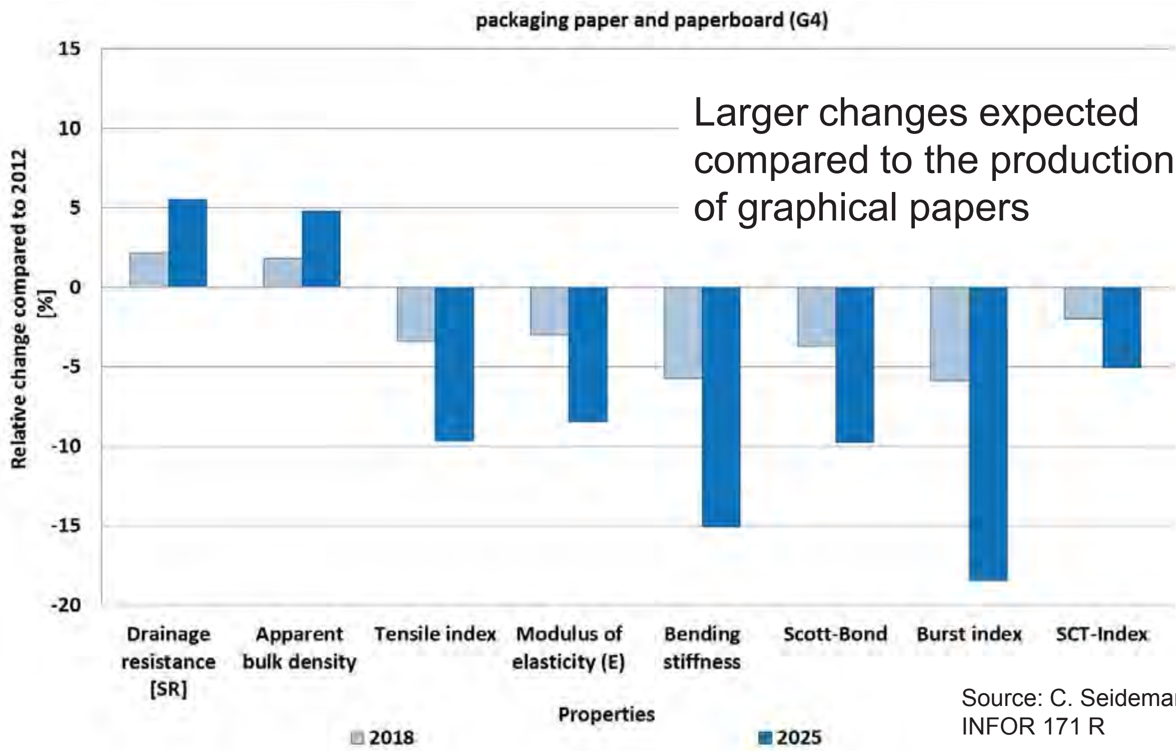
PfR will be one generation older on average

Strength properties to drop by 10 -15%.



Source: based on C. Seidemann et. al INFOR 171 R

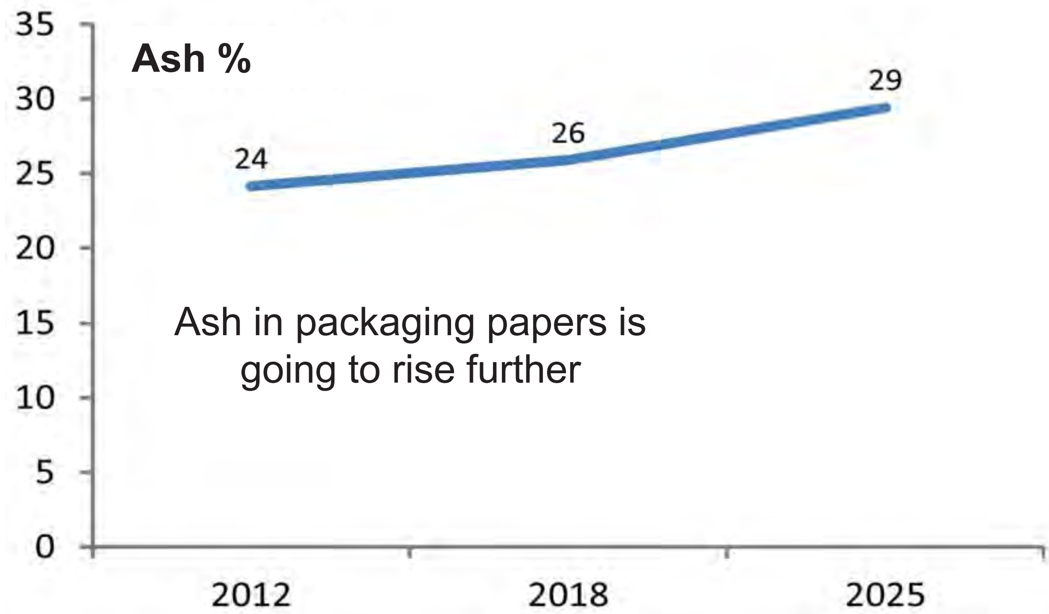
Impact on packaging paper and paperboard produced (predicted values, GER)



Larger changes expected compared to the production of graphical papers

Source: C. Seidemann et. al INFOR 171 R

Impact on packaging paper and paperboard produced (GER)

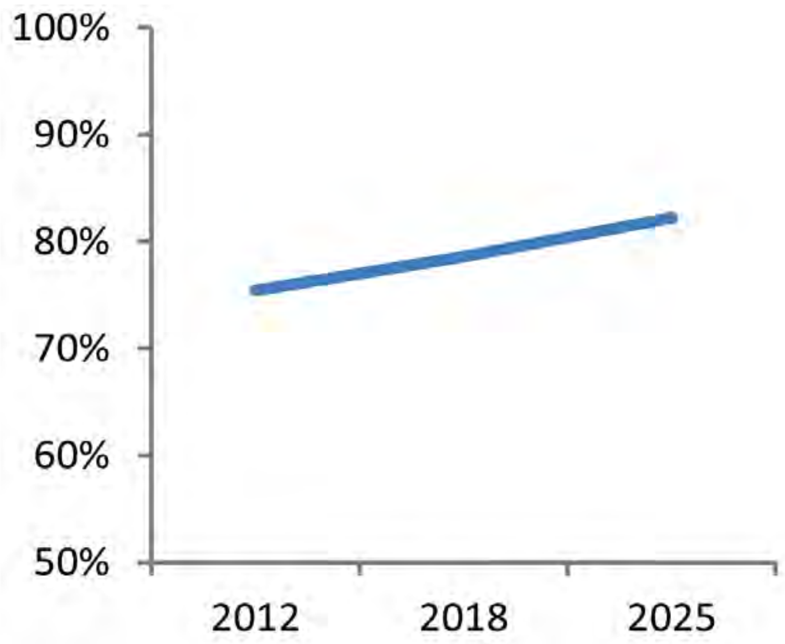


Ash in packaging papers is going to rise further

Source: INFOR 162, 171

The impact on our circular economy (GER)

PfR utilization rate



Forecast:
The utilization rate will increase above 80% in Germany.

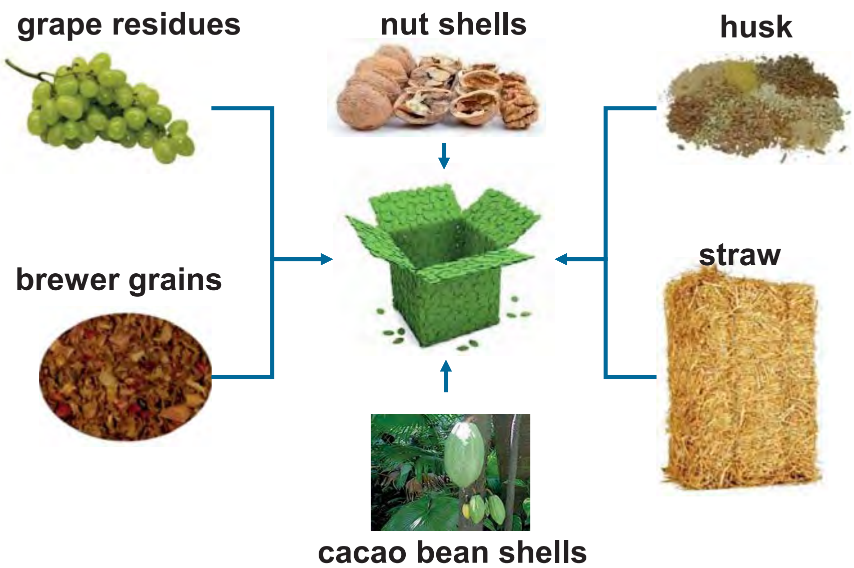
Where are the **limits of recycling**?
Will papermaking still work out?

(without hygiene and "other" paper grades)

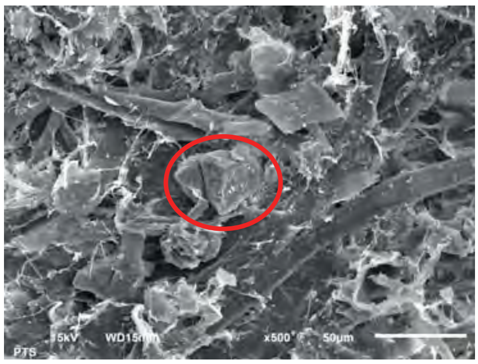
Source: VDP, C. Seidemann et. al. INFOR 171 R

Agricultural residues – a new threat?

Green packaging – Cheap packaging – Sustainable packaging?



More bulk but significantly lower strength



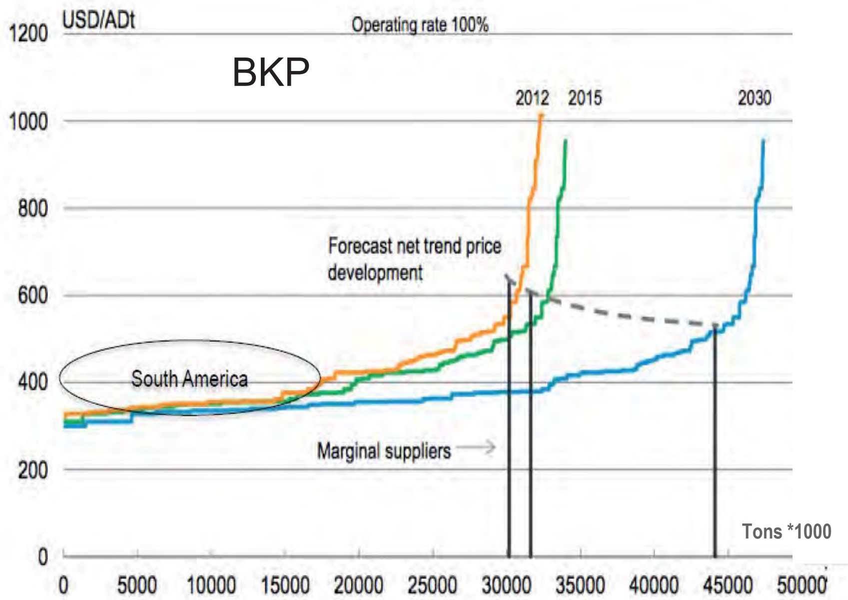
Contaminants – What is the next issue after mineral oil?

- **PAA (primary aromatic amines) contained in the coloring 7 printing of napkins (azo dye).**
- **Phthalates and its substitutes (DEHT, DINCH, …) contained in adhesives etc.**
- **Benzophenone caused primarily by an increasing amount of UV-prints (non-food applications)**
- **NIAS (non-intentionally added substances) added into products via pigments and chemical formulations**

And futheron:

- Bisphenol A and its substitutes
- Photoinitiators (Michler's Ketone, (Methyl-)Benzophenones …) contained in dyes and pigments
- Nanomaterials
- Xenobiotika / hormones, endocrine compounds
- Poly-/ perfluorinated organic compounds…

Will chemical pulp dominate the play?



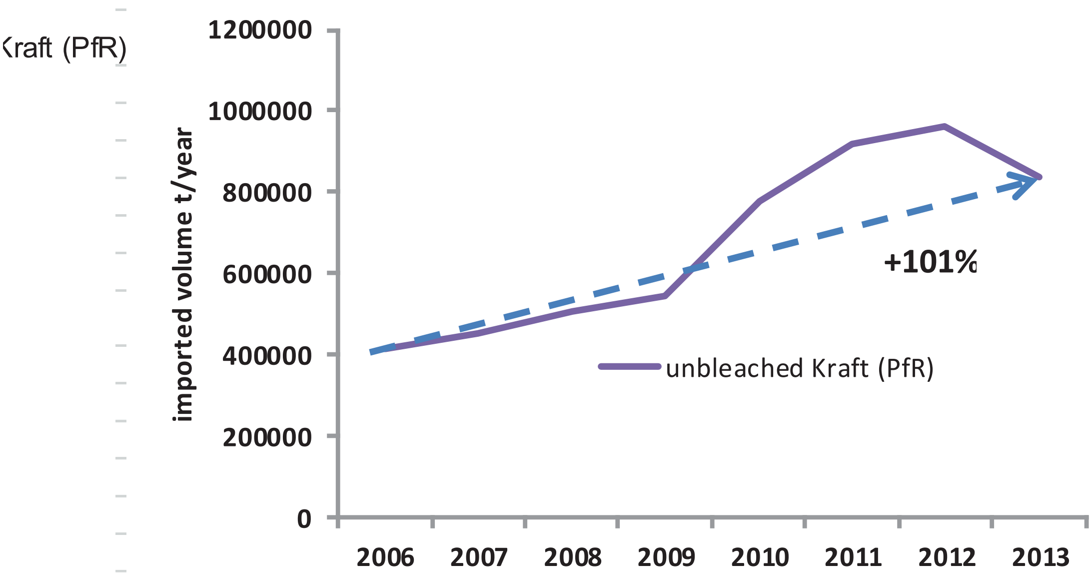
Source: Pöyry cited in “Virgin and Recovered Fiber Competitiveness”: Otavio Pontes – Biomaterials Business Area, bvse Altpapiertag 2013, Düsseldorf

Cheap chemical pulp are made available on European markets.

But: short fibre pulp from south America will not help to increase strength properties of PfR

Packaging paper mills react by buying imported kraft grades

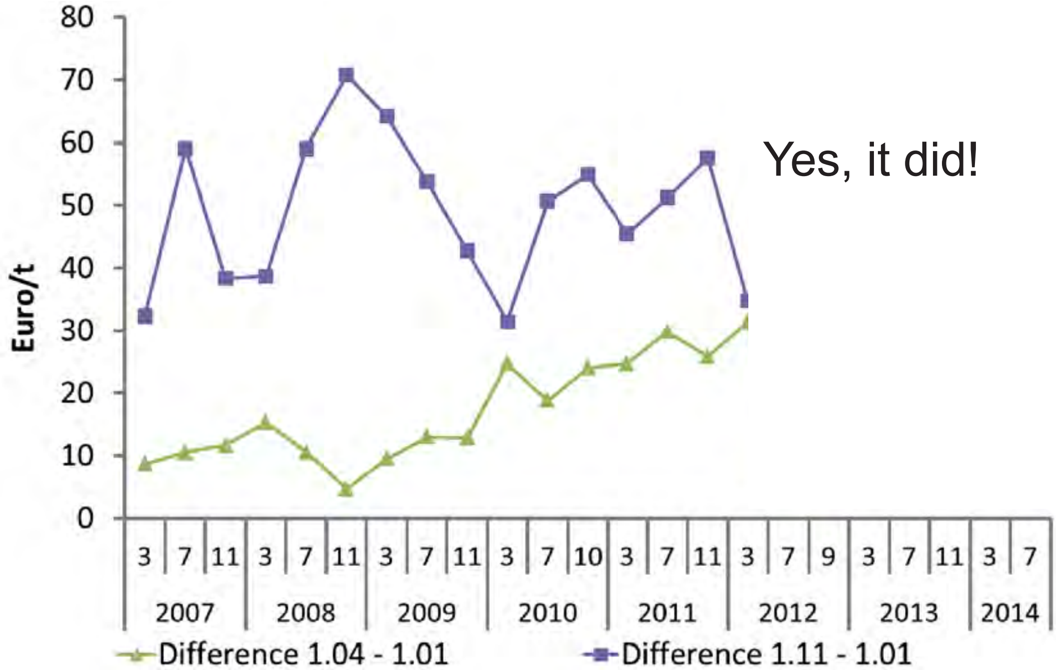
Significant increase of the imported volume of kraft paper for recycling to Germany – means to process the raw material properly are missing



Source: VDP Statistics

Does it pay of to sort PfR to the requirements of packaging grade producing paper mills?

Data: Germany, VDP

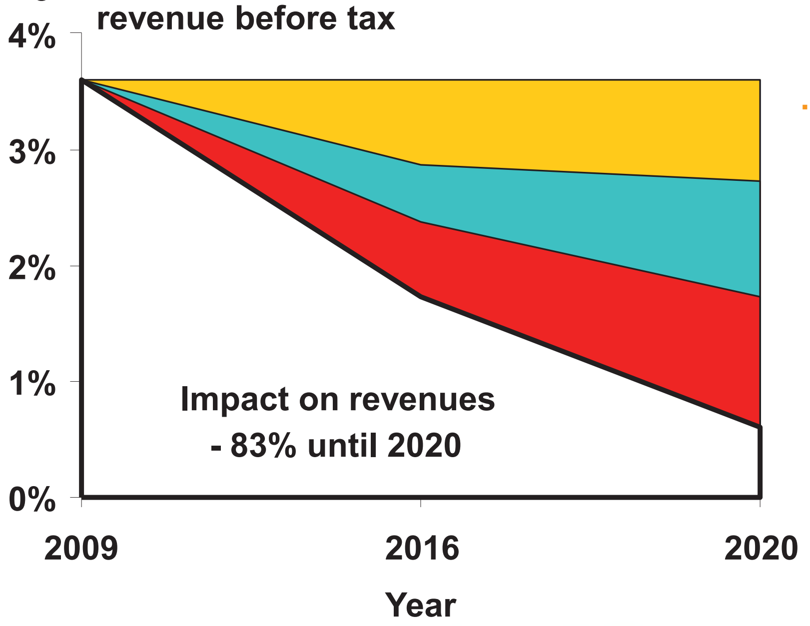


Yes, it did!

PTS FIBRE based solutions

The economic future of paper sorting?

The calculation is based on the assumption that sorting plant troughput is constant, change in input quality leads to less 1.11 being produced, higher variable cost and higher effort for baling of 1.04.



Basis:	62% 1.11; 21% 1.04
Sales:	68% of grade 1.11
	Price of 1.04 17 € below 1.11
	Price of 1.02 32€ below 1.11
Cost:	21% variable cost of sorting
	3% for baling

Efficient sorting: Key impact on quality of PfR

ENTSORGUNGSTECHNIK BAVARIA GmbH

Product 1.11

Recovered Paper

A new approach on automation of sorting plants

Gefördert durch:
Bundesministerium für Wirtschaft und Technologie
aufgrund eines Beschlusses des Deutschen Bundestages

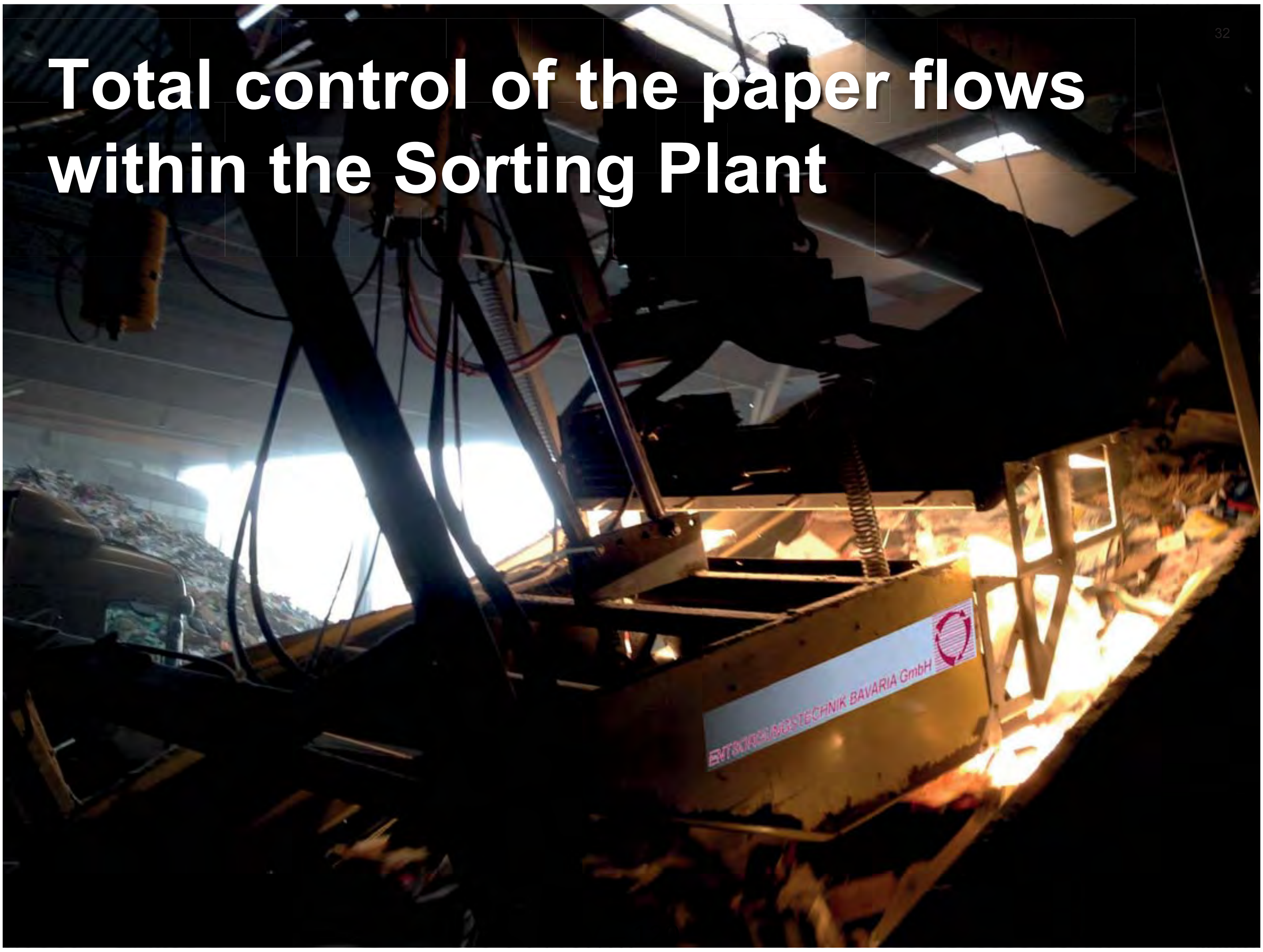
Questions to be solved

ENTSORGUNGSTECHNIK BAVARIA GmbH

For incoming material the variability is very high: Examples (Grade 1.01) at different days:

But:

- Not enough / no verified information on incoming quality
- Insufficient adaptation of production speed depending on change of incoming material
- Too little changes of operational set points of sorting plant stages as incoming material changes



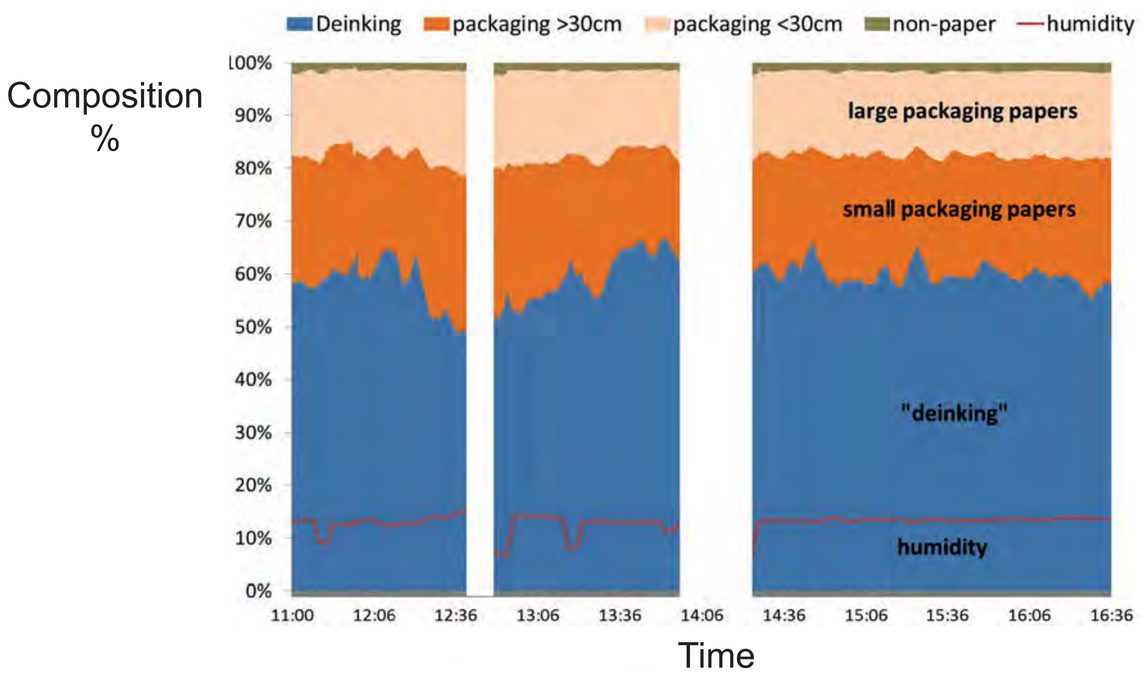
Features of the sorting plant controller

ENTSORGUNGSTECHNIK BAVARIA GmbH

- Online measurement combined with model based caculations:
- PfR-fractions (graphical paper, board etc.)
- Humidity
- Mass flows
- Size distributions
- Recommendations

Real data gathered in the installation

ENTSORGUNGSTECHNIK BAVARIA GmbH



Functionality of the controller

ENTSORGUNGSTECHNIK BAVARIA GmbH

Model enhanced Sensor:

- Quality of incoming material is measured as a maximum of up to 14 fractions of paper grades
- Either online Measurement or model based prediction of size distributions of PfR-fractions
- Model based mass flow prediction
- Compensation of de-mixing effect on conveyor band

Prediction of

- **Quantitative and written assessment of the incoming material**
- **Ability for sorting the paper**
- **Mass flow to optical sorting stages / bottle neck stages**

Recommendations on how to operate the system

Benefits

ENTSORGUNGSTECHNIK BAVARIA GmbH

- **Maximises throughput – increased productivity (<u>Keep operation at the upper tolerable production speed limit</u>)**
- **Reduction of still stands (too wet material etc.)**
- **Written recommendations on operational set points of the sorting stages**
- **Improved output quality**

Commment of the manager after 2 days of operation:
„Don‘t you ever turn it off again, please!“

More options on how sorting can support the improvement of the quality of paper for recycling

Monitored product quality:

100% control of the produced PfR
-> certified quality delivered to paper mill

Other sorting targets:

High quality packaging PfR

High brightness / woodfree PfR

Outlook

- The quality of PfR will change and both paper makers as well as recycling companies will have to adapt to it
- A good look on what is being produced as paper will tell what to expect on the raw material side as well
- Quality is a multidimensional issue – management of PfR needs some foresight and smart sensors to control it
- The sorting of paper still comprises lots of options for an improvement of quality of paper for recycling and the production of specific grades

Questions?

YOUR CONTACT

Dr.-Ing. Johannes Kappen
Division Manager
Resource Management
Phone +49 176 12146-162
johannes.kappen@ptspaper.de

Session on circular economy:

View of the Polish government on circular economy

Beata Kłopotek

MINISTRY
OF THE ENVIRONMENT

POLISH POSITION TO EU COMMUNICATION ”TOWARDS A CIRCULAR ECONOMY. A ZERO WASTE PROGRAMME FOR EUROPE”

Beata B. Kłopotek Ph. D.
Department of Waste Management
Cracow, 2nd December 2014

MINISTRY
OF THE ENVIRONMENT

Resource efficiency - documents

1. EUROPE 2020 A strategy for smart, sustainable and inclusive growth – COM(2010)2020
2. A resource-efficient Europe – Flagship in initiative under the Europe 2020 Strategy – COM(2011)21
3. Roadmap to a Resource Efficient Europe – COM(2011)571
4. THE 7th ENVIRONMENT ACTION PROGRAMME TO 2020 – ‘LIVING WELL, WITHIN THE LIMITS OF OUR PLANET’ – OJ L 354, 28.12.2013, p. 171

MINISTRY OF THE ENVIRONMENT

EU Communication – 1

Main goals:
- Sustainable growth
  - Effective and efficient management of resources
  - Sustainable reindustrialisation of the EU economy (sustainable industrial renaissance in the EU)

Main action:
- Moving from a linear model towards a more circular economy

Benefits:
- Savings
- Reduction of emissions and waste generation
- New jobs

3

MINISTRY OF THE ENVIRONMENT

EU Communication – 2

Barriers:
- Market barriers
- Existing infrastructure
- Business models and technology
- Established behaviour
- Lack of information
- Lack of confidence
- Lack of capacity to move to circular economy solutions

4

MINISTRY OF THE ENVIRONMENT

Setting up an enabling policy framework

Designing and innovating for a circular economy

- ❑ Additional data and reporting – fear of additional bureaucratic burdens
- ❑ New innovative technologies (also cost effective) – respect of technological neutrality

Unlocking investment in circular economy solutions

- ❑ Indicative 50% Green Public Procurement (GPP) target – fear of additional costs for state budget

Harnessing action by business and consumers and supporting SMEs

- ❑ Preparing of methodology of measuring the environmetal impact of products and organizations – insufficient real participation of SMEs and NGOs in consultations, ”geographical asymmetry” of participants in a pilot phase
- ❑ Increase of green jobs depends on varried factors

5

MINISTRY OF THE ENVIRONMENT

Modernising waste policy and targets: waste as a resource

Defining waste targets for a move to a recycling society

- ❑ Recycling targets should take into accout properties of materials; waste hierarchy is not only a 5-step-piramide but also includes life-cycle thinking (recycling in a ”sustainable” way); too ”ambitious” targets can cause down-cycling and export of waste

Delivering simplification and better implementation of waste legislation

- ❑ ”early warning system” – against rights of Member States to decide how to implement EU law
- ❑ ”tolerating more shipments of waste within the EU …” – against principle of proximity and principle of self-sufficiency
- ❑ ”third-party data verification”, „”mandatory electronic data interchange for waste shipments” – unclear

Tackling specific waste challenges

- ❑ Marine liter, food waste – no reliable data to establish targets

6

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Setting a resource efficiency target

- Resource productivity indicators, methodology of calculation of raw material consumption, targets – futher analyses are required.

7

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OF THE ENVIRONMENT

EMAS
Zweryfikowany system zarządzania środowiskowego

THANK YOU FOR YOUR ATTENTION

Beata B. Kłopotek Ph. D.
Department of Waste Management
Cracow, 2nd December 2014

Circular Economy Package – the paper industry's position

Ulrich Leberle

European Commission Proposal on a circular economy package: European Paper Industry‘s Position

Ulrich Leberle

CEPI Raw Materials Director

1

Outline

- Paper Recycling in a nutshell
- Targets
- Methods
- Definitions
- Additional measures
- Extended Producer Responsibility
- Conclusions

2

The circular economy package

What is it?

- Non-legislative communications and...
- Legislative Proposal to revise quantitative targets of
  - the Waste framework directive
  - the Packaging and packaging waste directive
  - the Landfill directive

3

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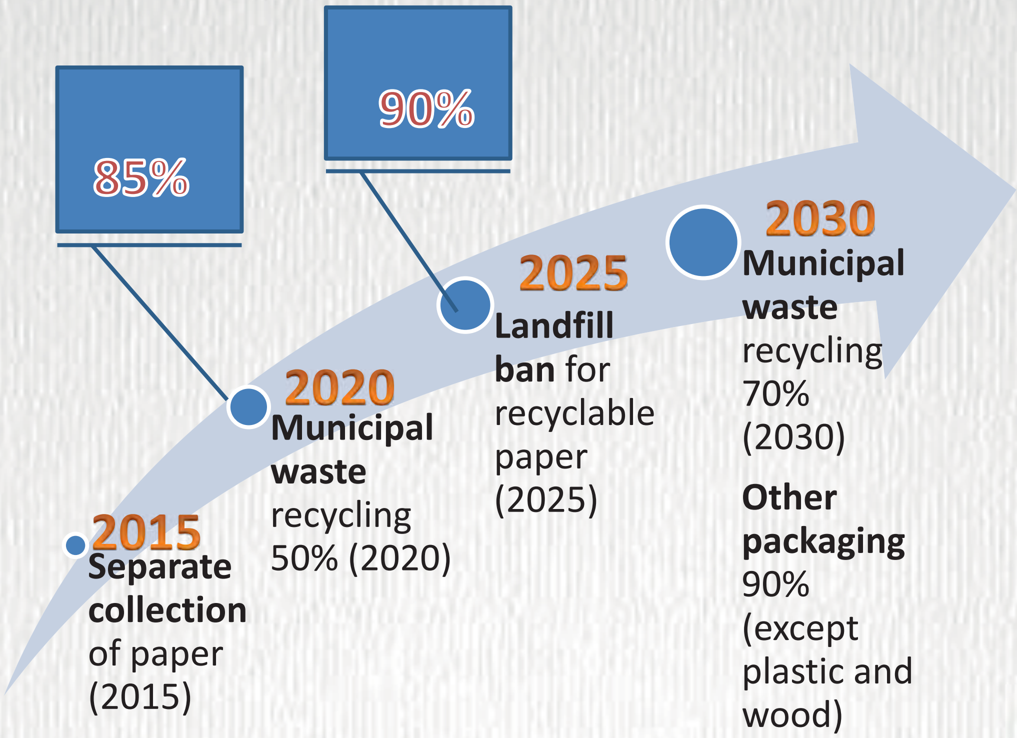
Commission Targets proposal



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Further main elements of the waste targets review

- Harmonized definition of municipal waste
- Harmonized calculation method of recycling rates
- Early warning system with yearly monitoring
- Extended producer responsibility: Minimum requirements for EPR schemes

5

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General Remarks

- Be bigger on big things and smaller and more modest on small things
- The move to the circular economy is not a small thing
- Resource efficiency and promotion of recycling needed for sustainable raw materials supply and competitive European industry
- We should continue discussing and improving the package

6

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Paper Recycling in a nutshell

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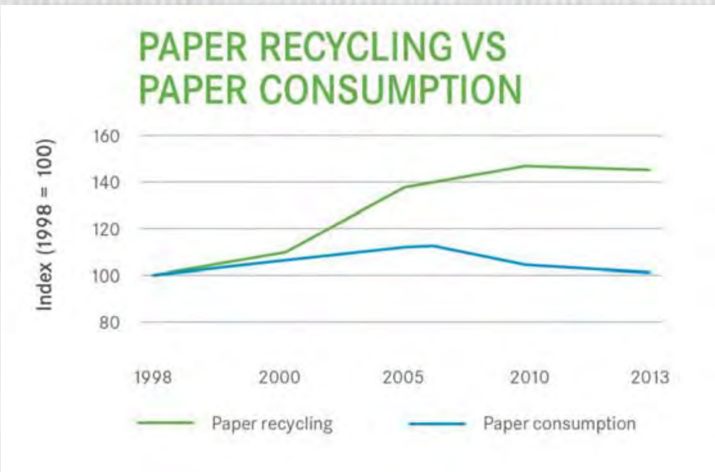
7

In other words...



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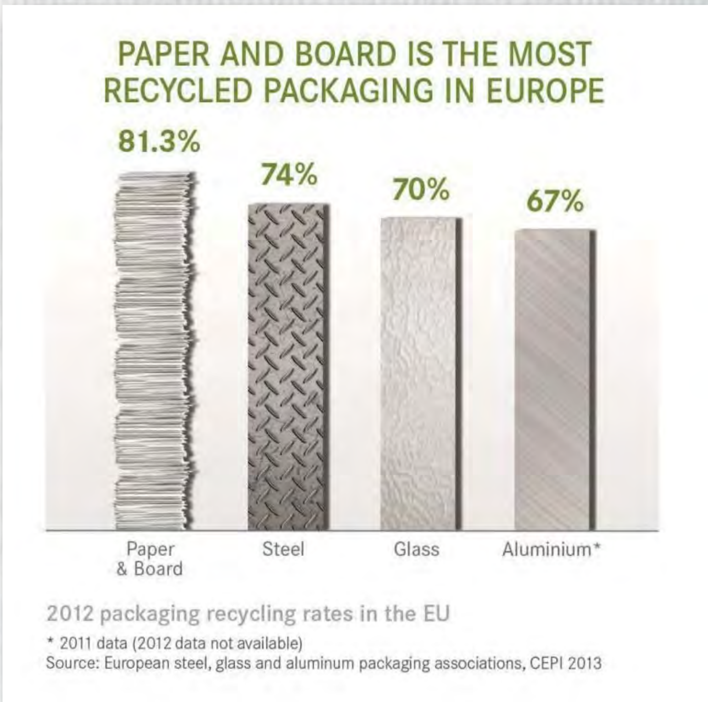
8

Strong regional differences

9

CEPI's view on targets

- Ambitious but realistic
- **80% paper packaging target 2020 as minimum** target in **all** Member States
- 2025 and 2030 targets once we know progress towards 2020 in the new framework
- No discrimination between consumer packaging materials
- No material should compensate for others in a Member State's overall calculation



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Calculation methods

- Focus on high quality recycling
- Distinguishing clean from less clean final recycling processes is the right approach
- For paper the input method should apply, but with strict quality requirements

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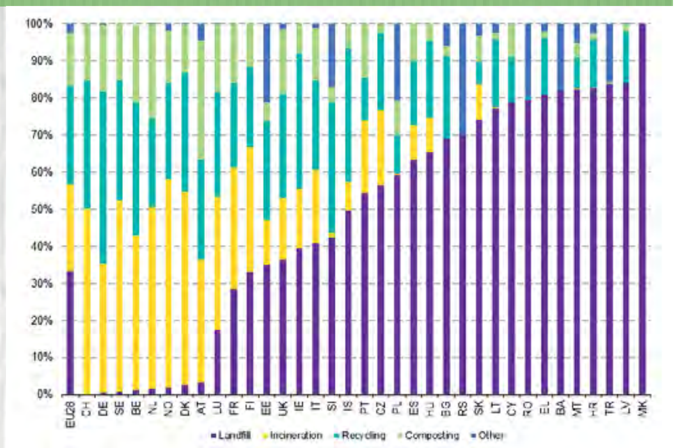
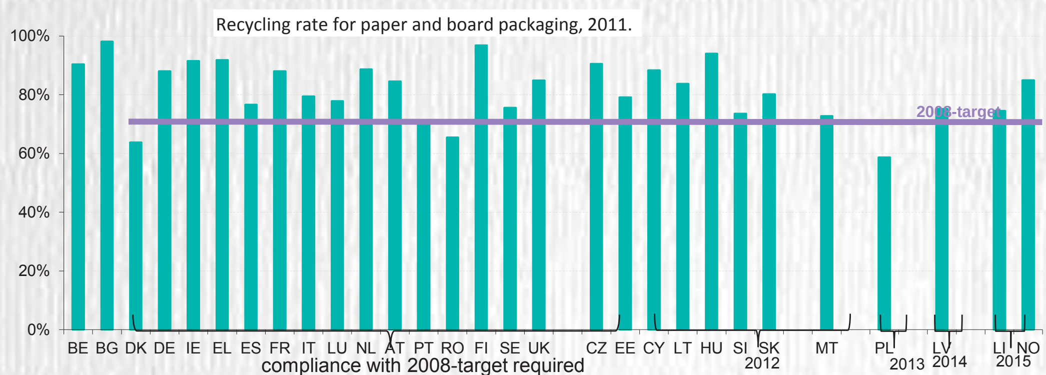
11

Calculation methods

- Reference to standard rather than a given percentage. EN 643 covers input to paper industry
- EN 643 to apply also to exports
- Harmonised method for the calculation of the recycling rate needed





Source: Eurostat

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Definitions

- Definition of recycling too broad
- Final recycling to be specified
- Definition of municipal waste should not include retail waste

13

Complementary measures

- Separate collection=

separate paper not only from waste, but also from other recyclables

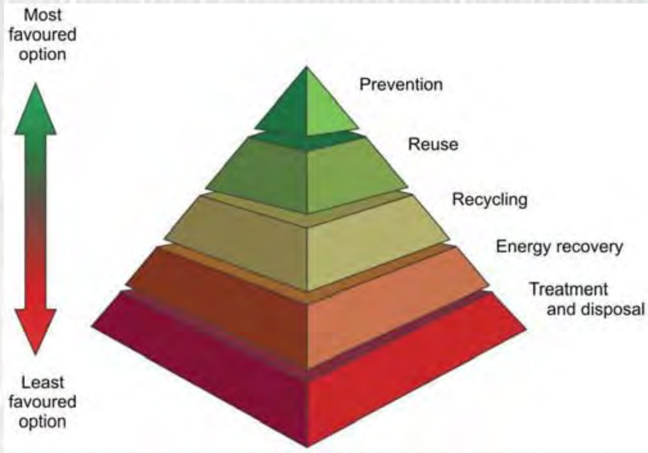
- IMPACT =

Paper Industry‘s Raw Materials Commitment

14

Complementary measures

- Landfill ban for recyclable waste a condition but not enough
- Incineration restrictions are needed



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Complementary measures

Extended Producer Responsibility

- Minimum requirements
- Consideration of sales revenues from collected materials
- Concerns on secondary legislation in this field

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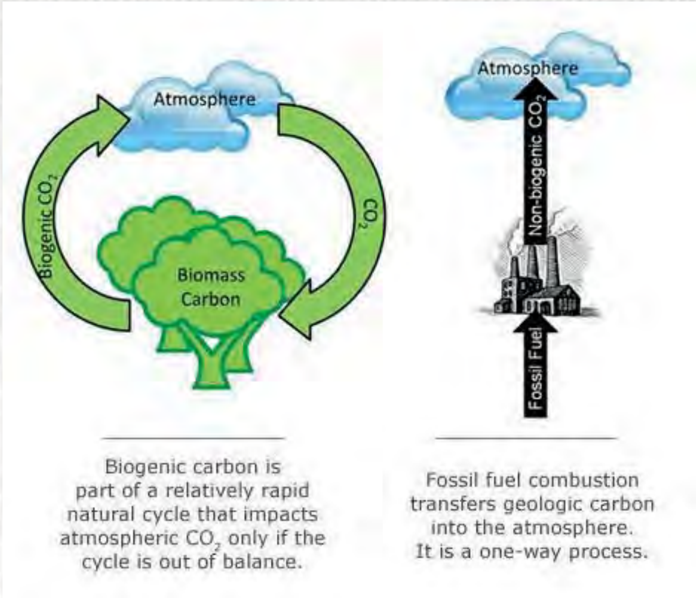
And one more thing:

- Renewability is not considered in the circular economy package.
- Renewability should be considered, e.g. in packaging ecodesign options for MS.
- Apply circularity one step earlier: Renewability should be acknowledged as contributor to the resource efficiency objectives.



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Conclusions

- We welcome intentions for meaningful recycling, but enabling measures are needed:
  - minimum targets that are ambitious but realistic and do not discriminate between materials!
  - Comparable data, reference to standards (EN 643)!
  - Strengthen separate collection, restrict incineration!
  - Enable EPR that is effective, transparent and inclusive!
  - Nature's circularity concept is renewability!
  - The Commission's proposal should be further discussed!

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ME RECYCLABLE YOU

Thank you!

u.leberle@cepi.org

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Recyclability of packaging products – test method, scorecard and results

Hans-Joachim Putz

Recyclability of Packaging Products – Test Method, Scorecard and Results

Dr.-Ing. Hans-Joachim Putz, Dipl.-Ing. Saskia Runte

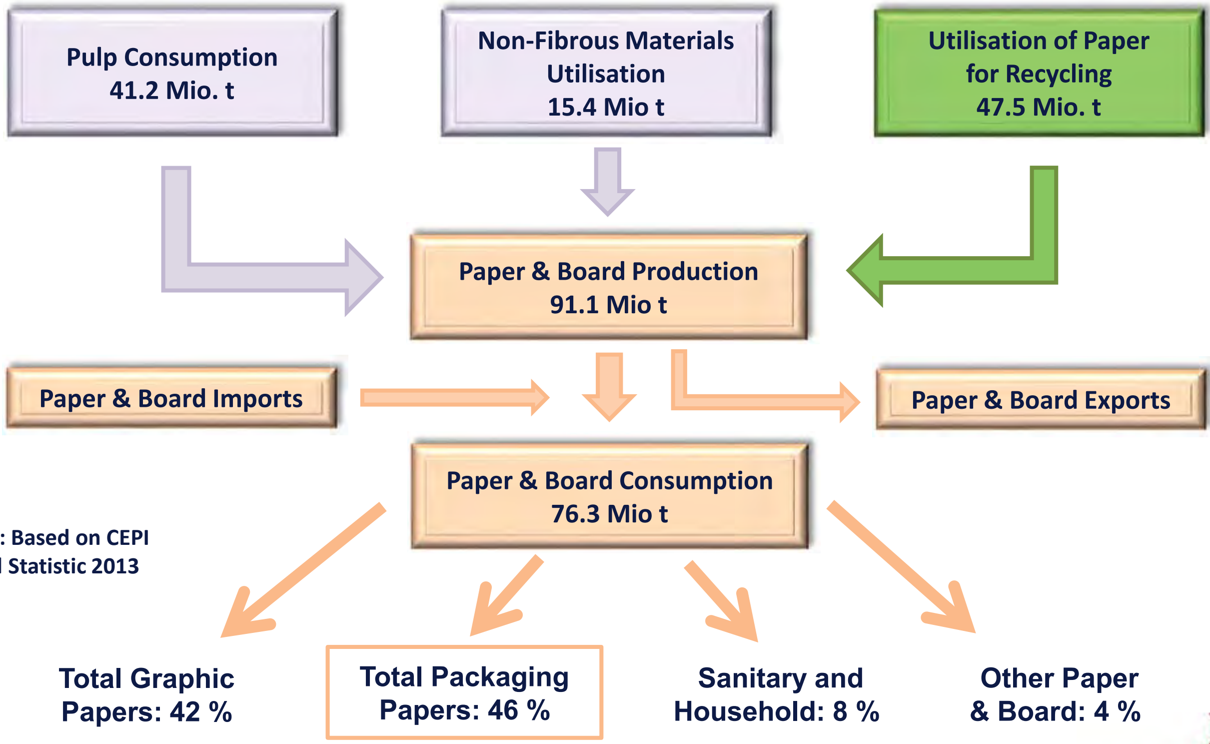
EcoPaperLoop Project Final Conference

Krakow, December 2nd 2014

Content

- Paper for Recycling – Demand, Production and Recycling
- Recyclability Test for Packaging Products
- Results of Recyclability Test of Packaging Products
- Score Card (Draft 5)
- Conclusions

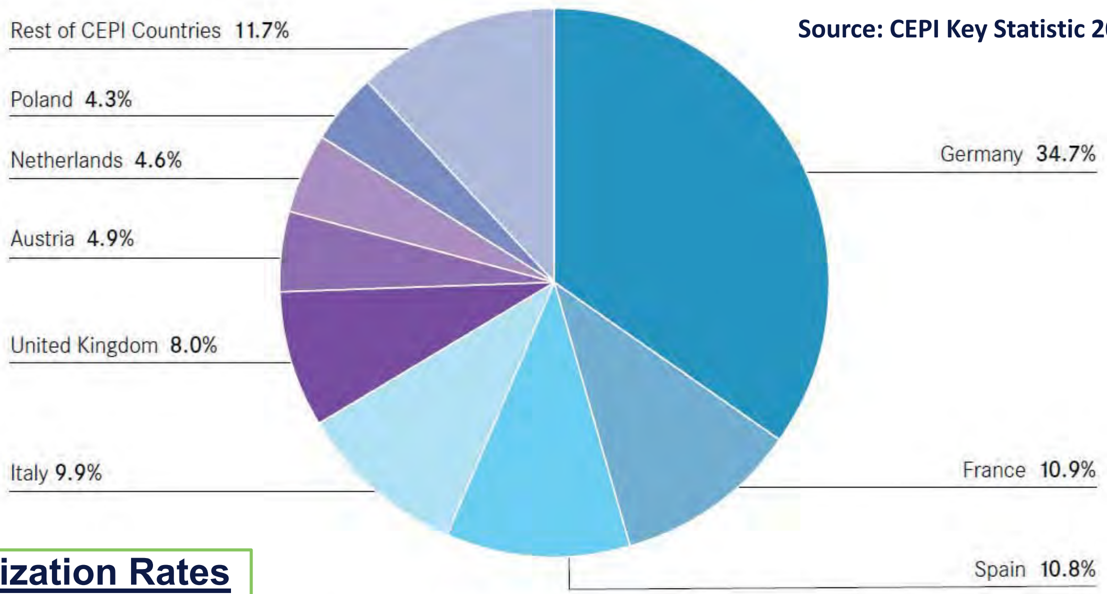
From Raw Material to Paper for CEPI Countries 2013



Source: Based on CEPI Annual Statistic 2013

CEPI Utilisation of Paper for Recycling (PfR) by Country in 2013

Source: CEPI Key Statistic 2013



Total Utilisation of Paper for Recycling: 47.5 Million Tonnes

PfR Utilization Rates

CEPI: 52.1 %

Germany: 73.6 %

Poland: 50.4 %

Challenges of Paper Recycling

Products have to achieve certain requirements in order to ensure improved recycling loops

- **Repulpable – important for all types of paper products**
- **Adhesives have to be removable – important for all types of paper products**
- **Deinkable – important for all graphic paper grades**

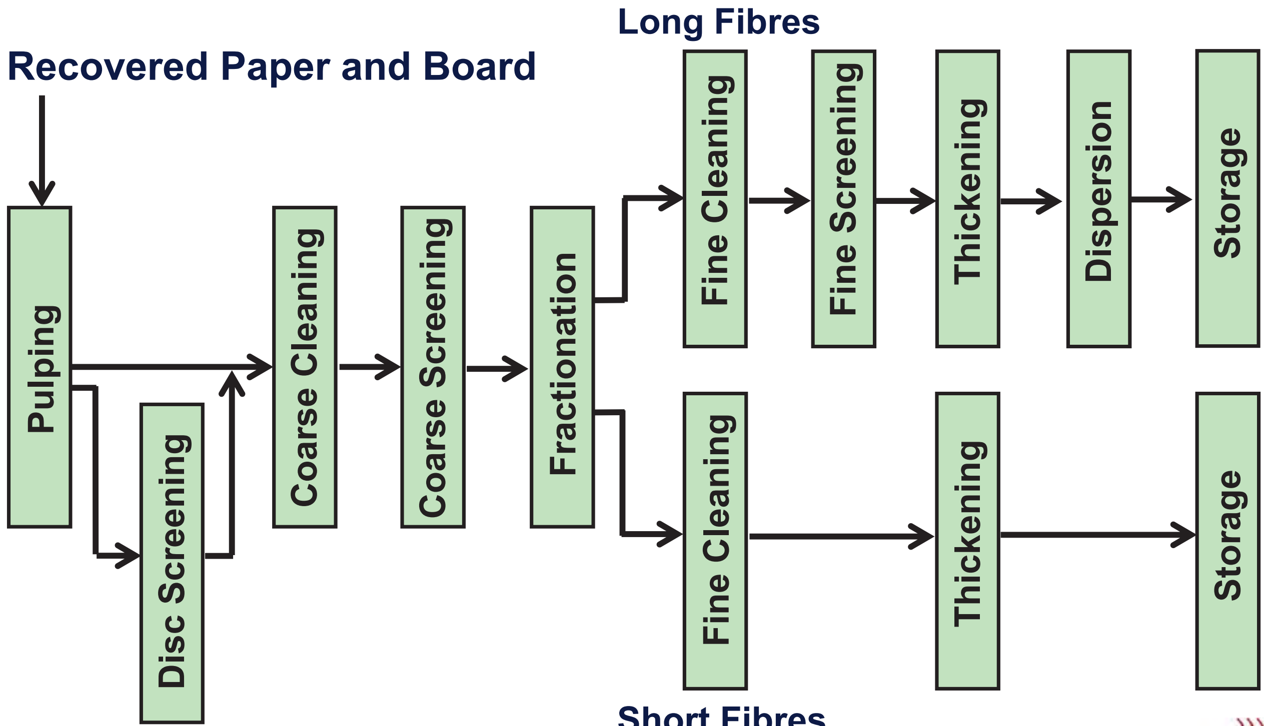
➢ **Test methods are needed to simulate a standard stock preparation**

Documents on Recyclability – Overview

	Test Methods	Assessment Schemes
Graphic Products	INGEDE Method 11 & 12 Assessment of – Print product deinkability – Fragmentation behaviour of adhesive applications PTS Method PTS-RH 021/97	Assessment of Print Product Recyclability – Deinkability Score – Adhesive Removal Score
Packaging Products	PTS Method PTS-RH 021/97 Aticelca MC 501-13 EcoPaperLoop Method 1 Recyclability Test for Packaging Products	Score Card for Recyclability of Packaging Products (Draft)

Recyclability Test for Packaging Products

Typical Standard Stock Preparation for Packaging Products



Typical Packaging Products

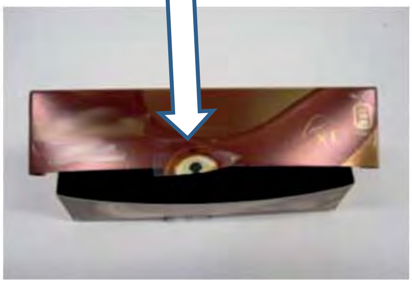
Non-paper product material

e. g. “window foils”

e. g. composite materials

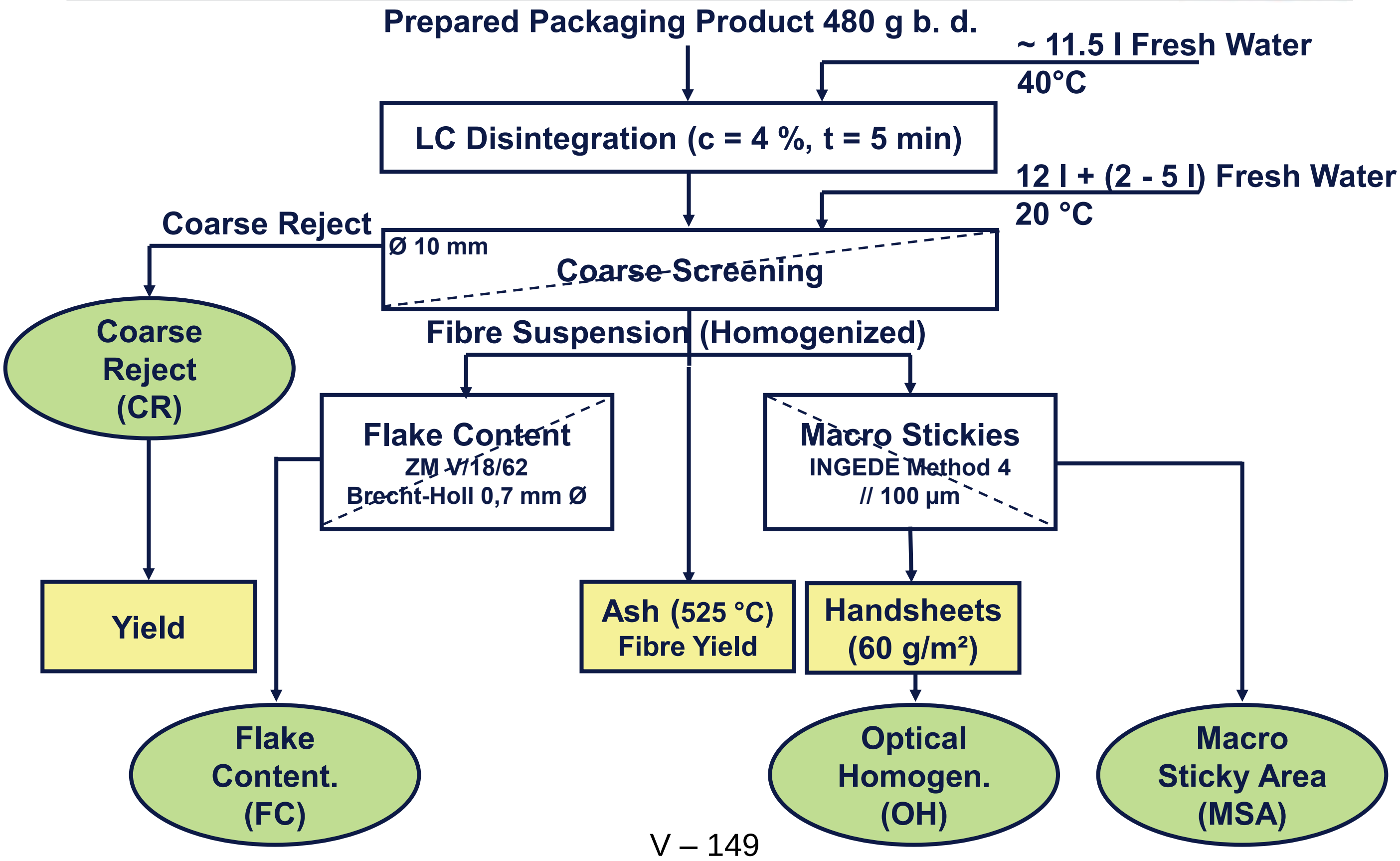
Glued parts

e. g. Hotmelts or adhesive stripes



→ A problem for a standard paper for recycling stock preparation?

Recyclability Test for Packaging Products (EPL Method 1)



Major Equipment

LC Disintegration

Coarse Screening

Flake Content & Sticky Evaluation

Results of Recyclability Test of Packaging Products

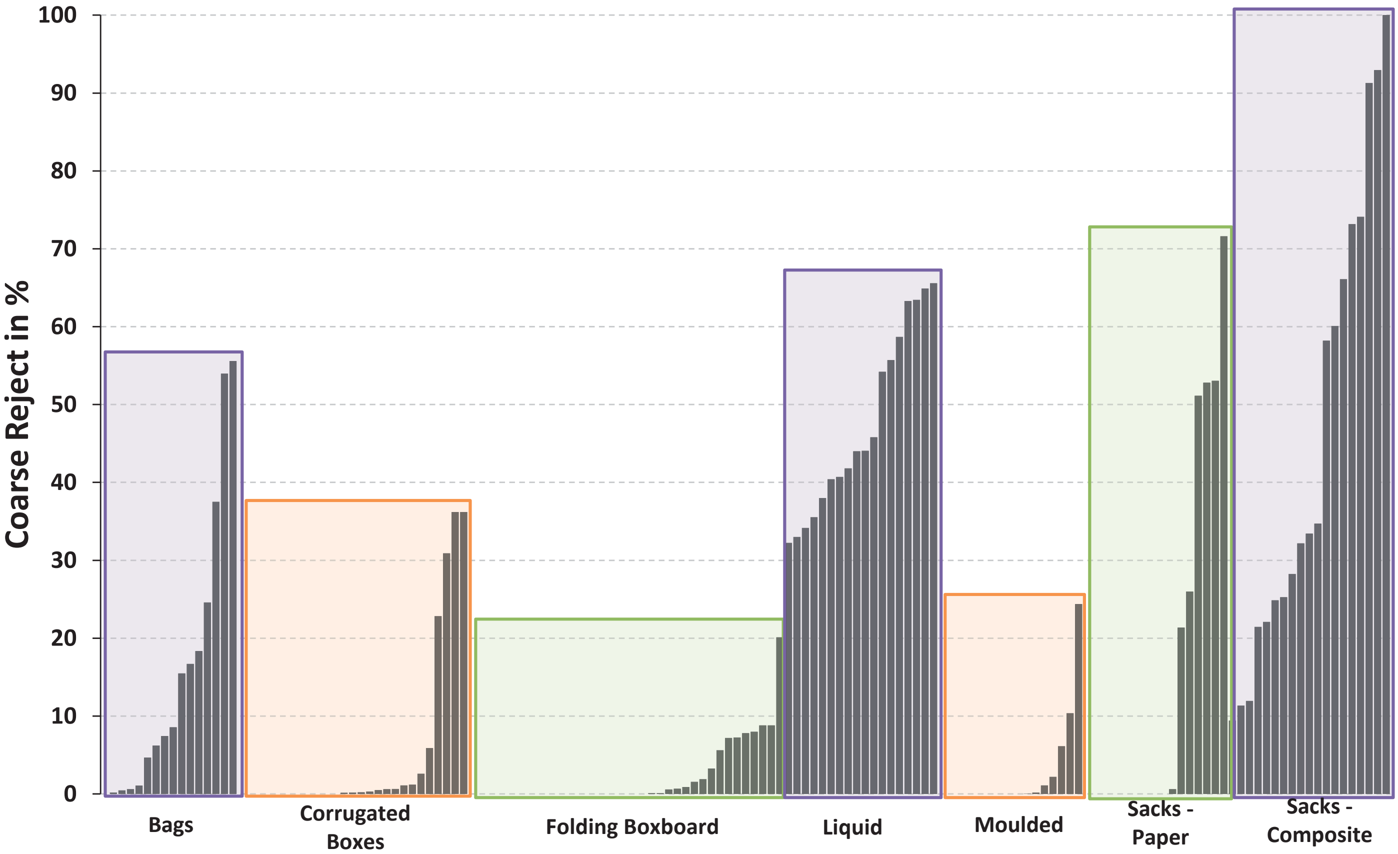
Investigated Product Groups

- Corrugated Boxes
- Folding Boxboard (for froozen food and other applications)
- Bags (with handles)
- Moulded Products
- Sacks (pure paper)
- Sacks (with composite materials)
- Liquid packaging
- Others

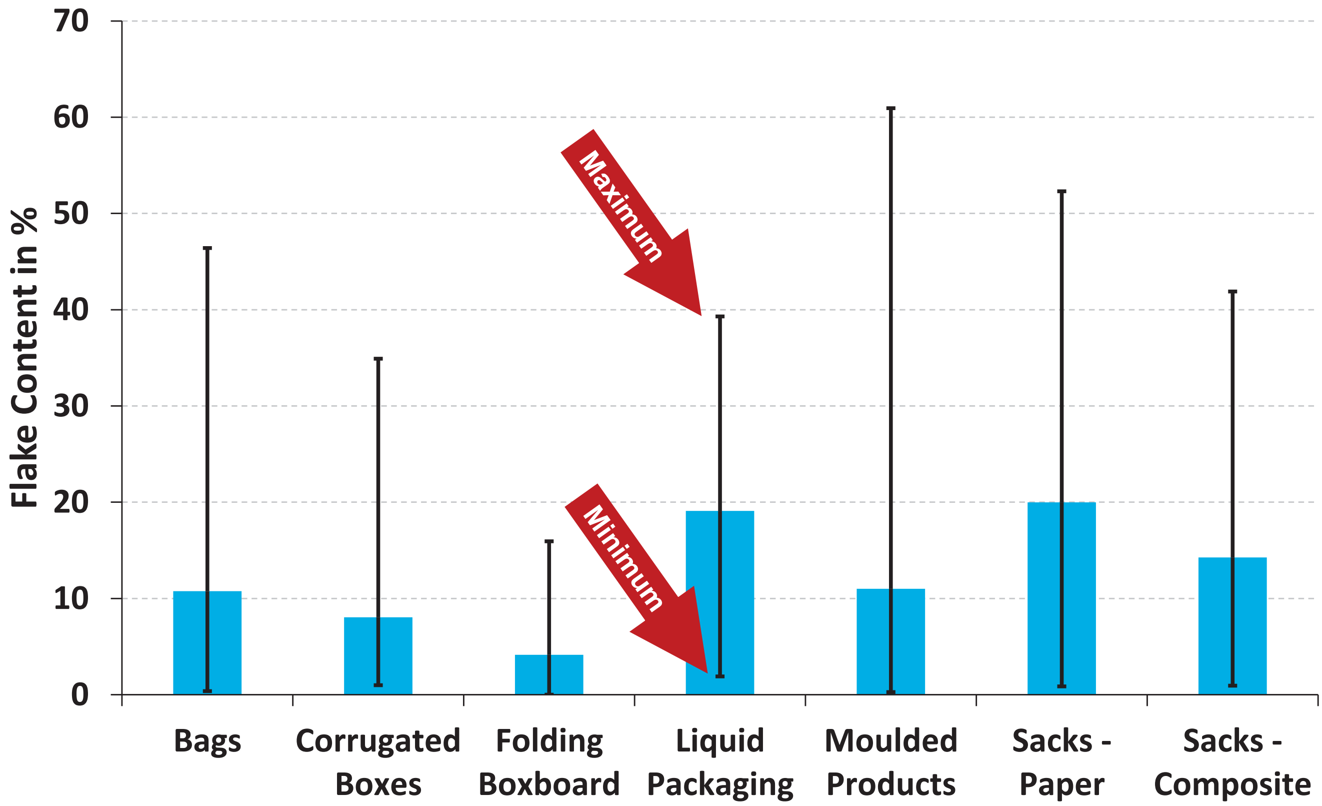
Investigated Parameters

- Coarse Reject (CR): coarse screening with 10 mm holes
- Yield of coarse screening
- Flake Content (FC): screening with 0,7 mm holes of the coarse screening accept
- Ash of the coarse screening accept
- Fibre Yield of the coarse screening accept
- Macro Sticky Area (MSA): screening with 100 µm slots of the coarse screening accept
- Optical homogeneits: visual inspection of handsheets of the macro sticky screening accept

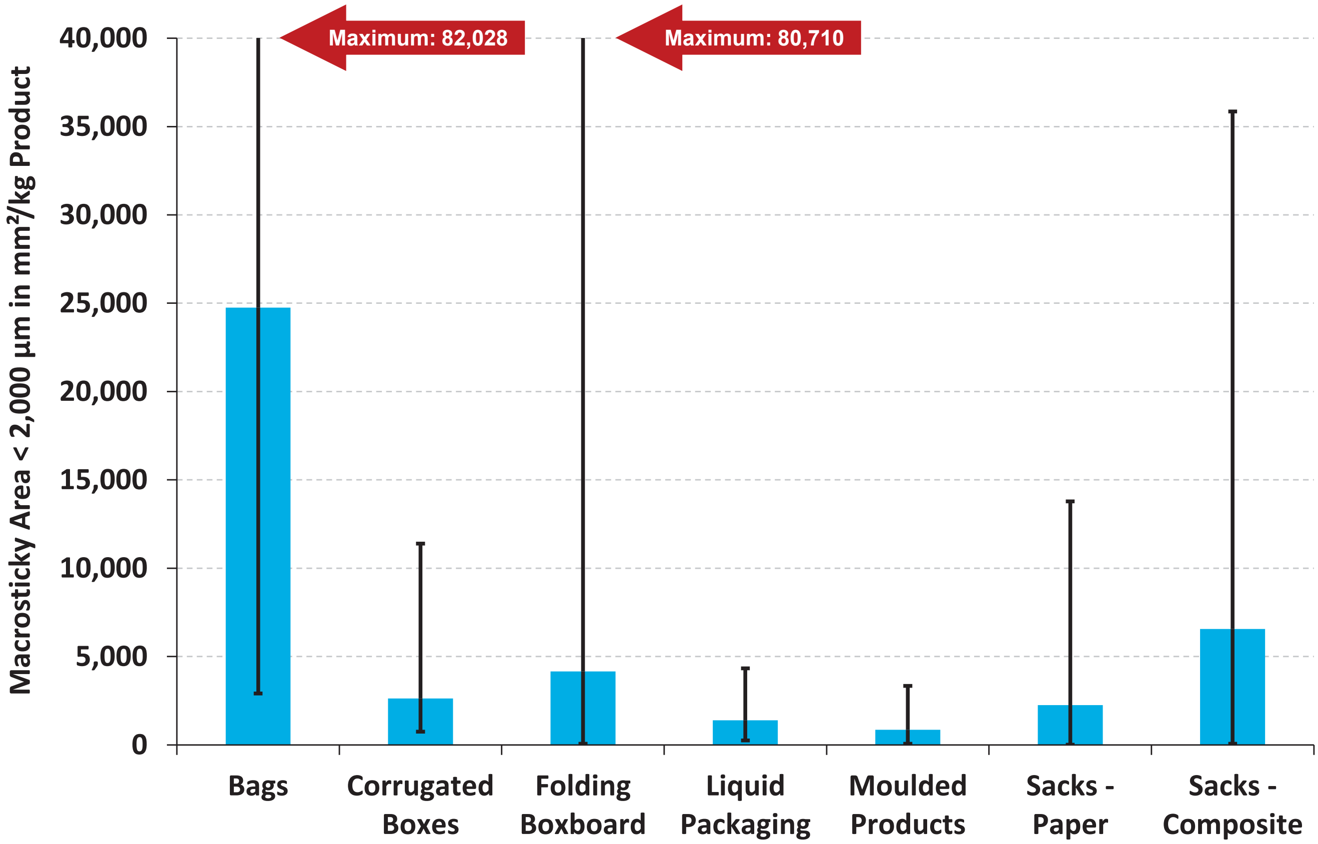
Coarse Reject of tested Packaging Products (Tested until 10.2014)



Flake Content of tested Packaging Products (Tested until 10.2014)



Macrosticky area of tested Packaging Products (Tested until 10.2014)



Score Card (Draft 5)

Recyclability Score Card (Draft 5)

Evaluation of recyclability for further improvements in material recycling within the paper industry

- **Products should be tested with final industrial seal**
- **Applicable to paper and board group 1 to 5 (acc. to EN 643) and not for paper products which are usually intended for deinking purposes**

Recyclability test have to be obtained according to

- **EcoPaperLoop Method 1 or**
- **ZELLCHEMING Technical Leaflet RECO 1 1/2014**

Recyclability Score Card (Draft 5)

- **Differentiation of 9 packaging product categories (Bags, Corrugated Boxes, Moulded Products, …)**
- **Evaluation of 4 tested parameters from recyclability test**

Parameter	Coarse Reject (CR)	Flake Content (FC)	Macro Stickies Area (MSA)	Optical Homogen. (OH)	Total
Maximum Score	35	15	40	10	100
	Process Parameters		Quality Parameters		

- **Definition of threshold and target values (except optical homogeneity) for each packaging product category are under discussion**

→ **Recyclability Score from -100 to + 100**

Recyclability Score Card (Draft 5)

Eco Paper Loop

Calculation of recyclability score according to achieved results

- **Comparable to Deinkability Score of ERPC**
- **Maximum score per parameter for all figures below target value**

Packaging Recyclability Score	Evaluation of Recyclability
71 to 100 Points	Good
51 to 70 Points	Fair
0 to 50 Points	Tolerable
Negative (failed to meet at least one threshold)	Not suitable for use in paper industry

Evaluation for the negativ score is still under discussion!

- **Another possible statement could be: „Not suitable for use in a standard paper mill*."**

  *** Product should be supplied as separate paper for recycling grade and further investigations required for final assessment of the recyclability"**

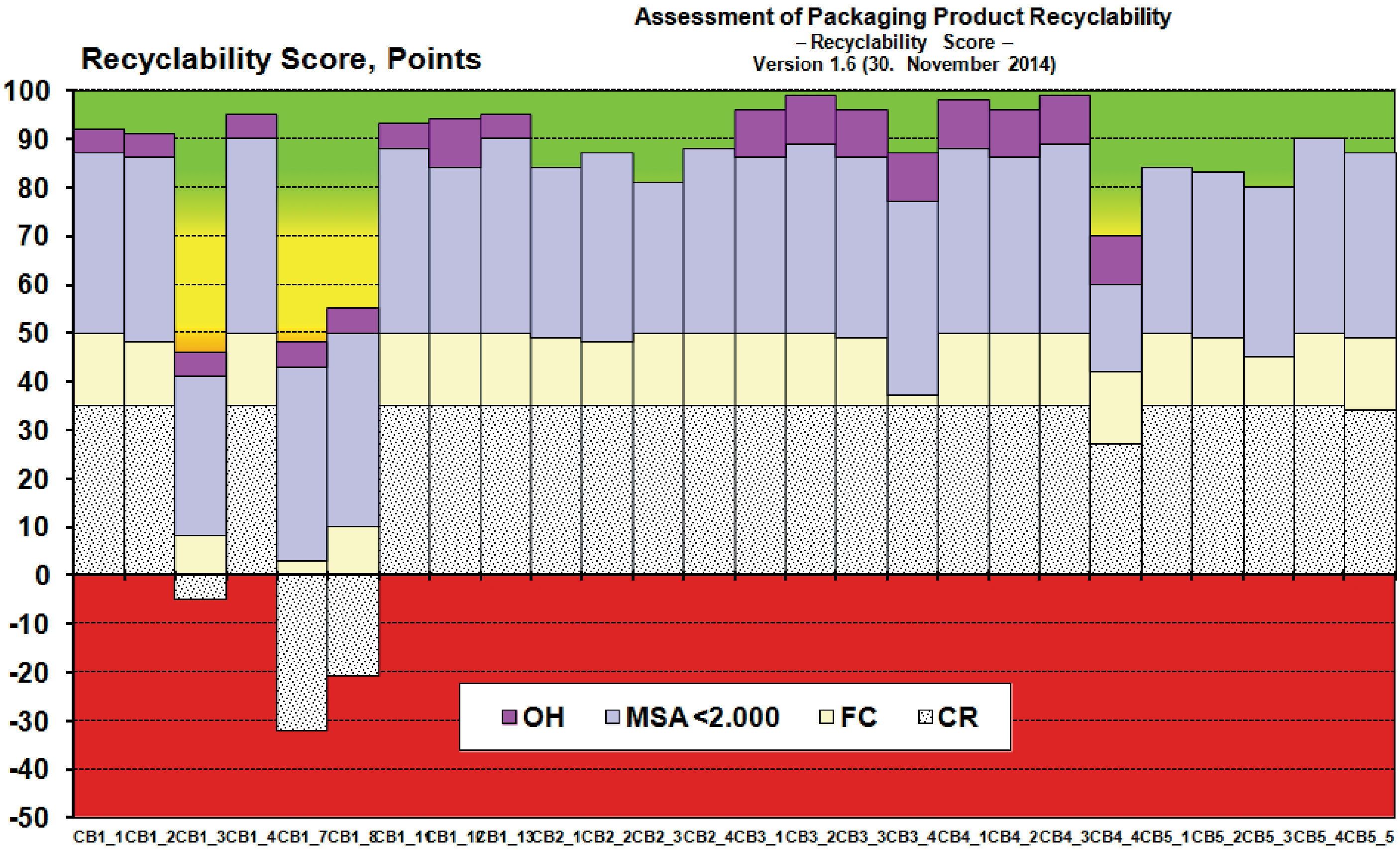
Overview of the Results

Minimum Value - (Mean Value) - Maximum Value

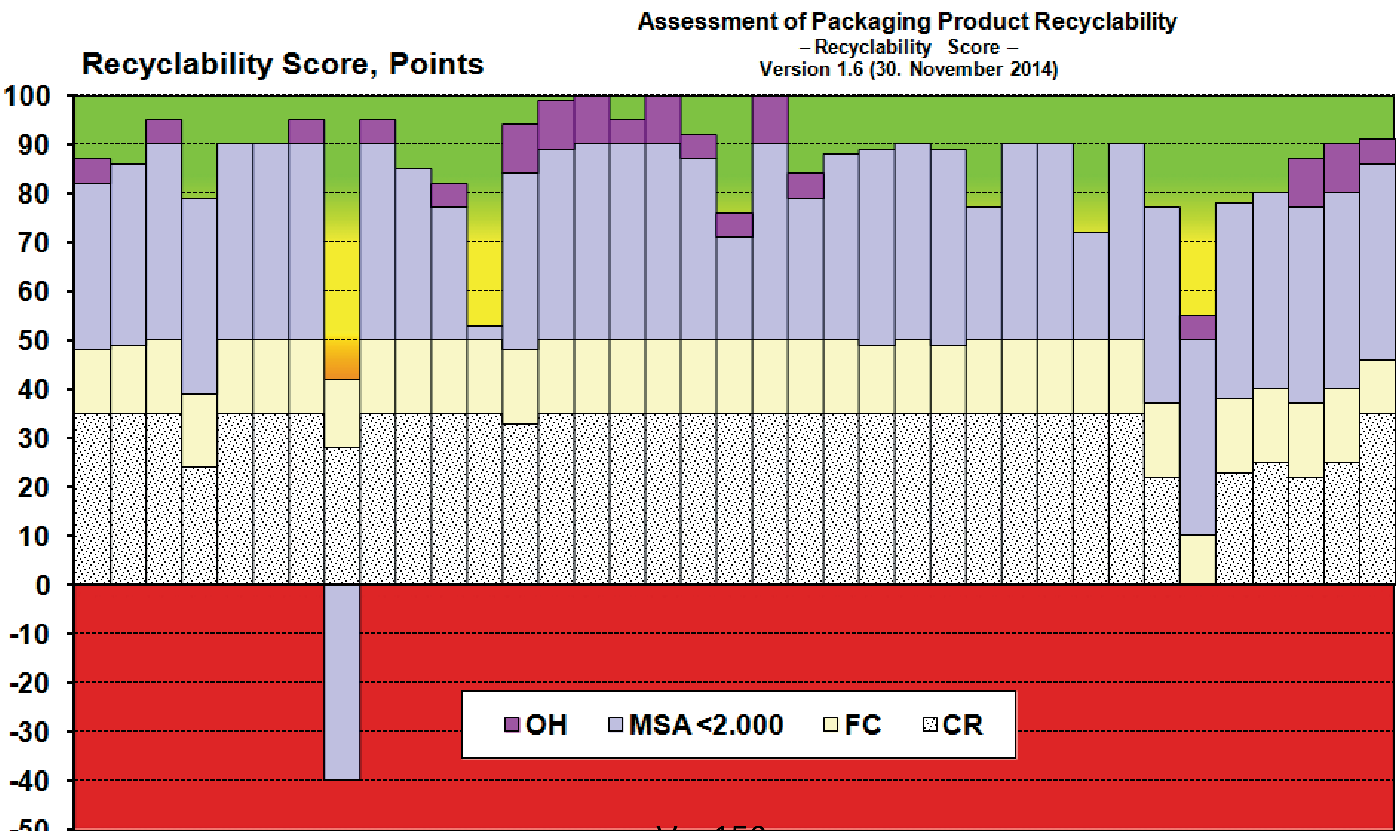
Eco Paper Loop

	Tested Products as No.	Coarse Reject in %	Flake Content in %	Sticky Area in mm²/kg < 2.000 µm
Corrugated Boxes	26	0 - (4.0) - 36.2	1,0 - (8.0) - 34.9	744 - (2,632) - 11,392
Folding Boxboard	36	0 - (2.2) - 20.1	0 - (4.2) - 15.9	200 - (4,551) - 80,710
Bags (handles)	16	0 - (15.7) - 55.6	0.4 - (10.8) - 46.4	2,904 - (24,755) - 82,028
Moulded Products	17	0 - (2.8) - 24.4	0.3 - (11.0) - 60.9	68 - (860) - 3,341
Sacks (paper)	17	0 - (16.3) - 71.6	0.9 - (20.0) - 52.3	8 - (2,254) - 13,779
Sacks (composite)	21	9.4 - (45.8) - 100	0 - (14.3) - 41.9	66 - (6,555) - 35,848
Liquid Packages	19	32.3 - (48.8) - 65.6	1.9 - (18.5) - 41.1	250 - (1,349) - 4,338
Others	7	0 - (11.4) - 38.1	2.0 - (7.1) - 28.4	115 - (14,851) - 53,967

Example of Score Points for Corrugated Boxes



Example of Score Points for Folding Boxboard



Conclusions

- Mainly packaging and graphic paper products are produced in the European paper industry
  → Paper for recycling is the major raw material for paper production
- A recyclability method was developed to benchmark the recyclability of packaging products in laboratory scale
  → Simulates conditions close to an industrial process of a standard stock preparation line
- Results of 159 investigated products show high deviations of the tested parameters within the same packaging category and between the various categories
- A score card for the assessment of the recyclability of packaging products is proposed within EcoPaperLoop, but has to be finalized by discussions between the industry partners of ERPC

Example of a Recyling Friendly Packaging Material

Thank you for your attention

For further information contact

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Deinkability of graphic products – news and results

Andreas Faul

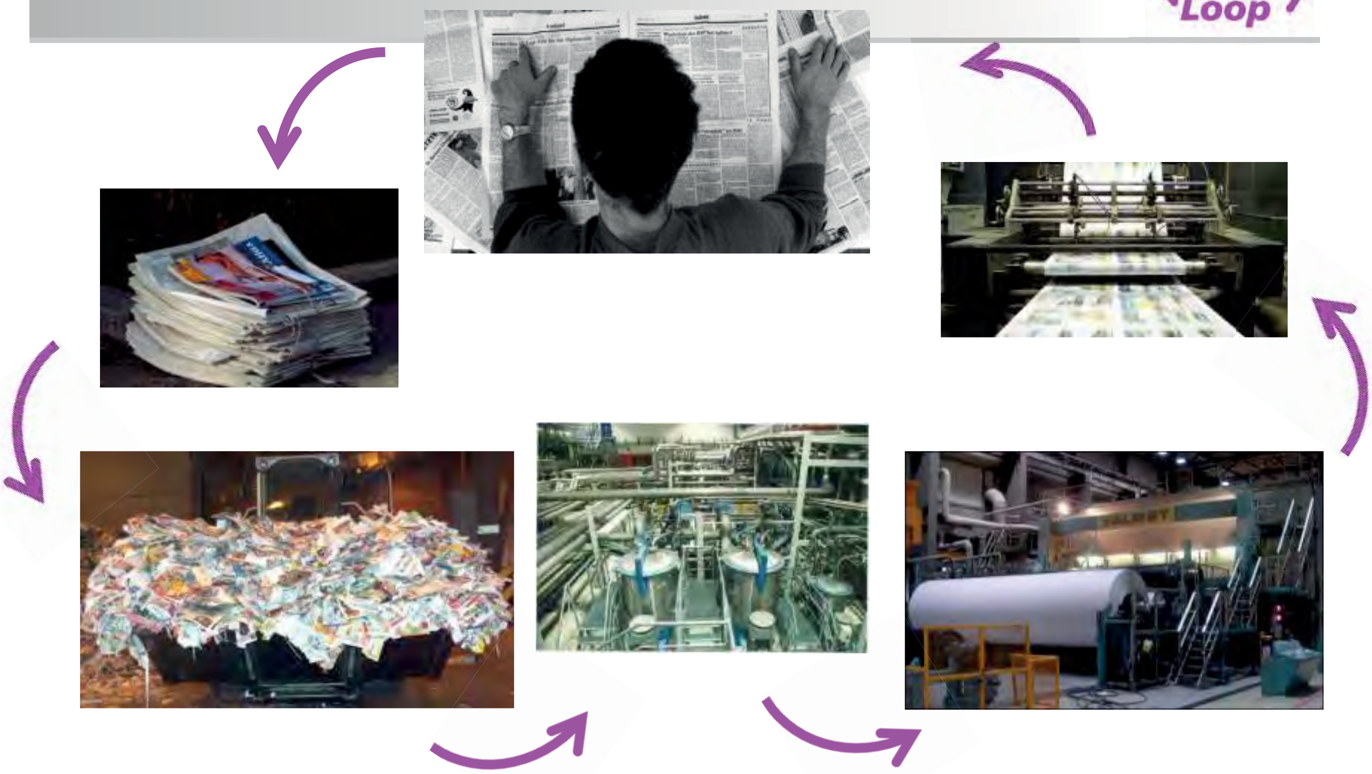
Eco Design for the Enhancement of Central Europe
Paper Based Products Recycling Loop

Deinkability of graphic products – news and results

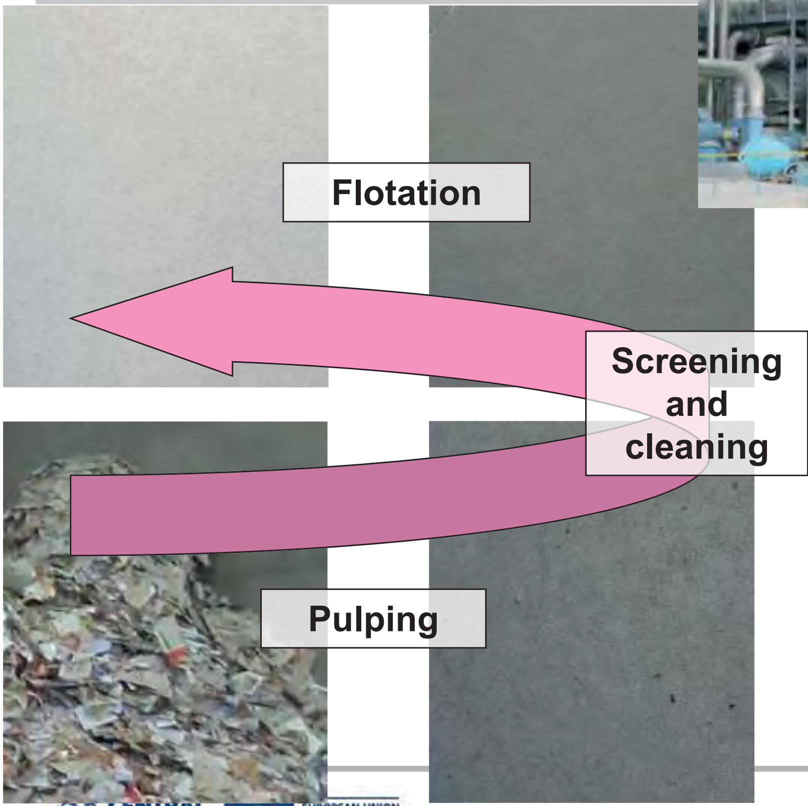
Andreas Faul

Krakow, 03 December 2014

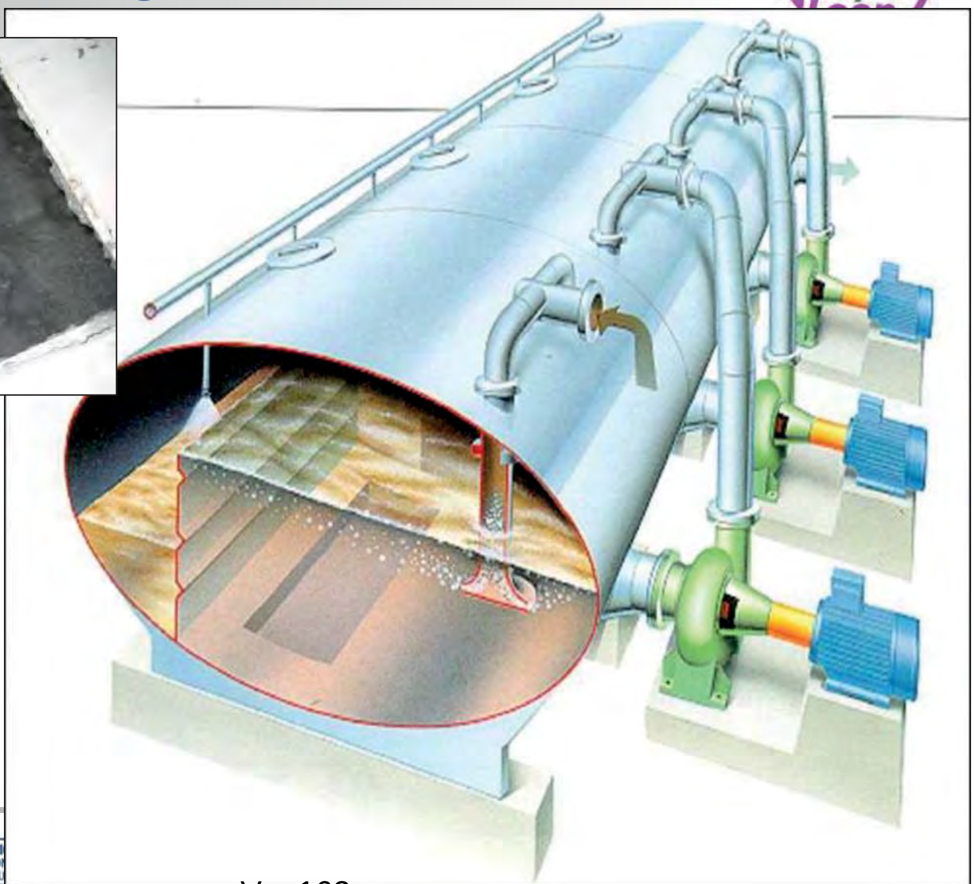
Why Deinking?



Principal process steps in a deinking plant



Flotation deinking



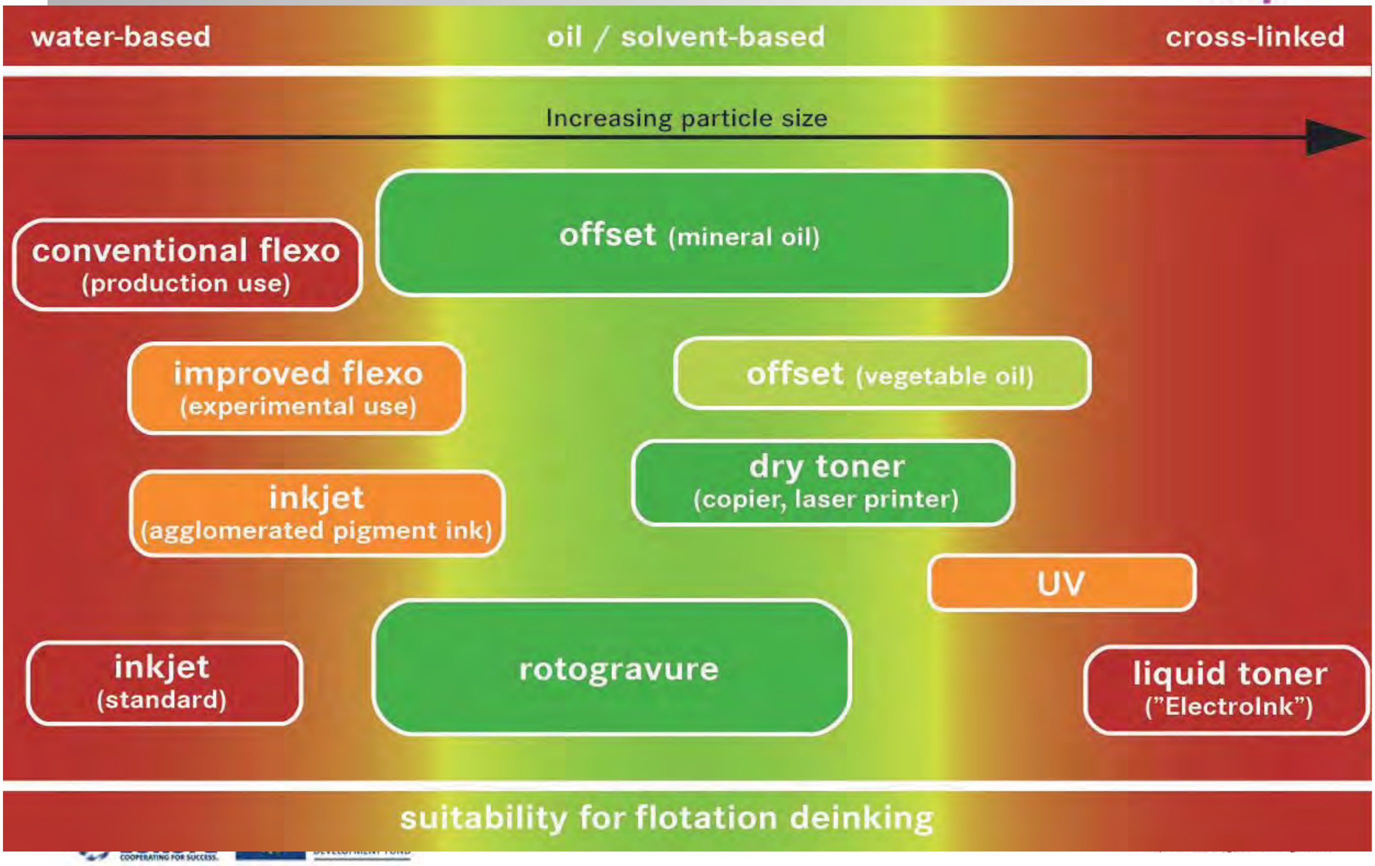
Basics of deinking

- 1st: Detachment of ink from the fibers (during re-pulping of the paper for recycling)
- 2nd: Removal of ink from the system
  - mostly used: flotation
  - in certain cases: washing

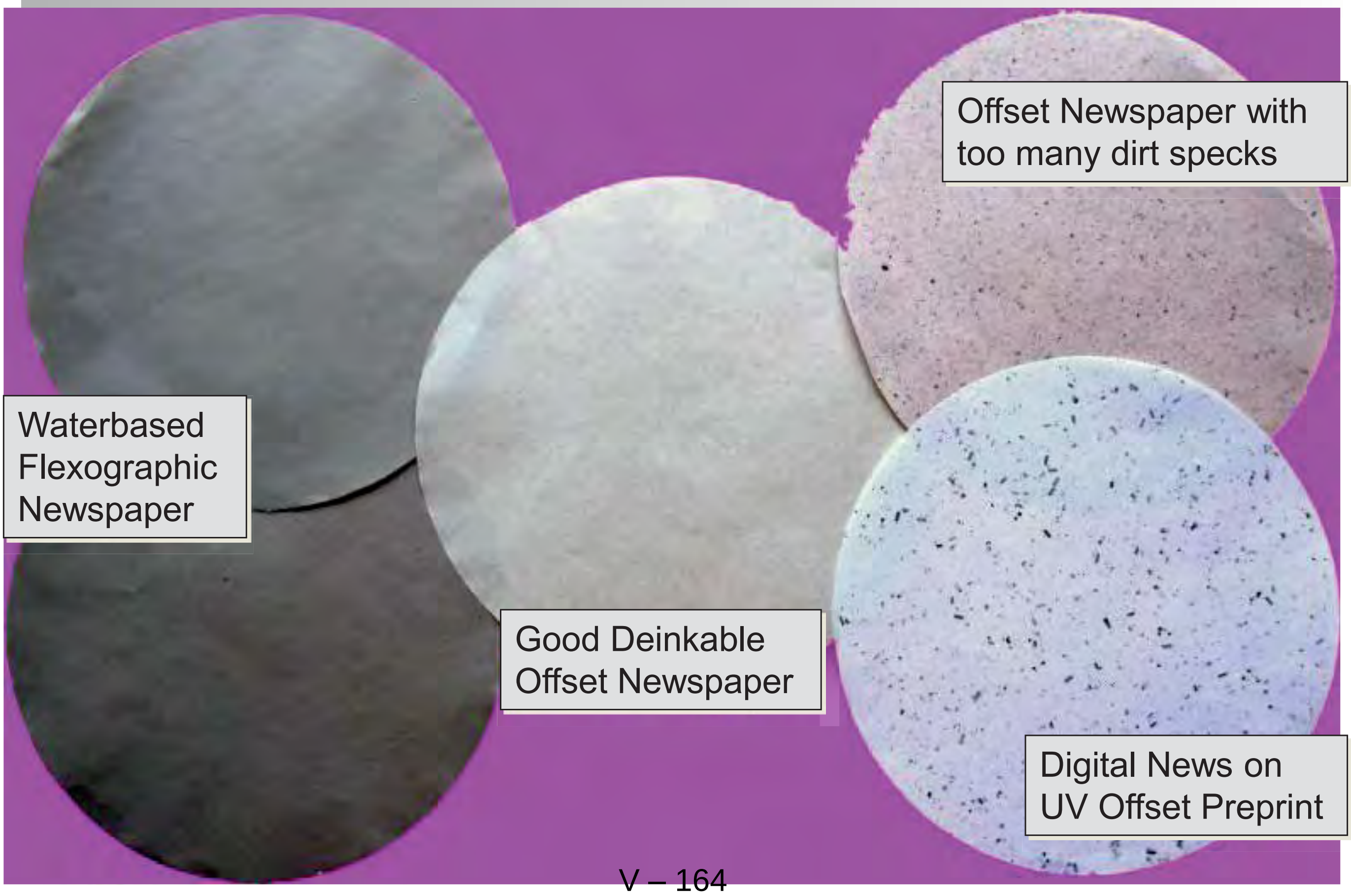
Efficient flotation deinking needs …

- a solid particle to be removed (will not work with dyes)
- a certain size range of the particles (ideally between 10 and 100 µm)
- hydrophobic particles
- the proper chemistry (deinking processes for newspapers and magazines use a detergent-like mix of chemical additives)

Printing – Deinking



Laboratory hand sheets from deinked pulp



Evaluation of deinkability

INGEDE Method 11: Simulation of pulping and flotation

Objectives	Evaluated Parameters	
High Reflection	Luminosity Y of Deinked Pulp	Quality Parameters
High Optical Cleanliness	Dirt Area A* of Deinked Pulp	
No Color Shade	a* Value of Deinked Pulp	
High Ink Removal	Ink Elimination IE	Process Parameters
No Discoloration of White Water	Filtrate Darkening ΔY	

Conversion of the results to a score system

Assessment of deinkability

- Procedure in the "Deinking Scorecard"
  - Simulation of essential process steps in laboratory scale (INGEDE Method 11)
  - Assessment of five parameters (cleanliness in two sub-categories)
  - Definition of a threshold (equal for all product categories) for each parameter
  - Definition of a target (depending on the category of the printed product – newspaper, magazine, stationery) for each parameter
  - Calculation of a score for each parameter
- The total score of all parameters allows an overall assessment of the product‘s deinkability
- If one or more of the thresholds is not achieved, then the assessment is "not suitable for deinking"

Deinkability Score
Assessment of test results

Score	Assessment of deinkability
71 to 100 Points	Good deinkability
51 to 70 Points	Fair deinkability
0 to 50 Points	Tolerable
negative (failed to meet at least one threshold)	Not suitable for deinking*

*The product may be well recyclable without deinking

Revision of the Deinking Scorecard (1)

- Total yield replaced by **fibre yield** and **minimum** set to **65%**
- Luminosity replaced by **brightness** to distinguish between the two product categories “**Low ink coverage products**”
- **Luminosity target lowered** from 90 to **80** for category “Low ink coverage products > 75”
- **Luminosity threshold increased** from 47 to **67** points for this category

Revision of the Deinking Scorecard (2)

- **Distinction** between “Magazines” and “Low ink coverage products” **improved** – by a more detailed description and by measuring mean grey value in case of doubts
- Definition how to assess print products with a very **low ink coverage** (if all results but IE are positive)
- **Reporting**
- **Exemptions from testing** for products which are usually good deinkable

Deinkability tests

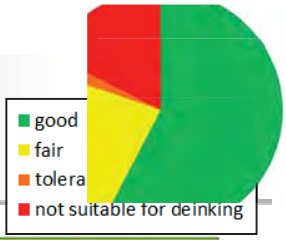
EcoPaperLoop

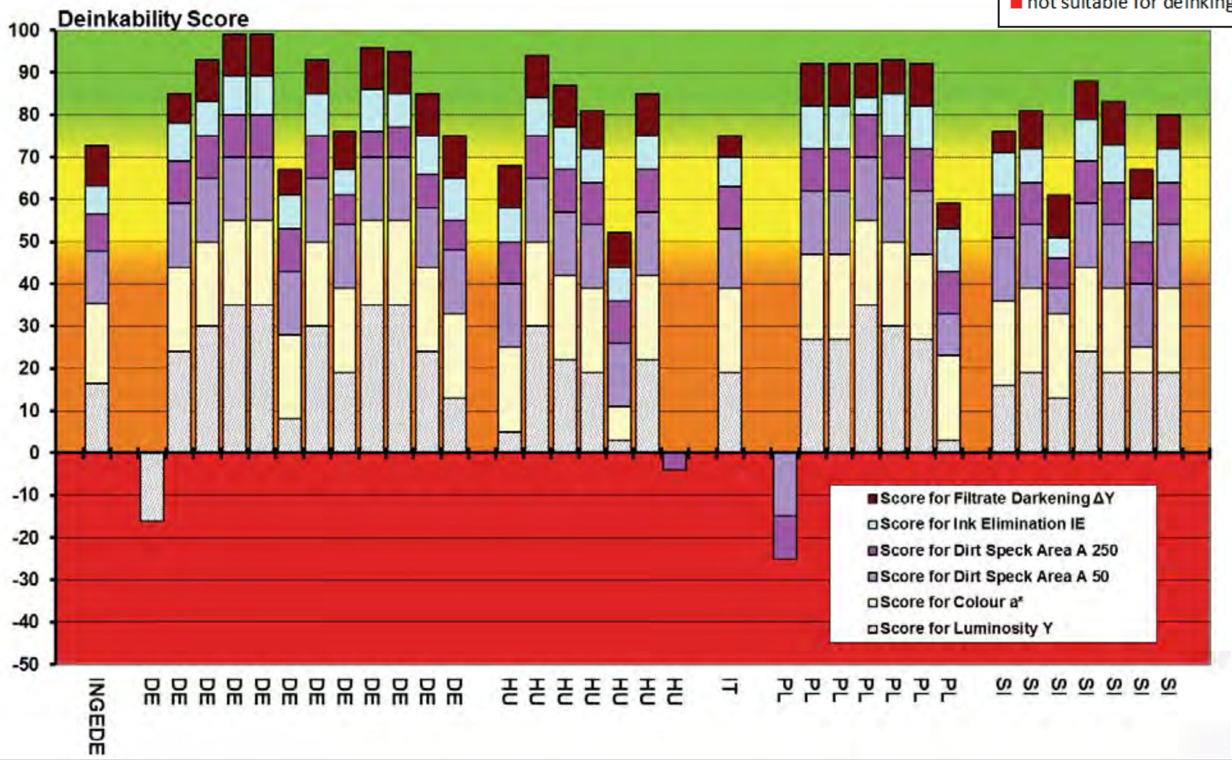
- about 80 newspapers and magazines
- 2013 to 2014
- originating from Germany, Hungary, Italy, Poland and Slovenia

INGEDE

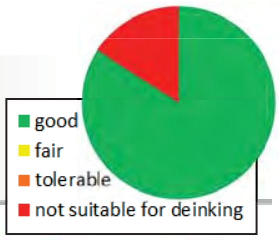
- about 470 printed products of all categories
- 2005 to 2014
- from Northern, Southern and Western Europe, as well as occasionally from USA and Japan

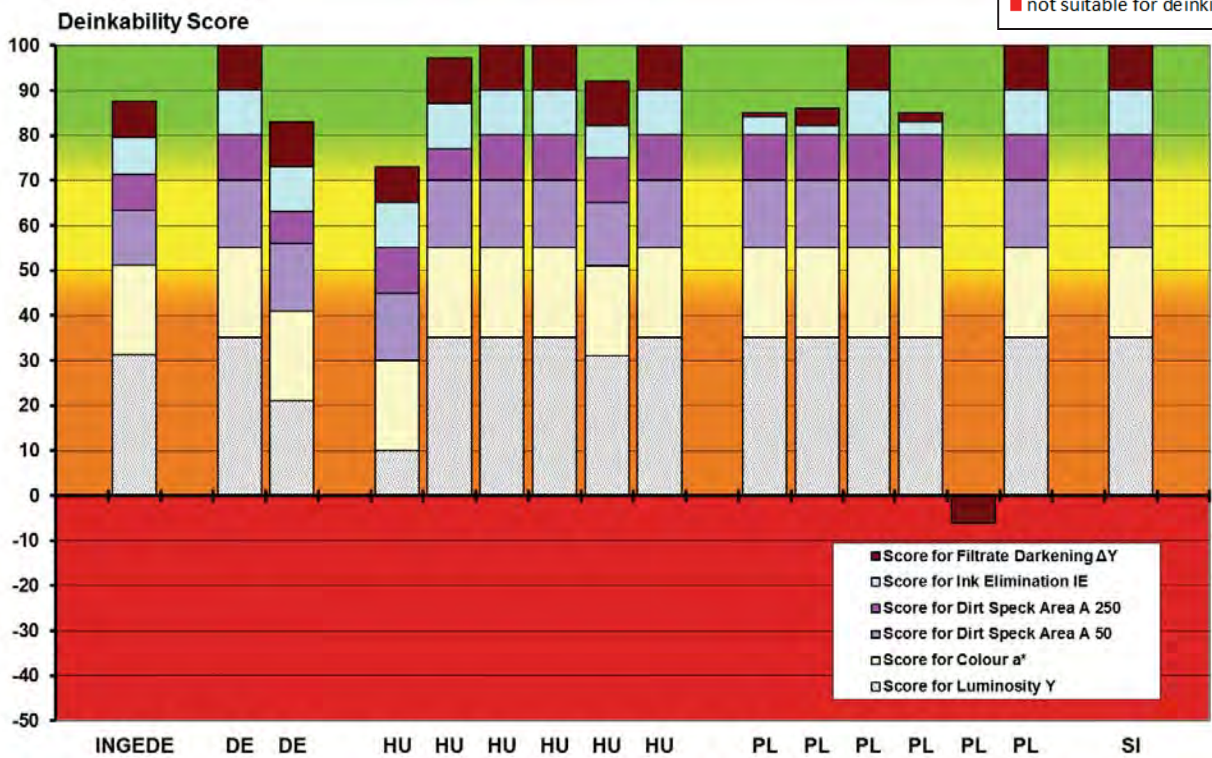
Deinkability of Newsprint (Offset)



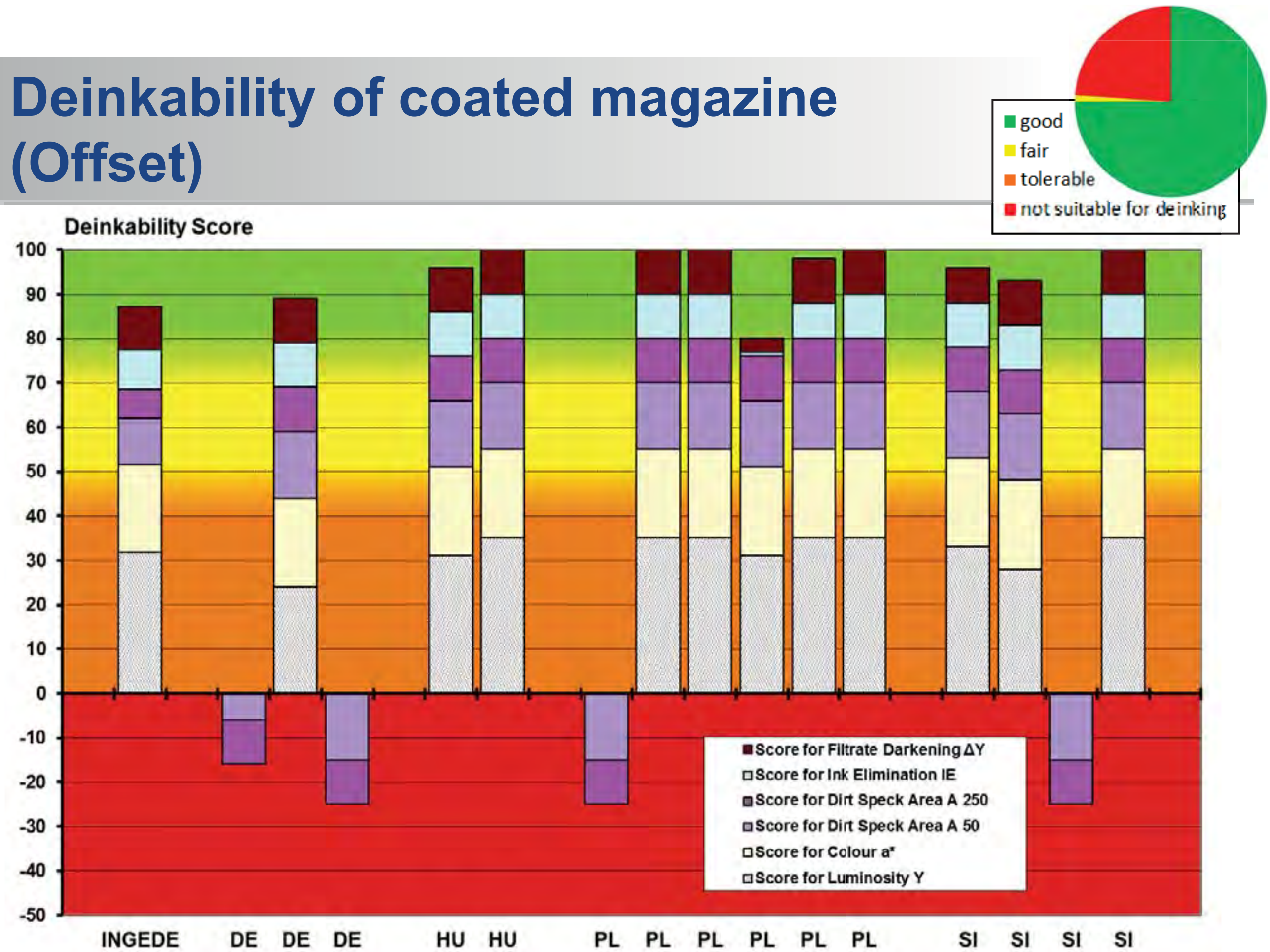


Deinkability of uncoated magazine (Offset)





Deinkability of coated magazine (Offset)



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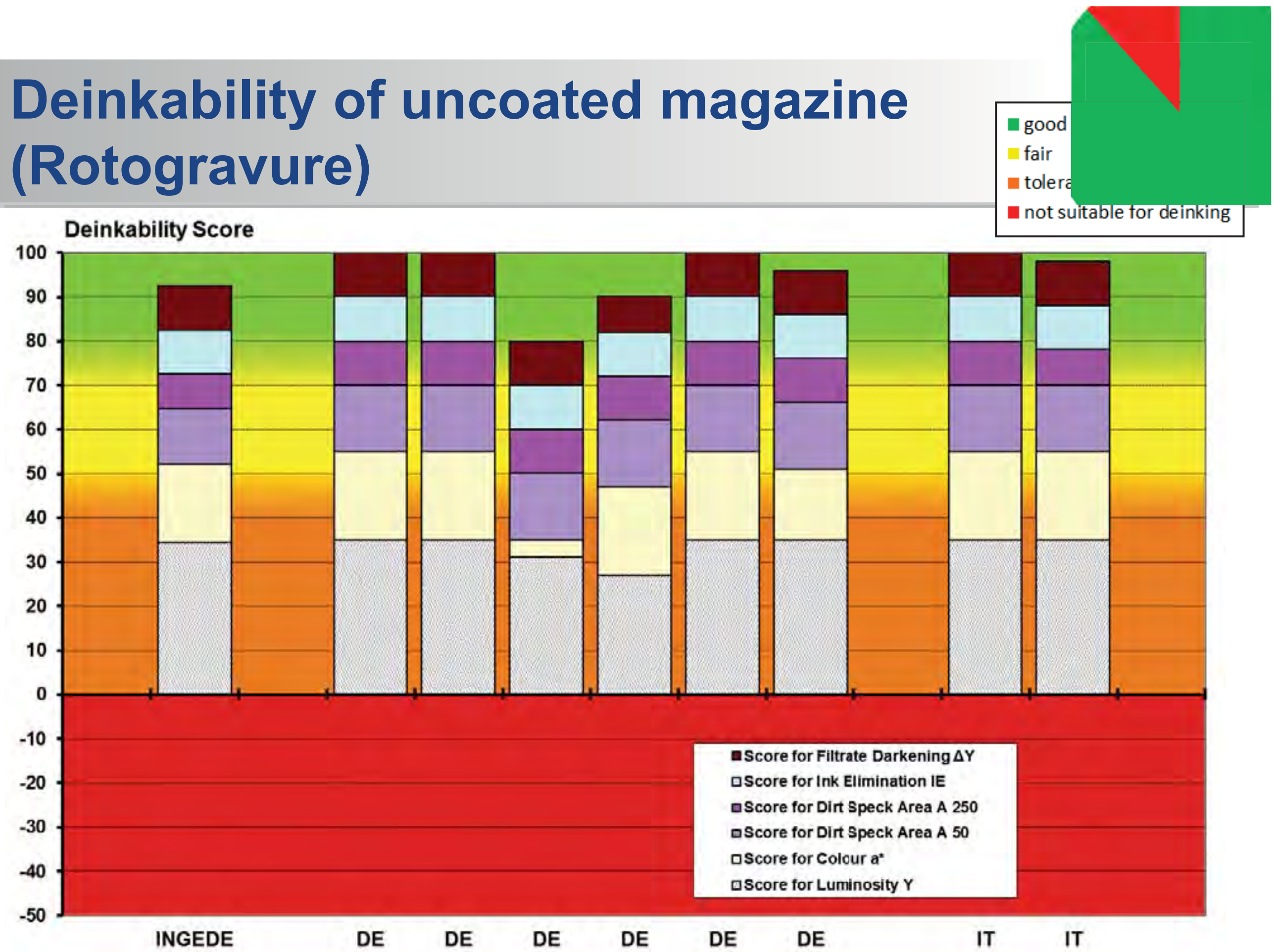
erma concepts Paper Technology Consulting GmbH

Deinkability of uncoated magazine (Rotogravure)



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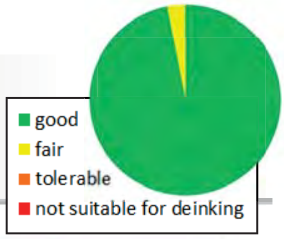
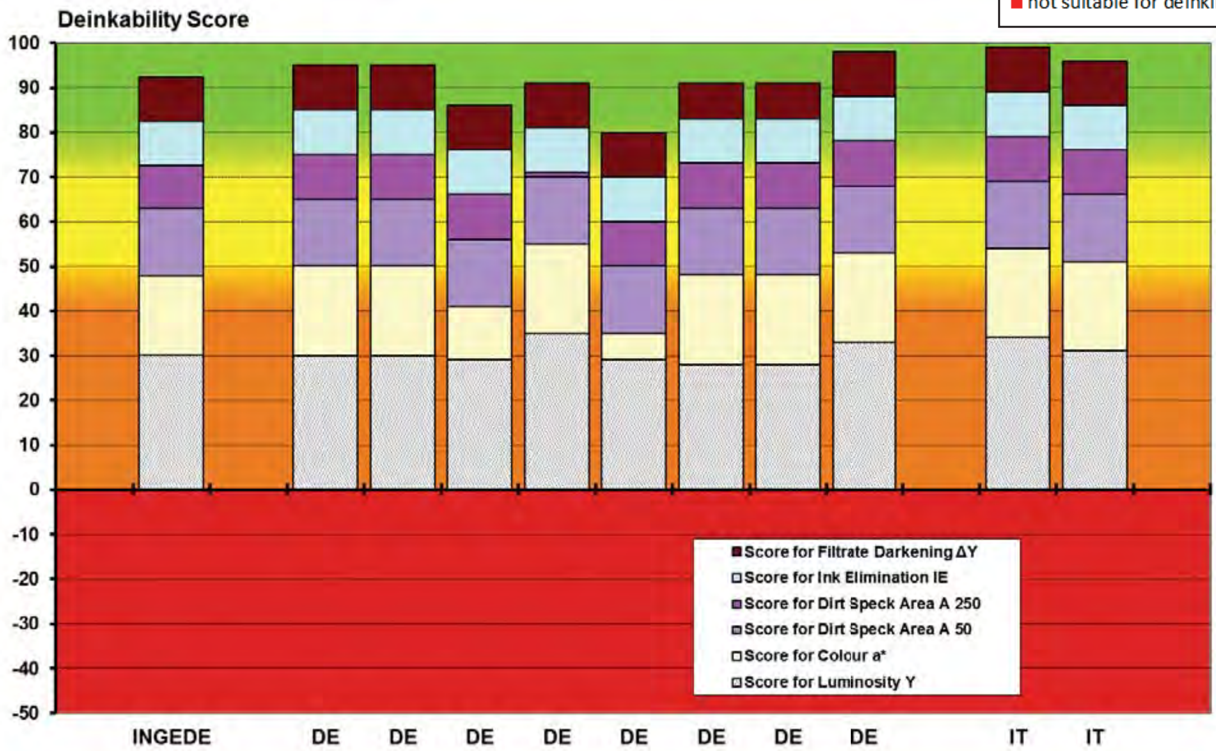
Deinkability of coated magazine (Rotogravure)





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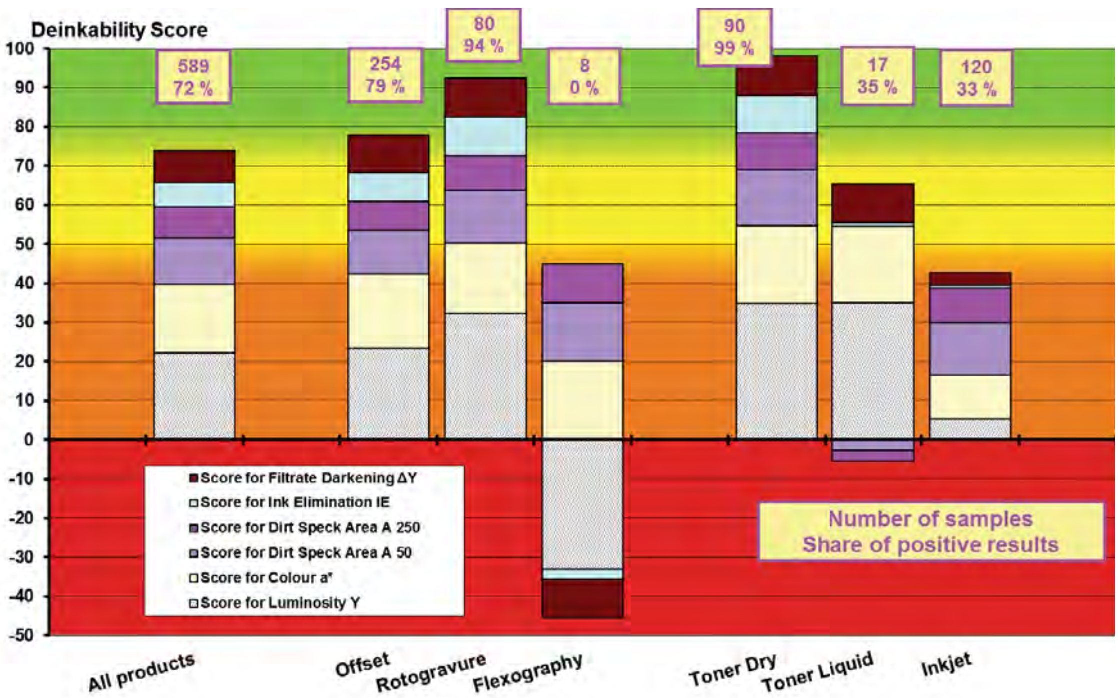
Deinkability results by printing technology

Eco Paper Loop



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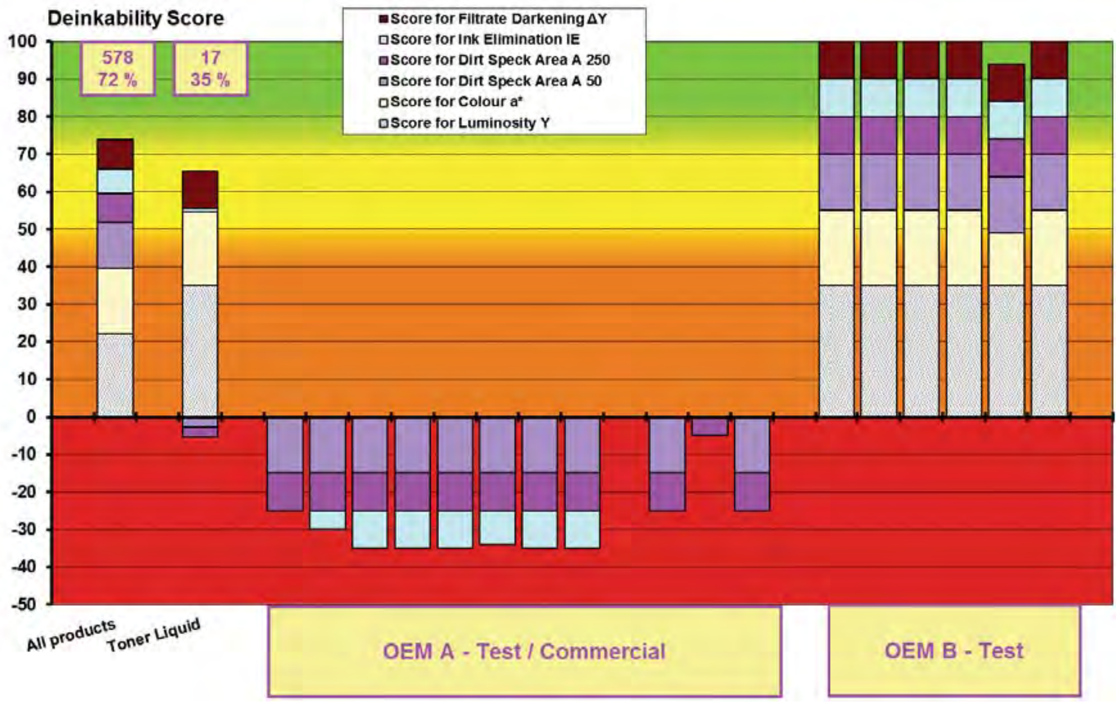
Deinkability results of liquid toner prints from different vendors



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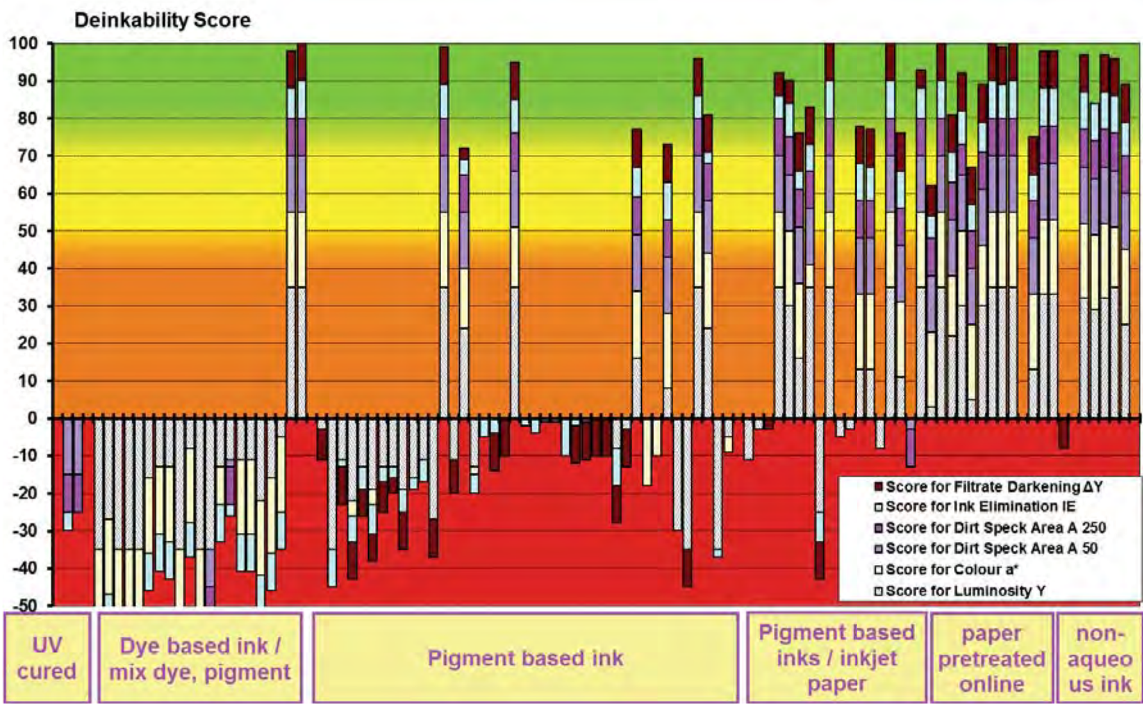
Individual deinkability results of inkjet prints grouped by ink technology and substrate



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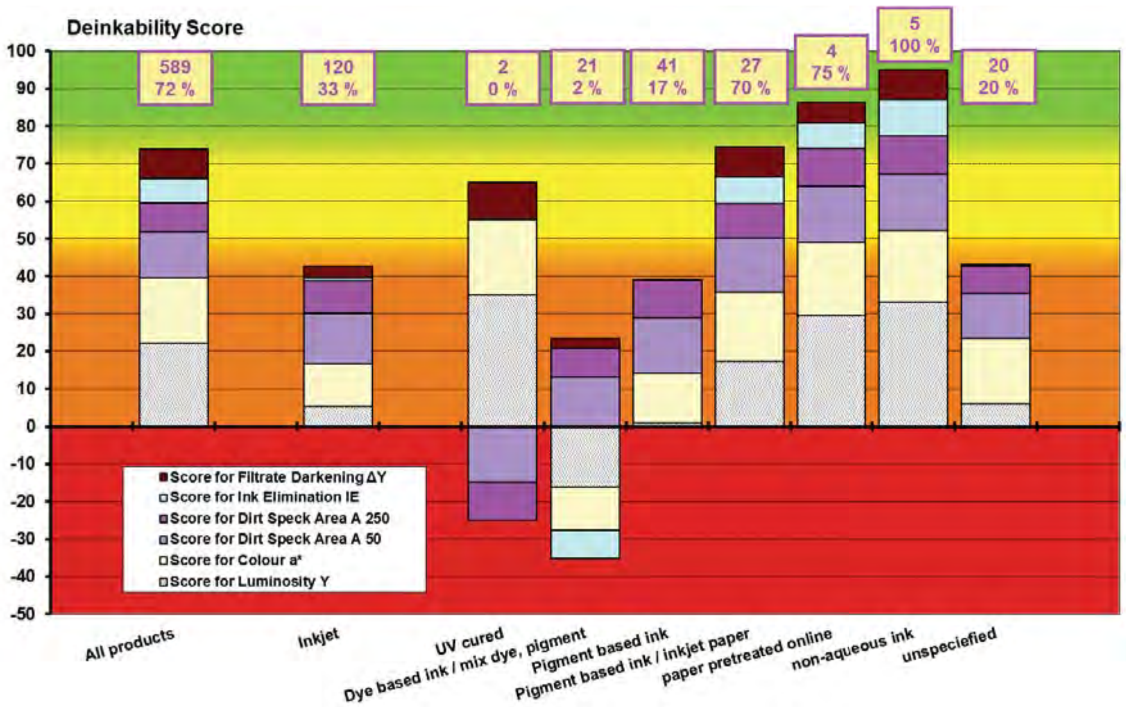
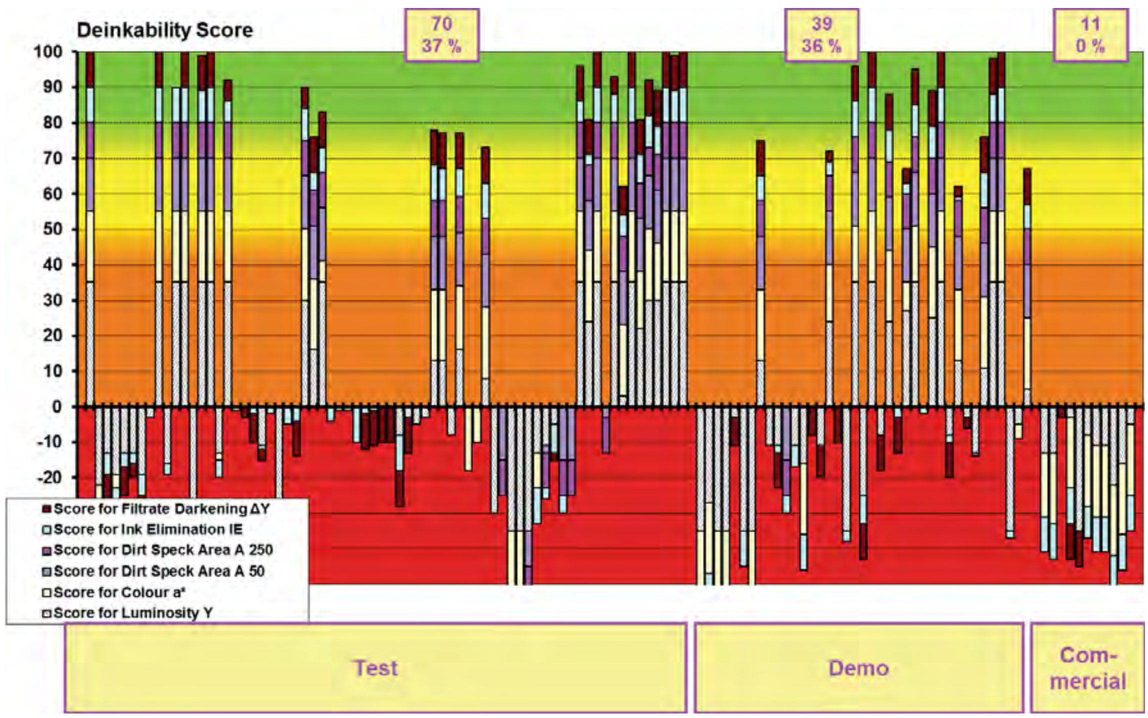
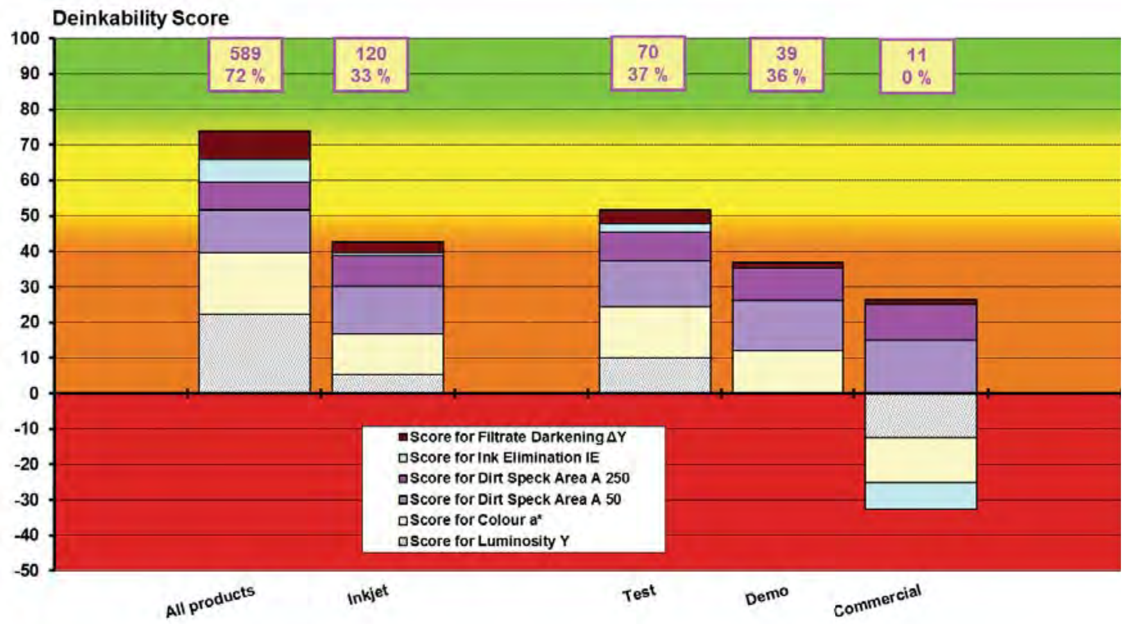
Average deinkability results of inkjet prints
grouped by ink technology and substrate



Deinkability results of test, demo and commercial inkjet prints



Deinkability results of test, demo and commercial inkjet prints



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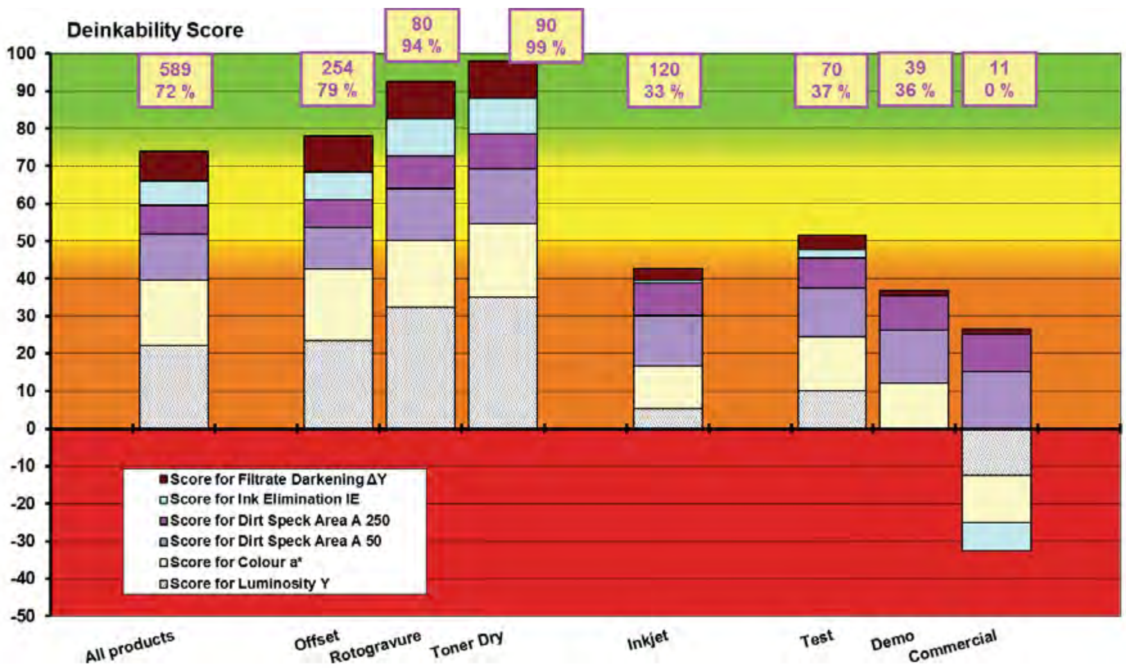
Average deinkability results of test, demo and commercial inkjet

in comparison with offset, gravure and dry toner prints



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Conclusion

- **Deinkability results** of newspapers and magazines from EcoPaperLoop partner countries **do not show a significant difference** to existing data
- Deinkers are concerned about **liquid toner** and **inkjet prints**
- **Liquid toner**:
  - Deinkability issue: Many and large dirt specks
  - There is no sign from the field of a better deinking performance of the prints from the market leader
  - Competitive systems with better deinkability are not installed yet
- **Inkjet**:
  - Deinkability issue: Low brightness, filtrate darkening, partly discolouration
  - All prints from the field failed in deinkability
  - Even R&D based test prints in average perform worse than offset, rotogravure and dry toner prints

Thank you very much for your attention!

This project is implemented through the CENTRAL EUROPE Programme co-financed by the ERDF (European Regional Development Fund)

www.ecopaperloop.eu

Sources

Pictures

- http://www.persoenlich.ch
- INGEDE
- http://www.graphische-revue.at

Deinkability results

- EcoPaperLoop
- INGEDE

Communicating sustainability in the paper chain

Axel Fischer

CENTRAL EUROPE
COOPERATING FOR SUCCESS.

erma concepts
Paper Technology Consulting GmbH

Eco Design for the Enhancement of Central Europe Paper Based Products Recycling Loop

Axel Fischer

EcoPaperLoop Final Conference, Kraków

December 2nd, 2014

The Situation

Competing with electronic media

Why EcoPaperLoop?

Environmental Commissioner **Janez Potocnik**

The Situation

Study, followed by statement of EU commissioner Potocznik:

Too many recyclables still go to landfill.

Situation differs in EU member states.

The Mission

Raise awareness and **provide tools to enhance** the **recyclability of paper products** as well as the **collection of paper for recycling** in the Central Europe region

The Mission

in order to **secure good quality raw material** for the **paper industry** and **reduce environmental impact**


OUR JOURNEY TOGETHER.
FOR GOOD.
FOOD
PLANET
PEOPLE


OUR JOURNEY TOGETHER.
FOR GOOD.
FOOD
PLANET
PEOPLE
McDONALD'S CORPORATE SOCIAL
RESPONSIBILITY & SUSTAINABILITY REPORT
2012 - 2013

ON THE WAY TO SUSTAINABLE PACKAGING

McDonald's aims to improve the overall sustainability of our packaging through product design and responsible sourcing. The packaging for items purchased by our customers is intended to contain and protect the contents from the restaurant to a customer's final destination. The majority of our packaging is fiber-based and McDonald's sources fiber-based paper and packaging—including fry boxes and sandwich "clamshells," wrappers, tray liners, cups and other items—from global and market-level suppliers.

DESIGN, SOURCING AND DESTINATION

McDonald's priority is to optimize the amount of packaging we use, and to use only sustainably sourced materials that are recyclable or compostable. In collaboration with our suppliers, we pursue these priorities in three critical areas:

- DESIGN
  Optimize weight and simplify the number of materials used in our packaging
- SOURCING
  Increase use of recycled or certified raw materials
- RECOVERY
  Work to use recoverable packaging with viable end-of-life options

MORE SUSTAINABLE PACKAGING FROM THE START

In 2007, HAVI Global Solutions (HGS), the Company's packaging category manager in most markets, collaborated with McDonald's to develop a framework for a packaging evaluation tool, Eco-Filter 2.0, to provide better information about packaging decisions. HGS leveraged the expertise of Environmental Packaging International, a consulting firm that specializes in design for environmental tools, to assist with building the tool. The tool was built on McDonald's historic key packaging performance indicators, best practices from European and North American markets and advice from outside experts and NGOs, such as the Environmental Defense Fund.

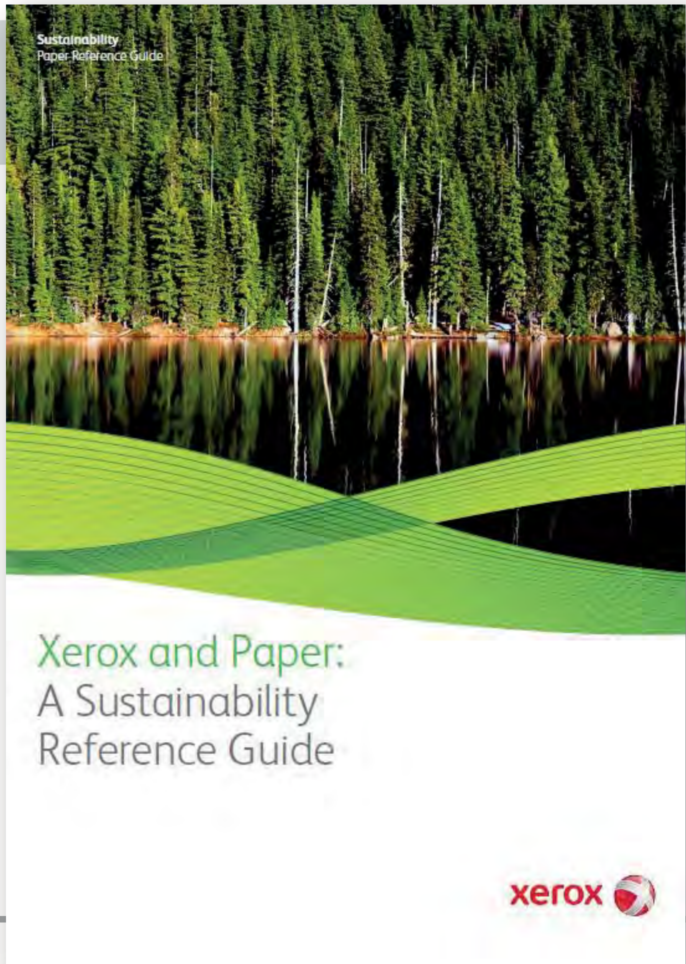
In 2012, we updated our Eco-Filter Tool to make better informed packaging decisions, with the objective of optimizing packaging weight, maximizing certified or recycled content, ensuring the safety of all materials used in the product and its production, and supporting responsible end-of-life options such as recycling or composting.

A CUP WITH LESS PLASTIC

The four-flap McFlurry cup in use by McDonald's Australia since late 2011 eliminated the need for a lid and reduced plastic use by more than 58 metric tons during 2013.

39

EcoPaperLoop



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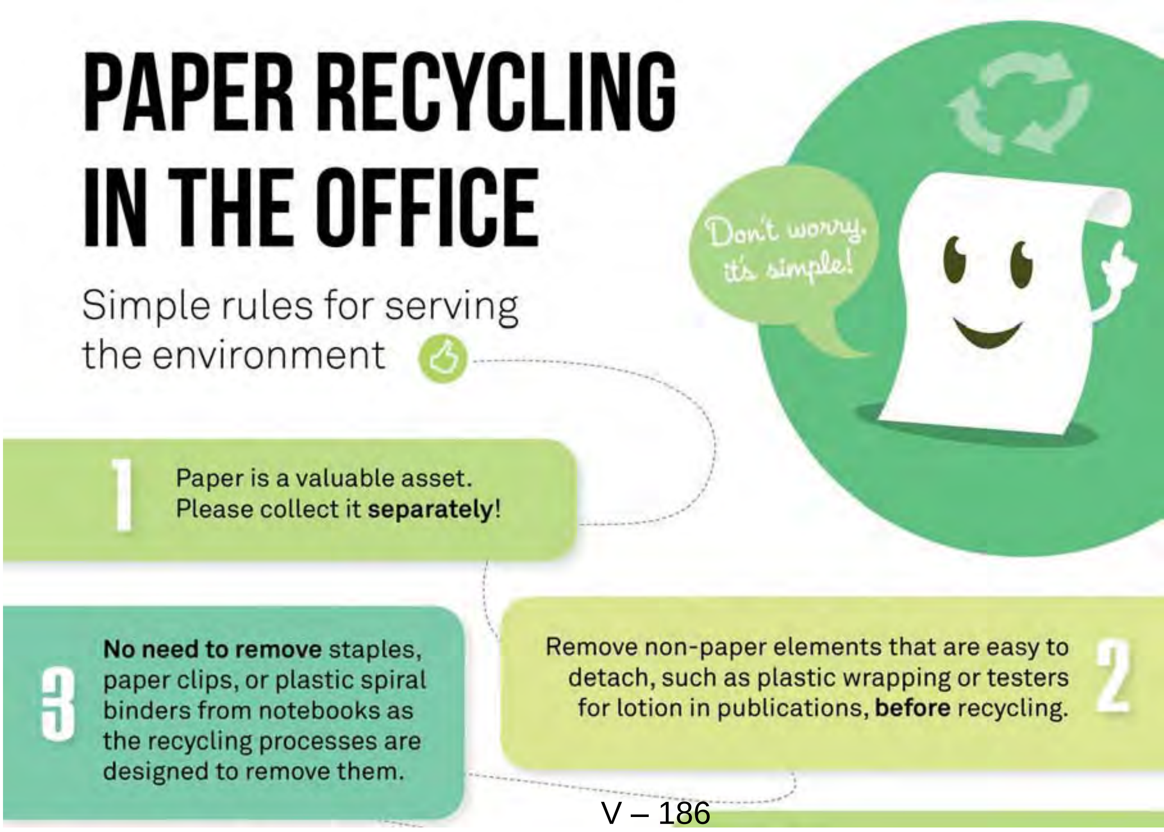


Central Europe region
(according to ERDF program)

WP 2 – Communication: Newsletter

Verstanden

Die Qualität von Altpapier verbessern

Newsletter des EcoPaperLoop-Projekts

1. Ausgabe – Frühjahr 2013

Kreisläufe verstehen

In Zentraleuropa ist Altpapier ein immer wichtigerer Rohstoff. Die Recyclingquoten unterscheiden sich in den einzelnen Regionen jedoch deutlich.

Altpapier wird nicht nur dort rezykliert, wo das Papier erfasst oder produziert wurde. Deshalb müssen wichtige Eigenschaften wie Öko-Design und richtige Sammlung gemeinsam entwickelt werden. Nur so lässt sich die Nachhaltigkeit des Papierkreislaufs und die Altpapierqualität verbessern.

*Das Projekt **EcoPaperLoop** läuft bis Ende 2014. Es wird von der Europäischen Union über den European Regional Development Fund (ERDF) gemeinsam mit den lokalen Projektpartnern finanziert.*

Graziano Elegir

Auf dem Weg zu einem nachhaltigen Papierkreislauf:

Rezyklierbarkeit von Verpackungen, Ökobilanzen und: richtig sammeln!

Wie wird ein Papierprodukt nachhaltig? Nur dann, wenn diese Nachhaltigkeit auch über den gesamten Lebensweg des Papiers gewährleistet wird – dazu gehört das Recycling. Für grafische Papiere heißt das auch, dass sich die Druckfarbe von den Papierfasern entfernen lassen muss: Das Druckprodukt muss **deinkbar** sein. Hierfür gibt es inzwischen einen etablierten Test.

Für Verpackungen hat das **PMV** in Darmstadt eine neue Methode zur Bewertung der Rezyklierbarkeit entwickelt und die Projektpartner geschult. *Mehr zur Methode auf **Seite 2**.*

Ein anderer Ansatz, die Nachhaltigkeit eines Produktes genauer zu betrachten, ist eine vergleichende Ökobilanz. Projektpartner **COBRO** in Polen entwickelt mit **Innovhub** in Italien eine solche Analyse. *Mehr dazu auf **Seite 4**.*

Verstehen ist der Schlüssel zum Fortschritt – Kommunikation ein entscheidender Bestandteil des Projekts. Eine Pressekonferenz in Mailand, ein Messestand in Berlin und ein Workshop in **Ljubljana** zum Thema „Ökologischer Kreislauf – gemeinsam!" sollen zu mehr Verständnis beitragen. *Mehr auf **Seite 4**.*

Die Projektpartner beim Auftakt in Mailand im September 2012

Awareness

Improving the quality of paper for recycling

Newsletter of the EcoPaperLoop Project

2nd Edition – July 2014

Impressive Figure: 71,7

In 2013, paper was recycled in Europe at the impressive rate of 71,7%. This achievement is doubly remarkable considering that since the pre-crisis peak year of 2007: paper consumption in Europe has dropped by 14% whereas collection and recycling volumes have been retained at a very high level.

The large majority of the 11 countries still under a 60% recycling rate have reported an improved performance. In parallel, 13 countries have already exceeded the target 70% recycling rate. Paper fibre is now collected and recycled an average of 3,5 times in the 30 European countries, far exceeding the world-wide average of 2,4. And: Paper recycling adds green jobs, skills and innovations to the European economy!

Jori Ringman-Beck, CEPI

On the way to a sustainable paper loop in Central Europe:

Recyclability Scores for Packaging: How good is your box after use?

What impact does a printed product have on the recycling process? For graphic papers, the "Deinkability Scores" of the European Recovered Paper Council (ERPC) are an established instrument for a couple of years. But for packaging, a reliable routine was not available yet. In the course of the EcoPaperLoop Project, a new test procedure has been developed at Technische Universität Darmstadt and verified and harmonised with the project partners.

"I think it is quite important to state that four laboratories in Central Europe can now perform this method", says Graziano Elegir of INNOVHUB-Stazioni Sperimentali per l' Industria in Milano who is the Project Coordinator for EcoPaperLoop. *More about the test method on the following pages.*

Awareness is a key issue – and communication is an important element of the project. A variety of presentations has been and will be given, including participation in relevant exhibitions and conferences, such as the PTS Symposium on Innovative packaging in Munich and the Ecomondo Exibition in Rimini coming up this November.

"World Cafe" at the EcoPaperLoop seminar in Ljubljana

Communication

- **Website www.ecopaperloop.eu**
- Twitter
- Newsletters
- Stakeholder dialogues
- **Video clips**
  - Recyclability testing, collection, stickies, LCA
- Flyer “*EcoPaperLoop at a Glance*”
- Project portrait
- **Guideline documents**
  - Recyclability assessment, collection, LCA, policy roadmap

EcoPaperLoop – Seminar Warsaw (Oct 2013)

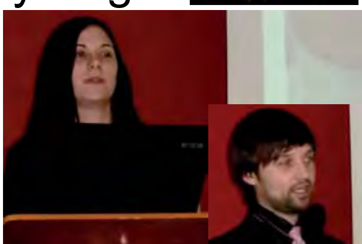
- **Lectures and speakers**

Overview

(Graziano Elegir)

The collection of paper for recycling

(Harald Grossmann)



Graphic paper recycling

(Ulrich Höke)

Packaging paper recycling

(Saskia Runte, Andreas Faul)

Life cycle assessment

(Greg Ganczewski)

Policy in connection with paper for recycling

(Jori Ringman)

EcoPaperLoop – Seminar Ljubljana (Jan 2014)

- **Lectures and speakers**
  Introduction (Graziano Elegir)
  EU and national legislation (Antonija Božič Cerar)
  Recyclability evaluation (Hans Putz)
  Ecolabels (Andreas Faul)
  Statistics and terminology (Ilpo Ervasti)
- **World Café topics and hosts** (brainstorming)
  Recyclability (G. Elegir, S. König)
  Collection strategies (H. Grossmann, K. Možina)
  Public awareness (A. Faul, R. Urbas)
  Legislation (G. Golob, A. Gross)
- **Training school on recyclability testing**
  Welcome (M. Mešl) & Theory (H. Putz)
  Laboratory demonstration (J. Zule, M. Kenda)

Conclusions from the World Café

- **Recyclability**
  Lack of knowledge, confusion of terms
  Information on recyclability on product (choice for consumer)
  Consumer to separate components
  Guidelines for fibre loop safety (contamination)
- **Collection strategies**
  Paper bins at households, collection once a week
  Graphic and packaging collected separately
  "Local currency"
- **Public awareness**
  Trustful information, printed on substrate, stories and slogans, motivate kids, reward good collection
- **Legislation**
  Education over legislation, regulation by market
  Recyclability over mandatory recycled content

www.ecopaperloop.eu

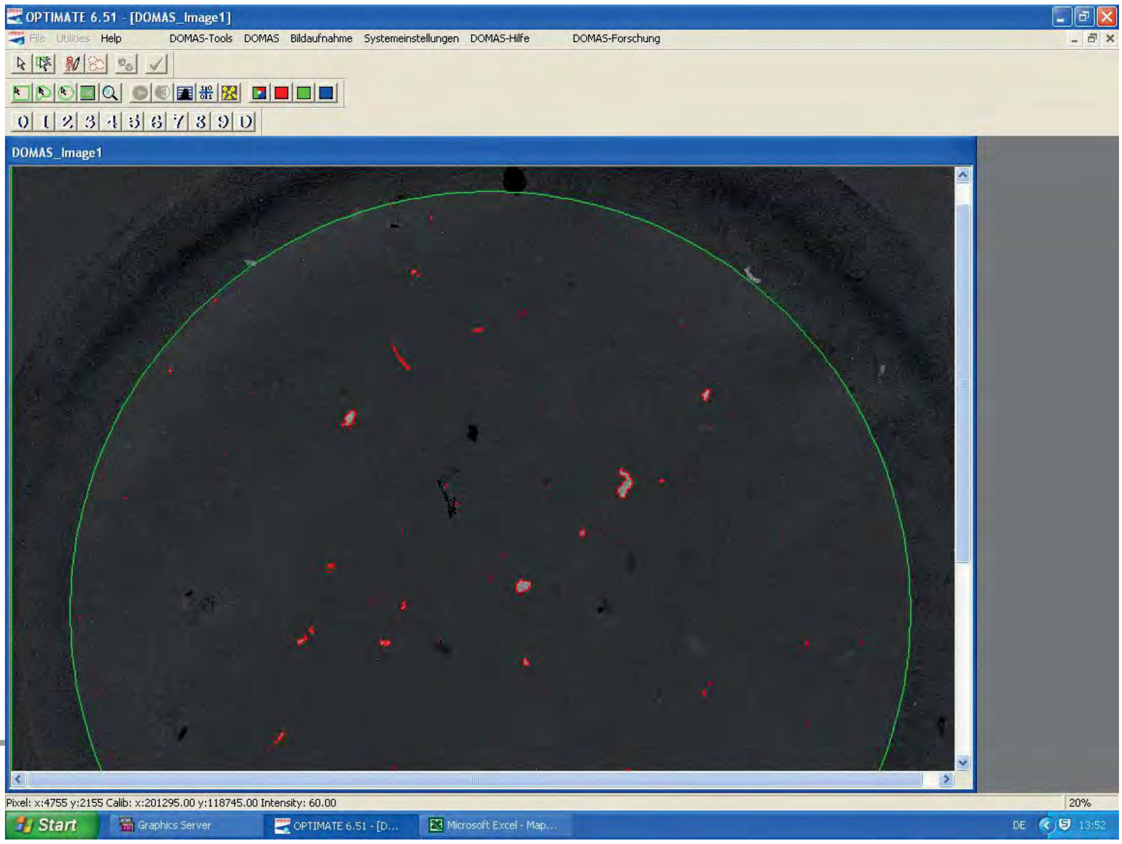
Proposals for slogans

- **Graphic products**
  - “I’ll be back! To provide you with more news next week. Recycle me!”
  - “I’ll be back! Providing you with the latest offers from your local supermarket. Recycle me!”
  - …
- **Packaging products**
  - “I’ll be back! To protect your electronic devices (books / equipment / purchase / …) next week. Recycle me!”
  - “I’ll be back! Bringing fresh fruit (milk /cheese / …) to the store near you again. Recycle me!”
  - …

Recyclability Method for

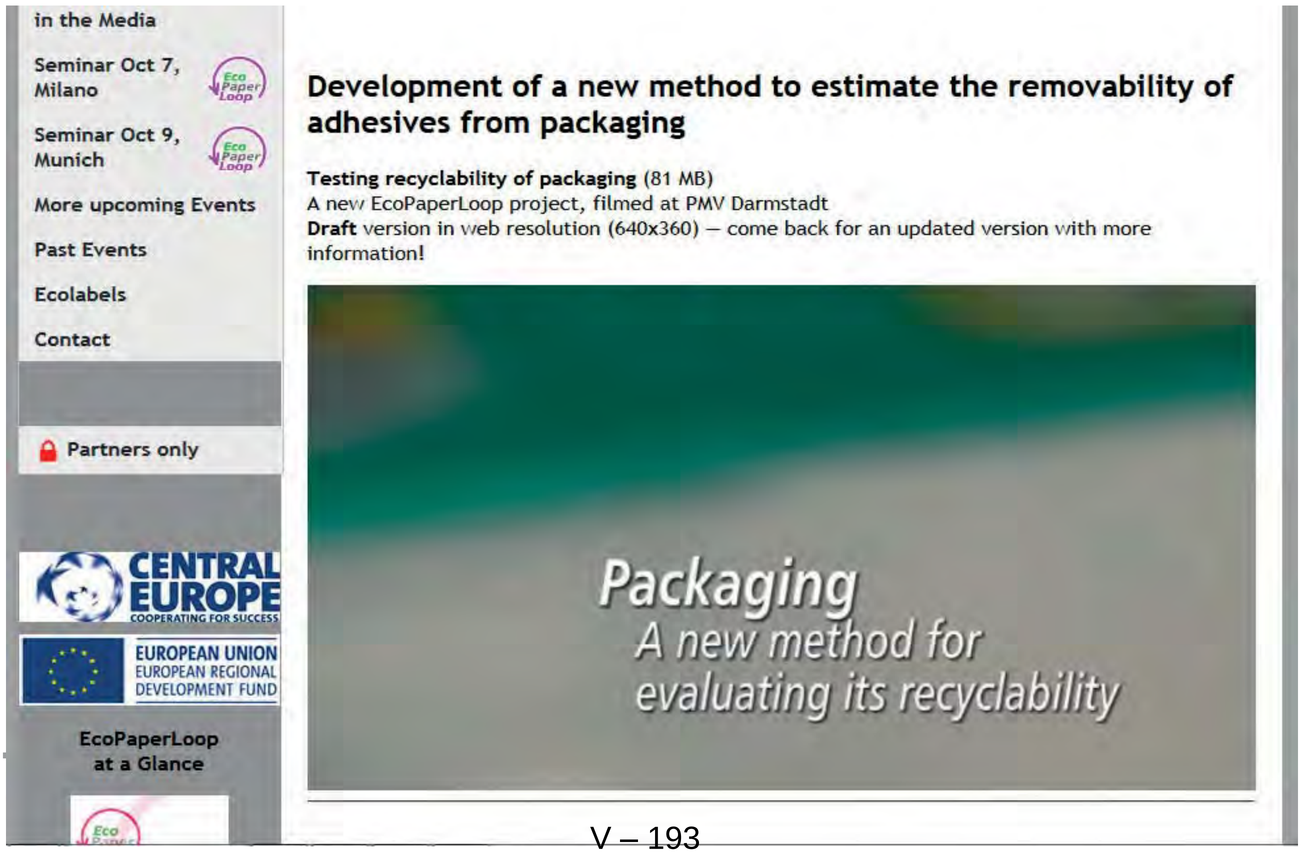
CENTRAL EUROPE COOPERATING FOR SUCCESS.
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

WP 2 – Communication

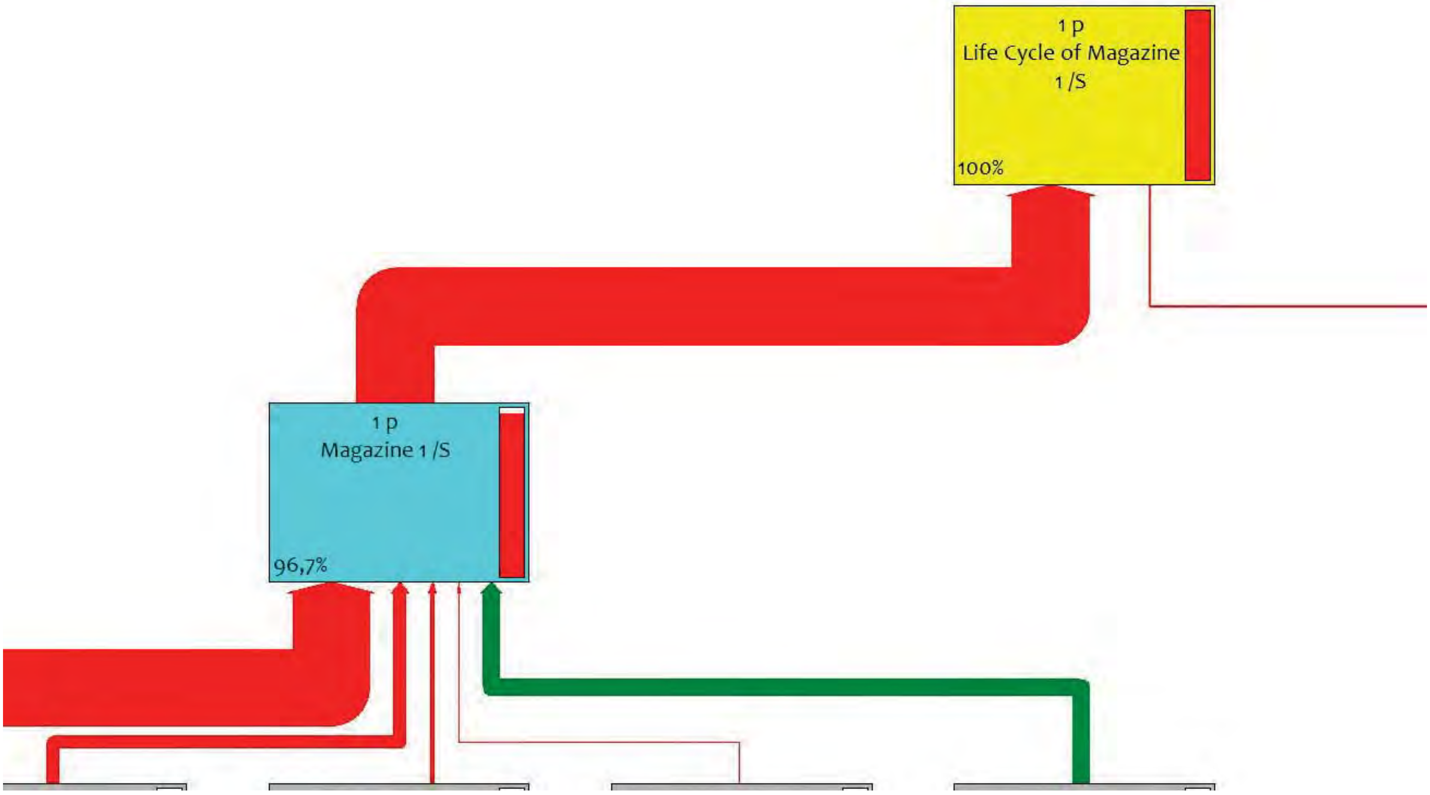


CENTRAL EUROPE
COOPERATING FOR SUCCESS.

WP 2 – Communication: Video



Life Cycle Analysis



WP 2 – Communication

Life Cycle Analysis

What is a Life Cycle Analysis?

EcoPaperLoop – recent major events

- **Booth at "Altpapiertag"**
  (Düsseldorf, April 2014)
- **Public workshop and training school on collection**
  (Sopron, July 2014)
- **Public seminar**
  (Milan, September 2014)
- **Public seminar**
  (Munich, 09 October 2014)
- **Final conference**
  (Poland, December 2014)

Thank you for your attention!

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