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THE REVISION OF EU ECOLABEL CRITERIA for Converted Paper Products

Draft Preliminary Report

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Table of contents

ABSTRACT

The project aims at revising the EU Ecolabel criteria for converted paper products as specified in the Commission Decision 2014/256/EU.

The preliminary report provides the background information for the criteria development and address the requirements for technical evidence as requested in the Regulation (EC) No 66/2010. It encompasses: the scope definition together with the description of the legal framework (Task 1); the market analysis (Task 2), an overview of the environmental impacts of the examined products, considering a life cycle approach (Task 3), and analysis of technical aspects that are considered relevant for the criteria revision (Task 4).

After bringing together the information identified within this Report, a set of proposed EU Ecolabel criteria will be included in the Technical Reports, together with supporting rationales.

Executive summary

Policy context

This draft Preliminary Report has been produced as one of the first steps in the revision process of EU Ecolabel criteria for converted paper products. It will act as a basic reference point to support discussions on future criteria and rationale that will be presented in upcoming Technical Reports that are also published during the same revision process, which is expected to be completed in the first half of 2020.

Main findings

An assessment of relevant technical standards, legislation, and policy instruments shows that the converted paper industry finds itself at the heart of many major policy challenges such as climate change and the shift towards renewables and towards a circular economy, and make a key contribution to all three.

The converted paper products market has undergone some major shifts in the last decade or so due to a major decline especially for envelopes, or production increase for paper bags.

The main environmental hot-spots in the converted paper products manufacturing were identified at the upstream materials production phase, mainly at the pulp and paper mill.

Related and future JRC work

In parallel to this report, a first Technical Report is also published (version 1.0) which will contain specific proposals and supporting rationales for product group scope and definition, criteria and corresponding assessment and verification text.

The Technical Reports will be discussed with stakeholders and subsequent versions will be published to reflect the ongoing developments and inputs to the revision process.

1. Introduction

The EU Ecolabel is an element of the European Commission's action plan on Sustainable Production and Consumption, and Sustainable Industrial Policy (SCP/SIP) adopted on 16 July 2008. This is a voluntary scheme established to encourage manufacturers to produce goods and services that are environmentally friendlier.

The EU Ecolabel promotes the production and consumption of products with a reduced environmental impact along the life cycle and is intended to be awarded only to the best (environmental) performing products in the market. A product (good or service) awarded with this label must meet high environmental and performance standards.

An important part of the process for developing or revising EU Ecolabel criteria is the involvement of stakeholders through consultation on draft technical reports and criteria proposals. This is achieved by stakeholder involvement in working group meetings and written consultation processes managed via an online platform.

This preliminary report addresses the requirements of the EU Ecolabel Regulation 66/2010 for technical evidence to inform criteria revision and sets the scene for the discussions planned to take place at the first Ad-Hoc Working Group Meeting. The revision process takes the existing criteria document as the starting point and seeks to update these, taking into account technological and economic changes in the European market, relevant legislative changes and improved scientific knowledge. The EU Ecolabel for converted paper products is established by the Commission Decision 2014/256/EU of 2 May 2014 (Commission Decision 2014/256/EU).

The report is split into 4 primary tasks, which are described as follows:

I. *Task 1: Scope and definitions. This involves the identification of relevant background information, and a description of the legal framework which applies to converted paper products in the EU. Stakeholder survey is also briefly analysed.*
II. *Task 2: Market analysis. This involves an analysis of key market data relating to converted paper products and should link well to the choice of product definitions.*
III. *Task 3: Life Cycle Assessment (LCA) evidence. This task involves a review of relevant available evidence relating to the environmental impacts of paper products generated across the entire life cycle of the product (cradle to grave or cradle to cradle). Suitable evidence may include full LCAs, studies that focus on particular aspects of the paper production process and on environmental product declarations (EPDs). Results should be considered in the context of any existing product category rules (PCRs) and each study should be evaluated according to minimum quality requirements and scored according to the quality and degree of relevance to the revision process for EU Ecolabel criteria.*
IV. *Task 4: Technical analysis. The material sourcing, production and possible recycling processes are broadly considered from a purely technical perspective, highlighting those areas where existing or potentially new EU Ecolabel criteria could apply. A more detailed technical analysis will be included in the subsequent technical reports for converted paper products.*

The study was carried out by the Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) with the support of The Institute of Sustainability in Civil Engineering (Institut für Nachhaltigkeit im Bauwesen - INaB), RWTH Aachen University, in cooperation with all interested stakeholders. All the results are presented on a dedicated website: http://susproc.jrc.ec.europa.eu/Converted_paper_products/.

2. Task 1: Scope and definition analysis

This section analyses the existing scope and definition of EU Ecolabel for converted paper products. It provides background to the legal, policy and technical framework in which converted paper lies as well as compare the existing EU Ecolabel scope and definition for the product group with those of industry and other ecolabel schemes. It also analyses stakeholders' feedback from the scoping questionnaire.

In conjunction with the adoption of the current criteria document on May 2014 (Decision 2014/256/EU), several statements listed below were requested to be further investigated in the occasion of the next revision. During the project, a feedback should be provided in respect of each of the listed points:

- Explore the feasibility of a more horizontal approach in relation to the equivalency of certified substrate fibres;
- Reassess the possibility of having a criterion on de-inkability and/or a criterion on reduced use of inks for envelops;
- Revise as soon as possible criteria for copying and graphic and newsprint paper in order to increase the mandatory content of sustainable/recycled fibres.

2.1. Current scope and definition

Current EU Ecolabel scope and definitions of the product group is based on the product description and its intended use. Following, Article 1 of Commission Decision 2014/256/EU[1]:

1. The product group 'converted paper products' shall comprise the following products:

(a) envelopes and paper carrier bags that consist of at least 90 % by weight of paper, paperboard or paper-based substrates;

(b) stationery paper products that consist of at least 70 % by weight of paper, paperboard or paper based substrates, except for suspension files and folders with metal fastener subcategories.

In the case referred to in point (b), the plastic component cannot exceed 10 % except for ring binders, exercise books, notebooks, diaries, and lever arch files where the plastic weight cannot exceed 13 %. Furthermore, the metal weight cannot exceed 30 g per product except for suspension files, folders with metal fasteners and ring binders where it can be up to 50 g and except for lever arch files, where it can up to 120 g.

2. The product group 'converted paper product' shall not include the following products:

(a) printed paper products included in the EU Ecolabel as established in Commission Decision 2012/481/EU (2);

(b) packaging products (with the exception of paper carrier bags).

Pursuant to Art 2(3), *'converted paper product' is a paper, paperboard or paper based substrates, either printed or unprinted, generally used to protect, handle or store items and/or notes, for which the converting process is an essential part of the production process, comprising three main categories of products: envelopes, paper carrier bags and stationery paper products*.

[1] OJ L 135, 8.5.2014, p. 24–48 (

Where:

- envelopes are designed for mailing purposes;
- paper carrier bags are designed for handling and/or transportation of goods and are the only packaging-like products included in the converted paper product group;
- stationery paper products cover a wide variety of paper products for writing/drawing and filing. Examples of stationery products can be grouped under purpose-related subcategories such as writing and filing.

In line with Art. 2(5), *converting process means a process whereby a material is processed into a converted paper product. This process can include a printing process (pre-press, press, and post-press operations)*.

Consequently, converted paper products included in the scope are used for mailing, filing, writing, storing, handling or carrying purposes. These products often contain non-paper components such as plastics and metals. The current scope takes into account the minimum permitted weight content of non-paper components that are required for the product functionality and durability.

2.1.1. Envelopes and Paper carrier bags

Envelopes are meant to maintain the privacy of the message. They are made mainly of paper although products made of synthetic material, i.e.; polyethylene, are also available on the market. Envelopes are usually sealed by wetting an area of the flap. Some of them are sealed with a metal fastener that is usually made of aluminium or other metals. The string that might be attached to some envelopes is mainly made of cotton. A recent development in envelopes is a thin strip of plastic, which is removed to reveal an area of the flap with an adhesive that does not need moistening.

Envelopes use to be rectangular and manufactured in a variety of sizes, and colours. They can be printed or unprinted, with or without window(s). Many envelopes have printed areas on the inside surfaces in order to conceal the contents; with or windows made up of plastic film; polypropylene (PP) or polystyrene (PS).

In the United States, standard sizes range from 89 × 152 mm to 254 x 330 mm. In Europe, sizes range from 81 x 114 mm to 280 x 400 mm. Sizes are somewhat different in the United Kingdom, with the most common being 108 x 219 mm[2].

Carrier bags are used to carry items usually from a retail store or supermarket (Figure 2). Most paper carrier bags are made up of paper folded and glued by the sides and at the bottom. Some have handles made of paper or textile material.

Paper bags cover a wide range of designs from the grocery bags to the fine art bags used to carry out gifts (decorative function). The main types of bags are as follows:

- Flat and satchel;
- Strip window;
- SOS (self-opening satchel).

The manufacturing process involves cutting, forming, and sealing (with adhesive) the paper material to form the final product.

[2] http://www.madehow.com/Volume-5/Envelope.html

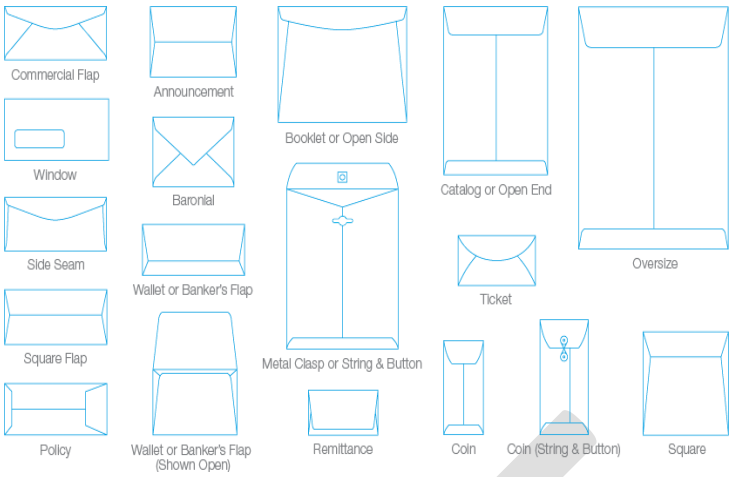


Figure 1. Different types of envelopes[3]

Figure 2. Flat and satchel paper bag[4]

Flat bags are the most basic form of bi-dimensional bags used to retail point of sale. Satchel bag have gussets (hence the term "satchel"), which allow the bag, once opened to become three dimensional. Both types of bags are use at the sale point. i.e. bag for postcard. Satchel bags can be supplied with window in one side allowing the product to be seen. By adding the hanger satchel bag is converted into basic carrier bags. Satchel bags may be used as carrier bags for point-of-sale use**Error! Bookmark not defined.**. SOS bags when fully opened are free standing, being ideally suited to serve as multiple opening bag, i.e. for sugar storage. The SOS bag can also be use as grocery bag, often with applied coatings, lamination, lacquers and protective lining materials incorporate into the bag.

Following the information found most of bags are produced from bleached or unbleached kraft pulp, and can be made from either coated or uncoated paper. Bags come in varieties of colours, patterns, and sizes, and can be printed (usually with flexo-printing) or unprinted. Satchel bags might have coating or inner ply of a protective material[5].

Nowadays, paper carry bags have the versatile use. In many places, the plastic carry bags have been replaced by paper carry bags. This is mainly due to restriction placed on lightweight plastic bags pursuant to Directive 2015/720.

[3] http://www.efoza.com/post_types-of-envelopes_394344/
[4] http://umcindia.in/Automatic%20Paper%20Bag%20Making%20Machine.html
[5] https://nextwhatbusiness.com/paper-bag-making-business/

2.1.2. Office stationary products

The products included in the current scope are stationery paper products that consist of at least 70 % by weight of paper, paperboard or paper based substrates, except for suspension files and folders with metal fastener subcategories. In line with the currently valid product group definition, the plastic components cannot exceed 10 % except for ring binders, exercise books, notebooks, diaries, and lever arch files where the plastic weight cannot exceed 13 %. Whereas, the metal weight cannot exceed 30 g per product except for suspension files, folders with metal fasteners and ring binders where it can be up to 50 g and except for lever arch files, where it can up to 120 g. 'Folders' mean folding cases or covers for loose papers, such as suspension files, indices and dividers, document wallet, 3-flap folders, and square cut folders; 'Binders' are paper-based products consisting of a cover, usually made of board, with rings for holding loose papers together, such as ring binders and lever arch files.

Within the group of stationary paper products there is a broad variety of goods, such as: folders, binders, notebooks, pads, notepads, exercise books, spiral-bound notebook, calendars with covers, diaries and loose-leafs; exercise books, notebooks and filing products contain metals and plastics. Metal components used are made of steel or iron, for example the ring/arch lever systems in folders or binders and the spiral binding of notebooks. Spiral rings in notebooks or calendars are coated with plastic polymers. Polypropylene is also used in most notebook plastic covers. Other stationery paper products such as autograph books, greeting cards and party or special occasion invite cards play a vital part in further increasing the business of these paper stationery products. All in all, the stationeries is a broad group of commodity which is mainly used to support office job, i.e. files and folders are important products required in any organization to store important documents, bills and other papers. Storage organizers are also essential in every office as it simplifies the task of documentation and work process. Possible segmentation of stationary paper product is indicated in Table 1 and Figure 3.

Figure 3. Examples of office stationary products

Table 1. Breakdown of stationery paper products by the scope of EU Ecolabel for converted paper products.

Sub-categories of stationery paper products
Writing purpose
Loose leafs
Exercise books and not books, notepads
Note books/pads
Spiral-bound notebooks
Flipcharts
Diaries
Albums
Calendars with cover
Filing purpose
Suspension files
Dividers
3-flap folders
Document wallet
Folders with metal fasteners
Sorters and part files
Lever arch files
Ring binders
Filing boxes

2.2. Scope of NACE classification

NACE Code 17 is dedicated to the economic activity: *Manufacture of pulp, paper and paper products*. There are essentially three activities included in this division: (1) manufacture of pulp, (2) manufacture of paper, and (3) manufacture of converted paper products. More than one of these activities is often carried out in a single manufacturing unit. Converted paper products are made from paper and other materials by various cutting and shaping techniques and can include coating and laminating activities. Thus according to NACE classification, ***converted paper products refer to further-processing of paper products by transforming it into the new article of different functionality***.

Furthermore, according to the NACE classification stationeries, including envelopes, fall under the sub-classification 17.23 (Manufacture of paper stationery) while paper carrier bags are included in the sub-category 17.21.

2.3. Existing legislations and standards

European environmental policies and legislations relevant to the topic are summarised in this chapter. Following its identification, specific EU legislations for printed paper products and several standards related to the environment, chemicals, health and safety have been analysed. The major impacts of printing processes are covered by European regulations which are applicable throughout the European Union. European legal

requirements have to be implemented via national legislation and are subsequently subject of implementation procedures at national level.

Moreover, a growing number of manufacturers are implementing environmental management schemes (e.g. EMAS) in order to improve their environmental performance. Standards, which also have a voluntary nature, such as BS EN 643:2014 on standard grades of paper and board for recycling can also being taken into account.

Two Technical Committees are active: The ISO/TC 6 committee on paper, board and pulp which develops standards on terminology, sampling procedures, test methods, product and quality specifications, and the establishment and maintenance of appropriate calibration systems and the ISO/TC 130 committee that addresses standardization in the field of printing and graphic technologies.

The main ecological labelling schemes, such as Nordic Swan, Blue Angel, NF Environment, Paper by Nature and the labels on forest management (FSC and PEFC) have been identified and analysed.

2.3.1. Legal framework

2.3.1.1. EU Ecolabel Regulation

The most directly relevant European Regulation is Regulation (EC) No 66/2010 on the EU Ecolabel. The Regulation shapes the way that criteria are examined and defines the processes and principles by which they should be developed. Some of the key points to bear in mind are that:

- Criteria shall cover the most significant environmental impacts, in particular, the impact on climate change, the impact on nature and biodiversity, energy and resource consumption, generation of waste, emissions to all environmental media, pollution through physical effects and use, and release of hazardous substances;
- It shall encourage reduction of hazardous substance use by: 1) substitution of hazardous substances by safer substances, 2) use of alternative materials, design or technologies which eliminate the need for hazardous substances, wherever technically feasible;
- The net environmental balance between the environmental benefits and burdens shall be covered, including health and safety aspects, at the various life stages of the products;
- To enhance synergies, criteria established for other environmental labels shall be considered, particularly labels that are officially recognised (nationally or regionally) and EN ISO 14024 type I environmental labels where they exist for that product group;

2.3.1.2. Chemical-based Regulations

The impacts of REACH Regulation (EC) No 1907/2006 are almost ubiquitous and the CLP Regulation (EC) No 1272/2008 is required to be addressed to one degree or another with all chemical substances and mixtures placed on the market. However, with EU Ecolabel criteria, these Regulations carry an even greater relevance due to Article 6(6), which make specific requirements for the non-presence of substances with certain hazard statements in the final product. Article 6(7) then makes an allowance for derogation

under certain circumstances although this shall not apply to any Substances of Very High Concern if they would be present at quantities >0.1%.

In paper processing, the use of fungicides and slimicides is commonplace and this means that the Biocidal Products Regulation (EC) No 528/2012 will have an influence on what chemicals can and cannot be placed on the market. While this is not a direct influence on any potential EU Ecolabel applicants (they can only buy products on the market) care must be taken due to the transitory nature of this Regulation, as certain biocidal products are being gradually phased out.

2.3.1.3. Industrial Emissions Directive

Directive 2010/75/EU on industrial emissions (IED) is the main EU instrument regulating pollutant emissions from industrial installations and has a strong influence on the European pulp and paper industry and is anticipated to have a strong role to play with the revised EU Ecolabel criteria.

The IED was adopted on 24 November 2010. It is based on a Commission proposal recasting 7 previously existing directives following an extensive review of the policy (EC, 2016). The IED entered into force on 6 January 2011 and had to be transposed by Member States by 7 January 2013.

The IED is based on several pillars, in particular (1) an integrated approach, (2) use of best available techniques, (3) flexibility, (4) inspections and (5) public participation.

The IED aims to achieve a high level of protection of human health and the environment taken as a whole by reducing harmful industrial emissions across the EU, in particular through better application of Best Available Techniques (BAT). Around 50,000 installations undertaking the industrial activities listed in Annex I of the IED are required to operate in accordance with a permit (granted by the authorities in the Member States). This permit should contain conditions set in accordance with the principles and provisions of the IED. The integrated approach means that the permits must take into account the whole environmental performance of the plant, covering e.g. emissions to air, water and land, generation of waste, use of raw materials, energy efficiency, noise, prevention of accidents, and restoration of the site upon closure.

The permit conditions including emission limit values must be based on the Best Available Techniques (BAT). In order to define BAT and the BAT-associated environmental performance at EU level, the Commission organizes an exchange of information with experts from Member States, industry and environmental organizations. This process results in BAT Reference Documents (BREFs); the BAT conclusions contained are adopted by the Commission as Implementing Decisions. The IED requires that these BAT conclusions are the reference for setting permit conditions.

According to paragraph 6.1 of the Annex I (Categories of activities referred to in Article 10) of the IED Directive: Industrial plants for the production of:

(a) pulp from timber or other fibrous materials;

(b) paper and board with a production capacity exceeding 20 tonnes per day,

are subject to the IED Directive rules and, in particular, they have to refer to the BREF, the Reference Document on Best Available Techniques (BAT), in order to reduce the environmental impacts associated to their productive processes.

The Best Available Techniques Reference Documents (BREF) on Production of Pulp, Paper and Board covers processes involved in the production of pulp and paper in integrated pulp and paper mills as well as non-integrated pulp mills (market pulp) and non-integrated paper-mills using market pulp.

In 2014, the best available techniques (BAT) conclusions, for the production of pulp, paper and board were established under IED Directive by means of Commission Implementing Decision 2014/687/EU.

BREF on Surface Treatment Using Organic Solvents (including Wood and Wood Products Preservation with Chemicals) is being revised. This BREF addresses installations for the surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating. The activities addressed are:

- printing (by heatset web offset, flexography and packaging gravure, publication gravure)
- painting and other coating activities (winding wires, cars, trucks, buses, trains, agricultural and construction equipment, ships and yachts, aircraft, wood and mirrors, furniture, metal coil, metal packaging, and other metal and plastic goods)
- waterproofing (by painting and wood preservation)
- adhesive application (in the manufacture of abrasives and adhesive tapes)
- cleaning and degreasing in conjunction with other surface treatment activities
- impregnation for the preservation of wood.

2.3.1.4. Renewable Energy Directive 2009/28/EC

The Directive establishes an overall policy for the production and promotion of energy from renewable sources in the EU. It requires the EU to fulfil at least 20% of its total energy needs with renewables by 2020 – to be achieved through the attainment of individual national targets. All EU countries must also ensure that at least 10% of their transport fuels come from renewable sources by 2020. The Directive specifies national renewable energy targets for each country, taking into account its starting point and overall potential for renewables. These targets range from a low of 10% in Malta to a high of 49% in Sweden[6].

2.3.1.5. Air Quality framework Directive

Council Directive 96/62/EC on ambient air quality assessment and management describes the basic principles as to how air quality should be assessed and managed in the Member States. It lists the pollutants for which air quality standards and objectives will be developed and specified in legislation. A substantial body of Community legislation adopted in relation to ambient air quality are summarised below and links the relevant documents provided.

- The **Directive 2008/50/EC** on ambient air quality and cleaner air for Europe;
- The **Directive 1999/30/EC** relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air.
- The **Directive 2000/69/EC** relating to limit values for benzene and carbon monoxide in ambient air.
- The **Directive 2002/3/EC** relating to ozone in ambient air.

[6] https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive

- The **Directive 2004/107/EC** relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air.
- The **Council Decision 97/101/EC** establishing a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution within the Member States. This "EoI Decision" describes the procedures for the dissemination of air quality monitoring data by the Member States to the Commission and to the public.
- The **Commission Decision 2004/461/EC** laying down a questionnaire for annual reporting on ambient air quality assessment under Council Directives 96/62/EC and 1999/30/EC and under Directives 2000/69/EC and 2002/3/EC of the European Parliament and of the Council.

2.3.1.6. Timber Regulation

Regulation (EU) 995/2010 lays down the obligations of operators who place timber and timber products on the market:

1) It prohibits the placing on the EU market for the first time of illegally harvested timber and products derived from such timber;
2) It requires EU traders who place timber products on the EU market for the first time to exercise 'due diligence'. The core of the 'due diligence' notion is that operators undertake a risk management exercise so as to minimize the risk of placing illegally harvested timber, or timber products containing illegally harvested timber, on the EU market.
3) Once on the market, the timber and timber products may be sold on and/or transformed before they reach the final consumer. To facilitate the traceability of timber products economic operators in this part of the supply chain (referred to as traders in the regulation) have an obligation to keep records of their suppliers and customers.

This Regulation covers a wide range of timber products listed in its Annex including solid wood products, flooring, plywood, pulp and paper. The application of the Regulation started in March 2013. The Regulation applies to both imported and domestically produced timber and timber products. Timber and timber products covered by valid FLEGT or CITES licenses are considered to comply with the requirements of the Regulation:

2.3.1.7. Policy framework

A number of different EU policies have a direct or indirect influence on the industry related to pulp and paper manufacturing and those with the most relevant influences are briefly summarized in this section.

Climate change strategy and targets

The EU has set itself targets for reducing its greenhouse gas emissions progressively up to the year 2050. The **2020 package** is a set of binding legislation to ensure the EU meets its goals and sets three key targets:

- 20% cut in greenhouse gas emissions (from 1990 levels)
- 20% of EU energy from renewables

- 20% improvement in energy efficiency

The targets were set by EU leaders in 2007 and enacted in legislation in 2009. They are also headline targets of the Europe 2020 strategy for smart, sustainable and inclusive growth.

Further key targets for the year 2030 have already been stated as follows:

- At least 40% cuts in greenhouse gas emissions (from 1990 levels)
- At least 27% share for renewable energy
- At least 27% improvement in energy efficiency

The framework was adopted by EU leaders in October 2014 and will build on the 2020 climate and energy package. It is also in line with the longer term perspective set out in the Roadmap for moving to a **competitive low carbon economy in 2050**, the **Energy Roadmap 2050** and the **Transport White Paper**. These targets are defined to put the EU on the way to achieve the transformation towards a low-carbon economy as detailed in the 2050 low-carbon roadmap.

The EU Emissions Trading System (EU ETS)

The EU emissions trading system (EU ETS) is the European Union's policy to combat climate change and cost-effectively reduce industrial greenhouse gas emissions. It is the first - and still by far the biggest - international system for trading greenhouse gas emission allowances that covers more than 11,000 power stations and industrial plants in 31 countries, as well as airlines and, of particular relevance to this report, the pulp and paper industry. The European Union Emission Trading System (EU-ETS) establishes quotas for CO2 emissions and allows trading emission abatements and surpluses. The cap is then reduced over time so that total emissions fall. In 2020, emissions from sectors covered by the EU ETS will be 21% lower than in 2005. By 2030, the Commission proposes, they would be 43% lower. Altogether the EU ETS covers around 45% of total greenhouse gas emissions from the 28 EU countries[7].

By putting a price on carbon and thereby giving a financial value to each tonne of emissions saved, the EU ETS has placed climate change on the agenda of company boards and their financial departments across Europe.

Third Energy Package

The third Energy Package is a legislative package for an internal gas and electricity market in the European Union. Its purpose is to further open up the gas and electricity markets in the European Union. The package was proposed by the European Commission in September 2007, and adopted by the European Parliament and the Council of the European Union in July 2009. It entered into force on 3 September 2009.

The Third Energy Package consists of two Directives and three Regulations:

- Directive 2009/72/EC concerning common rules for the internal market in electricity;
- Directive 2009/73/EC concerning common rules for the internal market in natural gas;
- Regulation (EC) No 714/2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003;
- Regulation (EC) No 715/2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No 1775/2005;

[7] http://ec.europa.eu/clima/policies/ets/index_en.htm

- Regulation (EC) No 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an Agency for the Cooperation of Energy Regulators.

Circular Economy Package

The Circular Economy Package includes revised legislative proposals on waste to stimulate Europe's transition towards a circular economy. The Circular Economy Package consists of an EU Action Plan for the Circular Economy[8] that establishes a concrete and ambitious programme of action, with measures covering the whole cycle: from production and consumption to waste management and the market for secondary raw materials. The proposed actions will contribute to "closing the loop" of product lifecycles through greater recycling and re-use, and bring benefits for both the environment and the economy.

The revised legislative proposals on waste set clear targets for reduction of waste and establish an ambitious and credible long-term path for waste management and recycling. Key elements of the revised waste proposal include:

- A common EU target for recycling 65% of municipal waste by 2030;
- A common EU target for recycling 75% of packaging waste by 2030;
- A binding target to reduce landfill to a maximum of 10% of all waste by 2030;
- A ban on landfilling of separately collected waste;
- Promotion of economic instruments to discourage landfilling;
- Simplified and improved definitions and harmonised calculation methods for recycling rates throughout the EU;
- Concrete measures to promote re-use and stimulate industrial symbiosis - turning one industry's by-product into another industry's raw material;
- Economic incentives for producers to put greener products on the market and support recovery and recycling schemes (eg for packaging, batteries, electric and electronic equipments, vehicles).

Guidelines on State aid for environmental protection and energy 2014-2020

The Guidelines provide criteria for the assessment of the compatibility of capacity mechanisms with State aid rules[9]. The guidelines on public support for environmental protection and energy address feed- in tariffs and many other aids. The Commission had identified several environmental and energy measures for which state aid under certain conditions may be compatible with the internal market under Article 107(3)(c) TFEU. The new guidelines both support Member states in reaching their 2020 climate targets and address the market distortions that may result from subsidies granted to renewable energy sources. The guidelines are designed to foster a gradual move to market-based support for renewable energy. Preferential feed-in tariffs will gradually be replaced by feed-in premiums, which expose renewable energy sources to market signals. There is also a special regime for small installations[10].

Biomass Action Plan

In 2014, the European Commission published a report on the sustainability of solid and gaseous biomass for heat and electricity generation. The report includes information on

[8] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Closing the loop - An EU action plan for the Circular Economy COM/2015/0614 final

[9] Communication from the Commission — Guidelines on State aid for environmental protection and energy 2014-2020 OJ C 200, 28.6.2014, p. 1–55

[10] Mäntysaari, P. 2015. EU Electricity Trade Law: The Legal Tools of Electricity Producers in the Internal Electricity Market. Springer, 614 pp.

current and planned EU actions to maximise the benefits of using biomass while avoiding negative impacts on the environment.

The European Commission has issued non-binding recommendations on sustainability criteria for biomass. These recommendations are meant to apply to energy installations of at least 1MW thermal heat or electrical power. They:

- Forbid the use of biomass from land converted from forest, and other high carbon stock areas, as well as highly biodiverse areas.
- Ensure that biofuels emit at least 35% less greenhouse gases over their lifecycle (cultivation, processing, transport, etc.) when compared to fossil fuels. For new installations this amount rises to 50% in 2017 and 60% in 2018.
- Favour national biofuels support schemes for highly efficient installations.
- Encourage the monitoring of the origin of all biomass consumed in the EU to ensure their sustainability.

Forest related policies

Key European cross-cutting policies that address forestry and support the implementation of sustainable forest management include:

- Forest Action plan 2007-2011;
- Rural Development Policy;
- Plant Health and Reproductive Materials Strategy;
- Biodiversity and Bioeconomy Strategies.

The 1998 EU Forestry Strategy[11] established a framework for forest-related actions that support sustainable forest management and are based on cooperative, beneficial links between EU and Member State policies and initiatives. The Forest Action Plan 2007-2011 was an important instrument for implementing the strategy and addressed four objectives: competitiveness, environment, quality of life and coordination and communication.

The EU strategy for forests and the forest-based sector promotes a coherent, holistic view of forest management, covers the multiple benefits of forests, integrates internal and external forest-policy issues, and addresses the whole forest value-chain[12]. All EU Member States have signed up to and are bound by FOREST EUROPE commitments to manage their forests sustainably, according to their national forest policies and legislation.

Market-based Sustainable Forest management initiatives

Sustainable forest management (SFM) uses very broad social, economic and environmental goals. A range of forestry institutions now practice various forms of sustainable forest management and a broad range of methods and tools are available that have been tested over time and space. In 2006 the World Bank Global Forest Alliance published together with the World Wildlife Fund for nature (WWF) the Forest Certification Assessment Guide (FCAG) wherein the criteria for SFM are specified.

SFM does not in itself establish the link between the forestry and the final product. Chain of Custody (CoC) certification is a mechanism that allows establishing the verification system of the material flow along the supply chain. It tracks back the certified products from forest to shelf, providing the link between production and consumption. The Chain-

[11] Council Resolution of 15 December 1998 on a forestry strategy for the EU COM(2006) 302
[12] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A new EU Forest Strategy: for forests and the forest-based sector. COM(2013) 659 final

of-Custody (CoC) certification attests that all of the wood used in the product originates from responsibly-managed forests.

Two main schemes now dominate the market for ensuring that wood in final products can be assured to be from sustainably managed forests, FSC and PEFC.

Chain-of-Custody (COC) certification attests that all of the wood used to make the certified paper comes from responsibly-managed forests. The wood is tracked from the forest, through the pulping process, to the paper mill, then to the merchant and printer.

FSC[13] and PEFC[14] are by far the two dominant international forest certification schemes that set requirements for the sustainable management of forestry and require third party verification of the chain of custody for timber products. As suggested by the Central Point of Expertise on Timber (CPET) FSC and PEFC certification schemes provide a high level of assurance in their verification of the chain of custody.[15]

There are three methods allowed for tracing the origins of forest-based products, tailored to the situation and needs of certified companies.

- The percentage system – this mechanism allows mixing certified and non-certified raw material during the production or trading process. The non-certified material has to be either from controlled sources/wood or reclaimed material. The resulting percentage on the output side reflects the average of the inputs. ;
- The transfer system – output claims are based on the lowest type of input claim. If the input is 100% certified, the output can be claimed as 100% certified. If the input contains also 70% certified materials, ALL output can be claimed as 70% output only. This is the system that can be used for the FSC 100% label only;
- The credit system - the company can mix different inputs and it can allocate "mix credit" claims to a certain part of the outputs. As the inputs always have to be at least from controlled wood/sources, the parts that cannot be claimed as "mix" can be claimed as "controlled"

Approximately 9% of the world's forest is certified by FSC and/or PEFC, with rates being much higher in Europe.

2.3.2. Paper industry terminology and classifications

According to the definition of the Confederation of European Paper Industries (CEPI): "*Paper is a generic term for a range of materials in the form of a coherent sheet or web, excluding sheets or laps of pulp as commonly understood for paper making or dissolving purposes and non-woven products, made by deposition of vegetable, mineral, animal or synthetic fibres, or their mixtures, from a fluid suspension onto a suitable forming device, with or without the addition of other substances. Papers may be coated, impregnated or otherwise converted, during or after their manufacture, without necessarily losing their identity as paper. Whereas board / paperboard is a generic term applied to certain types of paper frequently characterized by their relative high rigidity*" (CEPI, 2014).

Following the classification of CEPI, paper and board products are the main output of the pulp and paper industry, and include several different paper and board product

[13] See: https://us.fsc.org/en-us/certification

[14] See: http://www.pefc.org/certification-services/overview

[15] CPET, UK Government timber procurement policy – definition of legal and sustainable for timber procurement. April 2010

categories as defined in Table 2. The primary distinction between paper and board is normally based upon thickness or grammage (g/m2), though in some instances the distinction will be based on the physical characteristics (e.g. rigidity) and/or different intended functional use (e.g. book covers vs packaging). The revised EU Ecolabel criteria for graphic paper does not accommodate the grammage threshold as differentiation between paper or board, and criteria are developed addressing paper substrate made for graphic, printing or conversion purposes[16].

Depending on the market and product type, converted paper products can be produced from graphic, packaging and other paper and board grades.

Table 2. CEPI paper and board definitions (CEPI, 2014)

Graphic papers	
Newsprints	Paper used for printing newspapers is largely made of mechanical pulp and/or paper fro recycling, with or without a small amount of filler. Products in this category are generally manufactured in strips or rolls of a width exceeding 36 cm or in rectangular sheets with one side exceeding 36 cm and the other exceeding 15 cm in the unfolded state. Weights usually range from 40 to 52 g/m2 but can be as high as 65 g/m2. Newsprint is machine finished or slightly calendered, white or slightly coloured and is used in reels for letterpress, offset or flexo printing.
Uncoated printing and writing papers	***Mechanical***: Paper suitable for printing or other graphic purposes where less than 90% of the fibre furnish consists of chemical pulp fibres. This grade is also known as groundwood or wood-containing paper and magazine paper, such as heavily filled supercalendered paper (SC) for consumer magazines printed by the rotogravure and offset methods. It excludes wallpaper base. ***Woodfree***: Paper suitable for printing or other graphic purposes, where at least 90% of the fibre furnish consists of chemical pulp fibres. Uncoated woodfree paper can be made from a variety or furnishes, with variable levels of mineral filler and a range of finishing processes such as sizing, calendering, machine glazing and watermarking. This grade includes most office papers, such as business forms, copier, computer, stationery and book papers. Pigmented and size press "coated" papers (coating less than 5 g per side) are covered by this heading. It excludes wallpaper base.
Coated Printing and Writing Papers	Printing and writing papers, except newsprint, which have been coated on one or both sides with coating materials such as clay (beneficiated kaolin), calcium carbonate, barium sulphate, gypsum or zinc oxide, often supplemented with supercalendering, etc. It includes coated paper produced at the paper mill from base paper manufactured for own use or purchased, together with all paper made and coated in a single operation on the papermaking machine. It includes raw carbon and self-copy paper in rolls or sheets. It excludes other copying and transfer papers. ***Mechanical:*** made of fibres produced mainly (90%) by a mechanical pulping process and are also known as coated groundwood. ***Woodfree:*** Made of fibres produced mainly (90%) by a chemical pulping process and are also known as coated freesheet.
Packaging Papers	
Packaging Papers	Mainly used for wrapping and packaging purposes. Products in this category are generally manufactured in strips or rolls of a width exceeding 36 cm or in rectangular sheets with one side exceeding 36 cm and the other exceeding 15 cm in the unfolded state. It excludes unbleached kraft paper and paperboard that are not sack kraft paper or Kraftliner and weighing more than 150 g/m² but less than 225 g/m²; felt paper and paperboard; tracing papers; not further processed uncoated paper weighing 225 g/m² or more. It is reported in metric tonnes.
Sanitary and Household	
Sanitary and	Tissue and other hygienic papers for use in households or commercial and industrial

[16] For further details please check: http://susproc.jrc.ec.europa.eu/Paper_products/documents.html

Household	premises. Some tissue is also used in the manufacture of baby nappies, sanitary towels, etc. The parent reel stock is made from virgin pulp or recovered fibre or mixtures of these. It is reported in the production statistics at parent reel weight before conversion to finished products. Import and export statistics however take into account trade in both parent reels and finished products. Includes types of creped and uncreped papers such as disposable tissues, facial tissue, napkin, sanitary wadding, toilet tissue towelling, and wiper stock.
Other Paper and Board	
Other Paper and Board *(without further sub-classification)*	Other papers and boards for industrial and special purposes. It includes cigarette papers and stock of filter papers, as well as gypsum liners and special papers for insulating, roofing, waxing, asphalting and other specific applications or treatments; wallpaper base; unbleached kraft paper and paperboard that are not sack kraft paper or kraftliner and weighing more than 150 g/m² but less than 225 g/m²; felt paper and paperboard; tracing papers; not further processed uncoated paper weighing 225 g/m² or more; and raw copying and transfer papers, in rolls or sheets except carbon or self-copy paper. It excludes all composite, not coated, paper and paper board of flat layers stuck together; coated paper and paperboard not uniformly bleached throughout the mass; and paper and paperboard covered or coated with plastics (excluding adhesives).

EN 643 defines paper and board for recycling as natural fibre-based paper and board suitable for recycling; consisting of paper and board in any shape or product made predominantly from paper and board, which may include other constituents that cannot be removed by dry sorting, such as coatings, laminates, spiral bindings, etc (EN, 2013).

EN 643 makes use of the "European Recovered Paper Identification System" (RPID) to improve the traceability of the paper mill's supply and consequently the safety and security of paper production processes and products. The term Recovered Paper and Board has been substituted by the term Paper and Board for Recycling to highlight the intended use of this secondary raw material for paper recycling only. Furthermore, the European Recovered Paper Council has similarly changed the terminology within the new Declaration on Paper Recycling 2016–2020 (EPRC, 2016).

The standard establishes the tolerance level for unwanted materials (maximum of 1.5% for the majority of grades), along with the list of prohibited materials which presence should be directly notified to the supplier and the load should be returned. The concept of classification of recycled paper in reference to its origin (e.g. newsprints, wrapping) and grades help categorize waste paper for recycling, facilitate its trade, and organise collection, sorting, and re-processing.

2.3.3. Environmental labels and certification schemes

The International Organization for Standardisation (ISO) 1402X series of standards deals specifically with aspects of environmental labels and declarations. They define three broad types of voluntary labels:

Type I: voluntary, multiple-criteria based, third party program that awards a license that authorises the use of environmental labels on products indicating overall environmental preference of a product within a particular product category based on life cycle considerations. ISO 14024 lists the guiding principles for Type 1 Ecolabels;

Type II: self-declared environmental claim, i.e. environmental claim that is made, without independent third-party certification, by manufacturers, importers, distributors, retailers or anyone else likely to benefit from such a claim, in line with ISO 14021;

Type III: voluntary programs that provide quantified environmental data of a product, under pre-set categories of parameters set by a qualified third party and based on life cycle assessment, and verified by that or another qualified third party in line with ISO 14025.

ISO 14024 establishes that the life cycle of a product has to be considered in order to identify environmental impact hotspots for which thresholds are defined. The EU Ecolabel for converted paper products encourages the manufacturing of goods with reduced environmental impacts. The scheme is based on multiple criteria over the entire life cycle of the product category, addressing the most significant environmental impacts and the net environmental balance between the benefits and burdens products (Regulation EC 66/2010).

Apart from EU product policies, there are other national/regional ecolabel schemes that addresses products included in the current scope of the EU Ecolabel for converted paper products, such as: Nordic Swan (Ecolabelling, 2011), Blue Angel (Blue Angel, 2009), US Green Seal (Green Seal, 2013), Austrian Ecolabel (Austrian Ecolabel, 2013), French NF Environnement (Afnor Certification, 2011).

For the specific aim of the product group analysis, the main European and non-European Ecolabel schemes and standards that address converted paper product were analysed. The schemes were selected due to their market penetration, their recognition on the market and because they are usually used as benchmarks during the EU Ecolabel criteria development process. The way in which the scope of analysed labels is defined brings up additional indication on the possible scope recommendation. The summary of this study is presented in Table 3. More detailed information can be found in ANNEX I.

Table 3. Summary of the products covered by the scope of other Type I Ecolabels relevant to EU Ecolabel for converted paper products

Type I ecolabel	Criteria/ Standard
Blue Angel	**RAL-UZ 14** Recycled paper Finished products made from recovered paper for office and school demand
	RAL-UZ 56 Recycled cardboard (including finished products folders, binders)
Green Seal	GS-7
Nordic Swan	Printing companies, printed matter, envelopes and other converted paper products
NF Environnement	Cahier
	Enveloppes
	Sac Cabas

The current scope of EU Ecolabel for converted paper products does not entirely match with any product group addressed by the other schemes identified. It is rather distributed between different product categories/groups therefore needs to be analysed on the individual base.

The Blue Angel

Converted paper products are required to be made of recycled paper. The product groups that partially correspond to the scope of EU Ecolabel for converted paper products are addressed by Part (a) and Part (b) of DE-UZ 14. Criteria RAL-UZ 14 refers to finished products made up of recycled paper with a tolerance of 5% for virgin fibre:

- DE-UZ 14 a) - Recycled paper for the production of graphic paper according to the grade statistics for "Graphic Paper" from the German Pulp and Paper Association (Verband Deutscher Papierfabriken e.V.);

- DE-UZ 14 b)- Finished products made from recycled paper for office and school supplies, as well as colouring books and gift wrapping paper.

Printed matter which is also related to the product group under revision comes under the scope of DE-UZ 195.

Concerning non-paper components, RAL-UZ 14a sets a threshold of 5% w/w of other materials such as plastic and metal in the finished product. On the other hand, no requirement on non-paper content is mentioned for folders and binders to be certified under RAL-UZ 56.

Filing materials such as folders and binders as well as recycled cardboard used in their assembling are covered by the basic criteria RAL-UZ 56. There are no separate requirements for cardboard unlike in the case of RAL-UZ 14a which is designed specifically for graphic paper.

There are 205 products certified under RAL-UZ 14b and 320 under RAL-UZ 56. RAL-UZ 14a has registered 305 products including carrier bags (5 products) and waste bags (16 products).

Green Seal

The Green Seal GS-7 for *Printing and writing paper* covers some paper stationery products as defined in the EU Ecolabel (Commission Decision 2014/256/EU). It also encompasses various paper types used for drawing, printing and copying as follows:

This Green Seal standard includes recycled content requirement for high-speed copy paper, offset paper, forms bond, computer printout paper, file folders, and white woven envelopes, and for other uncoated printing and writing paper, such as writing and office paper, book paper, cotton fiber paper, and cover stock. These products shall contain at least 30 percent post-consumer materials, understood as paper fibre.

The Nordic Swan

The Nordic Swan Criteria "*Printing companies, printed matter, envelopes and other converted paper products*" refers to the production of printed matter by a printing company. This also includes the production process used by manufacturers of envelopes. Likewise, other printed matter without printing (e.g. post-it notes or note pads without printing) is included in the scope of this Nordic Swan Criteria document.

This is the only Type 1 Ecolabel with the term "converted paper products" but it does not provide a definition, nor indicate processes involved in the converting process. The Nordic Swan ecolabel is awarded to printing houses and hence to their related printed/manufactured products such as office paper stationeries and packaging bags, printed books, calendars, newspapers and labels, gift wrappings.

As of 2017, a total of 354 printing houses are awarded with Nordic Swan licenses, however this is not an indication of the number of converted paper products as the printing houses might or might not have converted paper among their products.

NF Environnement

The French NF Environnement label is provided for exercise books (cahier) and envelopes (enveloppes et pochette postales). There are nine license holders for envelopes with 769 products certified while no license holder nor certification exists for exercise books. The French based supplier for office and school products, Hamelin Brands, was the sole license holder for exercise books until 2017 when they decided to

switch to the EU Ecolabel. Hence, the criteria for exercise books will be withdrawn by 2019.

In regard to the requirements established under EU Ecolabel criteria for converted paper products, the scheme addresses environmental aspects coming from wood sourcing, pulp, paper and converted paper products manufacturing, use phase and waste management (Table 4). The Nordic Swan label, Austrian Ecolabel and the French NF Environment certification are also based on a holistic evaluation of environmental impact arising from the production of goods included in the scope. Not only the environmental effects of the use phase are considered but also the production process, disposal as well as quality and fitness for use. In addition, the Austrian Ecolabel addresses the transport and distribution phase.

Table 4. Converted paper product life cycle aspects addressed by different schemes

Type 1 Ecolabel	Fibre recovery	Wood sourcing	Chemicals	Energy	Emissions	Waste
EU Ecolabel	X	X	X	X	x	X
Nordic Swan	X	X	X	X	X	X
Austrian Ecolabel	X	X	X	X	X	X
NF Environnement	X	X	X	X	X	X
German Blue Angel	X	X	X			
El Distintiú	X	X	X			

Furthermore, the environmental labels identified do not provide a clear definition of converted paper products nor conversion process; rather they list the products which are eligible to be certified. Table 4 indicates the specific schemes that addresses converted paper products as defined in Commission Decision 2014/256/EU.

2.4. Stakeholders survey – scoping questionnaire

The initial scoping questionnaire brought relatively limited results. The feedback was collected from 9 stakeholders, as follows: 3 replies represent industry, 4 - Member States, 2 – NGOs, and one represents another type of activity.

As indicated below (Figure 4), stakeholders clearly expressed the need to revise/change the current scope and definition of the product group. The name of the product group was assumed as well reflecting the scope and definition. Still, 2 out of 9 stakeholders agreed that the product group name "stationary paper products" would be more adequate to describe the products covered by the current scope (6 stakeholders expressed no preference in respect).

The grammage threshold was withdrawn from the EU Ecolabel for graphic paper, being assumed as not consistent with the industry practice. Nevertheless, majority of stakeholders did not agree to withdraw the grammage threshold from the criteria for converted paper products. The grammage threshold establishes the differentiation between substrate requirements for graphic paper (Part A) and paper board (Part B). The requirements for board are based on the graphic paper approach, with additional specification for the board making process. In this sense, the majority of stakeholders agreed that the requirement for paper substrate (both board and graphic paper) should be harmonised with recently revised EU Ecolabel for graphic paper. (additional requirement for product lamination and board production should be added, when applicable). Hence, merging part A and B of the currently valid criterion 1 seems

justified. This would consequently require the withdrawal of the reference to grammage. The answers gathered during the survey are therefore assumed not to be consistent.

In regard to the question that refers to the threshold for non-paper material content in the final product, the majority of stakeholders expressed a neutral opinion, without providing any further details. The magnitude of possible changes (if applicable) should therefore be further clarify/discuss during the upcoming technical meetings.

Some additional comments and suggestions in regard to the to the scope and definition of the product are as follow:

- The revise the feasibility to certify brown envelopes; i.e. envelopes produced out of kraft paper;
- To simplify the requirements for board substrate;
- To revise the threshold for non- paper material content (plastic and metal) i.e. plastic windows in envelopes, metal based mechanisms for arch levers files.
- Packaging products should be allowed to be labelled;
- Use of PVC in the product should be excluded;
- It should be clarified if the following items are included: bags for grocery shopping, bags for separate collection of wastes (e.g. for recycled paper or food waste), wrapping paper, wallpapers.

Q1.	*Should the scope and definition be amended?*
Q2	*The differentiation between paper and board is establish by the grammage threshold (400 g/m2). Should this distinction be withdrawn*
Q3	*Do you think the product name "Converted paper products" is adequate and reflects the scope of the product group?*
Q4	*Do you think that the name "stationary paper products and carrier bags" reflects the scope of the product group in a more appropriate way?*
Q5	*Please provide state your opinion on the following statements referring to non-paper contents in point b) of the scope definition: The percentage threshold for plastic component reflects existing technologies for manufacturing binders, exercise books, notebooks, diaries and lever files.*
Q6	*Please provide state your opinion on the following statements referring to non-paper contents in point b) of the scope definition: The percentage threshold for plastic component should be 10% with no exceptions for binders, exercise books, notebooks, diaries and lever files*
Q7	*Please provide state your opinion on the following statements referring to non-paper contents in point b) of the scope definition: Metal threshold of 300g for lever arch files reflects existing manufacturing technologies.*

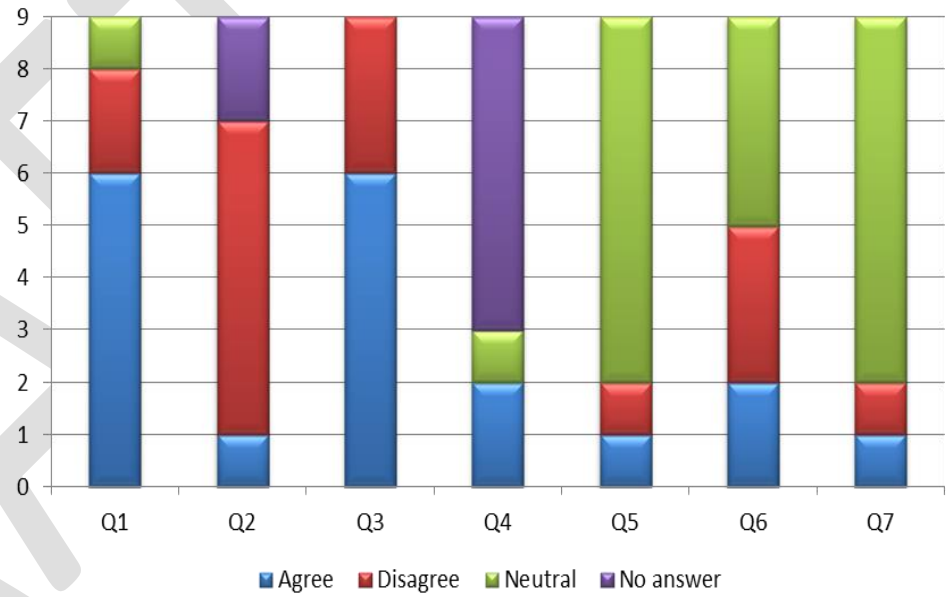


Figure 4**.** Feedback collected on the scope and definition of the product group

Q1.	*Should criterion 1 Part A (paper substrate) and Part B (board substrate) be merged into one common requirement?*
Q2	*Criterion 1 - Part A (applies to paper raw material up to grammage 400g/m2). Should the criterion be harmonized with EU Ecolabel for graphic paper?*
Q3	*Criterion 1 - Part B (applies to board substrate with the grammage higher than 400g/m2). Should the requirement be harmonized with EU Ecolabel for graphic paper, (incorporating additional requirement for product lamination and board production, when applicable)?*
Q4	*Criterion 1 - Part B -For board production - the recent BREF document (2013) and BAT conclusions (2014) should be used as the appropriate ambition level for emissions to water and air of P, S, NOx and COD?*
Q5	*Criterion 1 - Part B - (P, S, NOx and COD) Whenever applicable, Criterion B1 (a) should be harmonized with graphic paper requirements?*
Q6	*Criterion 1 - Part B - AOX emission- Whenever applicable, Criterion B1 (b) should be harmonized with graphic paper requirements?*
Q7	*Criterion 1 - Part B - CO2 emissions - Whenever applicable, Criterion B1 (c) should be harmonized with graphic paper requirements?*
Q8	*Energy use - Should Part A and Part B (B2) be merged?*
Q9	*Part B - Criterion 2 - The requirement should be harmonized with EU Ecolable for graphic paper, and incorporate additional requirement for product lamination and board production, when applicable)?*

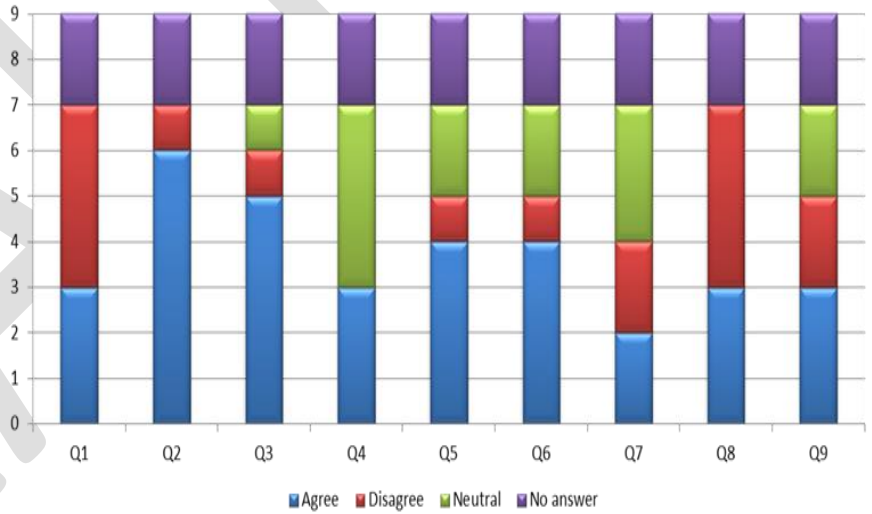


Figure 5 Revision of the EU Ecolabel criterion for substrate – questionnaire results

2.5. Concluding remarks on the scope and definition

Paper converting industry usually refers to operations that aim at transforming raw paper substrate into new finished products, such as: books, envelopes, paper tubes, paper towels, diapers, paper bags, boxes, containers, and a full range of other paper-based articles of different function and destination.

The ISO 4046-1 2016 defines converting as the manufacture of products by processes or operations applied after the manufacturing of basic paper or board. This general understanding is also reflected in the NACE code 17 which splits product assembly into the manufacture of pulp, paper and converted paper products, the latter referring to further-processing paper and paper products. Hence, the broad category of the term "*converted paper products*" when compared to the specific definition of product under the current EU Ecolabel scope and definition (stationery paper products,, envelopes, and paper bags) can make it difficult to identify what products are to be considered. It should also be mentioned that envelopes are assumed to be stationery products following the NACE classification industry practice.

Non-paper content
Information provided by manufacturers show that envelopes and paper carrier bags usually contain barely 3.5% of non-paper content. In the case of other paper stationeries, though no threshold for metal and plastic content was identified for folders and binders, the Blue Angel RAL-UZ 14a specifies a 5% threshold for printing and writing paper products.

2.5.1 Interrelation between the criteria for converted and printed paper product groups

Some schemes, such as Nordic Swan, accommodate converted and printed paper products under one scope and definition (singular product group). This stems from an interrelation between the product groups, given that printing process might form a part of converted paper product manufacturing i.e. printing of envelopes, notebooks. etc. This overlap is also reflected in the current EU Ecolabel criteria for converted and printed paper products. Table 5 presents an overview of the criteria for converted, and printed paper product groups. It distinguishes the criteria areas that are product specific. In fact, the key difference observed between the criteria sets lies in the requirements on waste management and corresponding thresholds established for each activity. Additionally, converted paper product might include metal and plastic elements.

The EU Ecolabel is part of a wider package of product policy instruments that contribute to the Circular Economy. The Fitness Check (evaluation study and stakeholder consultation) results show that the uptake of the schemes could be better and more efficient if applying a more focused approach to maximize impacts on the ground (European Commission, 2017). In order to improve the performance of the EU Ecolabel scheme and make it more focused to ensure bigger cumulative impact a more targeted approach should be addressed. It should include bundling of closely related product groups where appropriate.

With the objective to ensure coherency between different product groups, and to avoid redundancy, it is preferable to tend towards aggregating within the same product group category similar articles for which analogous criteria could apply.

The above mentioned Fitness check conclusions support the idea to merge both Decisions into one (i.e. as currently being done for graphic and tissue paper). On the

other side, as most products are printed and converted, these two product groups could also be merged into one Annex.

Furthermore, the magnitude of correlation between the product groups justifies the preparation of one Technical Report that will address the common issues, and separate these areas that are product specific.

The scope and definitions of merged product groups should be further explored and discussed with stakeholders.

Table 5 Comparison between the criteria subject matter for converted paper products and printed paper products

Criterion	*Printed Paper (PP) Decision 2012/481/EU*	*Converted Paper Products (CPP) Decision 2014/256/EU*	*Substantial dissimilarities between the valid criteria sets*
Substrate requirements	**1**	**1**	X*
	1 (a) Referred to EU Ecolabel for graphic paper (2011/333/EU)	1 (a) Referred to EU Ecolabel for graphic paper (2011/333/EU), for newsprint paper (2012/448/EU)	X*
	1 (b) Referred to EU Ecolabel for newsprint paper (2012/448/EU)	1 (b) Board Substrate requirements	CPP accommodates the use of board the main differences consist in a specific requirements for lamination, and board manufacturing. Requirements for board substrate that accommodate lamination and board manufacturing
Fibres: sustainable forest management	(requirement covered by EU Ecolabel for graphic paper, and newsprint paper)	**2**	*X (different thresholds set for the content of uncertified material)
Excluded or limited substances and mixtures	**2**	**3**	X*
Hazardous substances and mixtures	2 (a)	3 (a)	X*
Substances listed in accordance with Article 59(1) of Regulation (EC) No 1907/2006	2 (b)	3 (b)	X*
Biocides	2 (c)	3 (c)	X*
Washing agents	2 (d)	3 (d)	X*
Alkylphenolethoxylates — Halogenated solvents — Phthalates	2 (e)	3 (e)	X*
Printing inks, toners, inks, varnishes, foils and laminates	2 (f)	3 (f)	X*
Metal components	-	3 (g)	Applicable only to CPP (stationary paper products)
Recyclability	**3**	**4**	CPP does not include de-inkability requirement
Emissions (from printing process)	**4**	**5**	
Emissions to water	4 (a)	5 (a)	X* (*In the CPP criterion the*

Criterion	*Printed Paper (PP) Decision 2012/481/EU*	*Converted Paper Products (CPP) Decision 2014/256/EU*	*Substantial dissimilarities between the valid criteria sets*
			recommended test methods are specified for rotogravure printing)
Emissions to air	4 (b)	5 (b)	X*
Emissions from publication rotogravure printing	4 (c)	-	Applicable only to PP
Printing processes to which no legislative measures apply	4 (d)	-	Applicable only to PP
Waste	**5**	**6**	
Waste management	5 (a)	6 (a)	X*
Waste paper	5 (b)	6 (b)	CPP sets the threshold for the specified type of product (envelopes, stationary, and paper bags), and accommodates printing and conversion process. PP sets the threshold in function of the type of printing technique used.
Energy use	**6**	**7**	X*
Training	**7**	**8**	X*
Fitness for use	**8**	**9**	X*
Information on the product	**9**	**10**	X*
Information appearing on the EU Ecolabel	**10**	**11**	X*

* no substantial differences in the subject matter of the requirement were observed

Key aspects identified for the further consideration when discussing the product groups merging are as follows:

1. Scope and product group definition

Conversion process aims at creating a new "made of paper" product such as envelope, notebook, book or magazine, among others. In this line, printing process that in principle falls under the scope of EU Ecolabel for printed paper products could be incorporated into the revised scope and definition. This is in line with the current criteria that accommodate requirements for the product that is both printed and converted. The exact wording of the merged product groups should be further discussed with stakeholders.

2. Paper substrate

Under the currently valid criteria for converted paper products paper substrate is separated into two material types:

`**Board substrate'**: means paperboard, cardboard or board, unprinted and not converted, with a basis weight higher than 400 g/m²;

`**Paper substrate'** means paper sheets or reels of not converted, unprinted blank paper and not converted boards up to basis weight of 400 g/m²;

This distinction is built on the former scope of EU Ecolabel for copying and graphic paper with the grammage restrictions (upper limit of 400 g/m2). Nevertheless, within the revision of EU Ecolabel criteria for graphic paper, the grammage restriction was assumed as being misleading and not related to the industry practice, and consequently removed. Hence, the reference to grammage threshold is proposed to be withdrawn, harmonising

the approach with the revised scope of EU Ecolabel for graphic paper. In this line, criteria developed within the revision of EU Ecolabel for graphic paper are proposed to serve as key reference. This way it is possible to increase the uptake of the paper based product groups. Harmonisation will also simplify the administrative procedure required for the criteria verification. This might imply merging of Part A and B of substrate requirement. The differences between Part A and B i.e. energy consumption during lamination and board production should be further discussed with stakeholders.

Fibres: sustainable forest management requirement refers to paper substrate. It is therefore proposed to be integrated under Criterion 1. The sustainable forest management criterion developed during the revision of graphic and tissue paper product groups should be taken as the starting point. It needs to be confirmed if the level of sustainable fibre (certified virgin and/or recycled) content is transferable to the finished products, taking into account life cycle consideration, market availability of certified material and companies marketing strategies for green products.

Last but not least, within the revision process, the following substrate-related aspects should be further discussed with stakeholders:

1. Should only EU Eco-labelled paper substrates be allowed (as it is now the case for Printed Paper) or should alternative means of proof apart from an EU Ecolabel certificate for the paper substrate be allowed?
2. Could other ISO 14024 type I officially recognized ecolabel be considered as equivalent to the EU Ecolabel?
3. Should the paper substrate used in Printed and Converted Paper need to comply with all or only the main criteria of the revised criteria for Graphic Paper?
4. Is an exemption for certain paper components, like back labels for folders needed?

3. Excluded or limited substances and mixtures – metal components

The requirements is product specific and refers to type of stationary paper products, i.e. suspension files can, in weight, include 25% of metal (bar & eyelets); lever Arch files can easily include 18% of metal. In filing products, 3 different kind of metal parts can be considered:

- Metal bar for suspension file is made of steel with nickel surface treatment.
- Mechanisms for ring binder and lever arch file are made of steel with nickel surface treatment.
- Flat metal bar for folder consists of steel with tin surface treatment.

The criterion is based on Toy Standard of Nordic Swan Label and addresses products used for coating and surface treatment.

4. Recyclability

De-inkability requirement is not considered under the current recyclability criterion for converted paper products. Use of deinkable flexo-inks was assumed not to bring a measurable environmental improvement (Background Report, 2013)[17]. It is nevertheless accommodated under criteria for printed paper. The deinking efficiency depends on printing method, printing substrate type, and printing ink chemical composition (Carre and Galland, 2007)[18]. Considering the product that is both printed and converted (i.e. envelopes), the need to harmonised the de-inkability requirement between the product groups should be further explored in line with the Commission statements for converted paper products.

[17] Bureau Veritas. 2013. Converted Paper Products. The EU Ecolabel criteria Background Report.
[18] Carré,B., and Galland,G. (2007). "Overview of deinking technology,"8th CTP/PTS Deinking Training Course, Grenoble ,pp.1-24.

5. Waste – waste paper

The quantity of waste paper generated during production process might be assumed as of particular discrepancy between converted paper products and printed paper products. In case of converted paper products, criterion sets the threshold based on the product type (envelopes, stationery, paper bags), whereas for printed paper products specified printing processes are addressed. The preliminary analysis shows that total quantity of paper waste generated during the conversion process will include paper rejects from printing process and from conversion process (i.e. cuttings). It seems therefore important to revise the criterion maintaining the current structure. Merging the criteria would therefore imply the development of product specific sub-criteria.

3. Task 2: Market analysis

The aim of this section is to provide market information required to support the revision of the EU Ecolabel for Converted paper products. It seeks to increase the understanding of the economic and environmental importance of converted paper products at the global, European, and Member States level.

It must be noted that this chapter is developed using publically available information with limited access to underlying primary data. **It should therefore be treated as an estimation of the related market trends**. Converted paper products are often not addressed separately in the publicly available industry market research reports. While the scope for EU Ecolabel converted paper products refers to a small number of specific product types (envelopes, paper bags and paper stationary), publically available market statistics are aggregated and include other products, such as corrugated boxes, sanitary paper products, die-cut paper for non-office use and moulded pulp products, among others. Additionally, the current scope of EU Ecolabel for converted paper products corresponds to product type(s) that are included in various statistical categories. Attempts in contacting main statistics and/or market research bodies, or companies showed that most do not have readily available additional product-specific information. Industry associations and individual companies were more proactive, though data provided was aggregated. This has significant implications on the representativeness and completeness of analysis provided.

For the market analysis information presented in this section, the following should be considered when referring to the data quality:

- Converted paper products which fall under the scope of EU Ecolabel (envelopes, paper stationeries and paper carrier bags), represent a niche industry when contrasted with pulp and paper industry as a whole;
- Data is usually available in an aggregated form and might include other products not covered by the scope of the EU Ecolabel. In particular, from the definition of paper stationeries provided in the EU Ecolabel there seems to be an overlap with printed matter covered by the EU Ecolabel criteria for Printed paper;
- Paper stationery covered by the current scope is just a small part of stationery products. Most reports/analysis address stationery products in general, including non-paper stationeries i.e. pens;

Paper carrier bags, mostly for the retail market, are often addressed under packaging aggregated data including food and construction material packaging.

3.1 Methodology

Alongside, publically available statistical information, industry feedback, scientific publications, and market research reports, this chapter considers specific data referring to the European market of converted paper products drawn from official EU production statistics in PRODCOM for distinct categories covered by the scope and definition of the product group (Commission Decision 2014/256/EU).

Import and export related data has been considered using the PRODCOM database. PRODCOM headings are classified according to the combination of production types in line with Statistical Classification of Economic Activity in the European Union (NACE Rev 2). The analysis presented in this chapter is based upon sold production, defined as *the production sold outside the enterprise during the reference period*, which differs from actual total production. This is due to the fact that, foreign trade data recorded in the PRODCOM corresponds to production data necessary for the evaluation of products

traded on the market. Therefore, only trade related to sold production is included, and not that related to total production (EU, 2008).

The NACE codes for converted paper products are extracted from the PRODCOM database and are provided in Table 6 that additionally indicates key products included in each category.

The majority of converted products fall under two NACE codes 17.12 (manufacture of paper and paperboard) and 17.23 (Manufacture of paper stationery). It is assumed that the code 7.23.14 (*'Other paper and paperboard, of a kind used for writing or printing or other graphic purposes, printed, embossed or perforated'*) includes other converted paper products such as loose leafs, calendar and flipcharts which are not specifically mentioned in the other categories. Unfortunately, due to the high level of data aggregation the further breakdown is not feasible. Furthermore, some specifically analysed product groups i.e. 'Sacks and bags' contain articles that could not be considered eligible for the EU Ecolabel purposes.

Table 6. Converted paper products classification

NACE code		Description	Comext code	Macro category (presenting market analysis)
17.12		Manufacture of paper and paperboard		
17.21.12	**17.21**	**Sacks and bags of paper**		
17.21.12.30	17.21.12	Sacks and bags, with a base width ≥ 40 cm, of paper, paperboard, cellulose wadding or webs of cellulose fibres	4819 30	Paper carrier bags
17.21.12.50	17.21.12	Sacks and bags of paper, paperboard, cellulose wadding or webs of cellulose fibres (excluding those with a base width ≥ 40 cm)	4819 40	Paper carrier bags
17.21.15	**17.21**	**Box files, letter trays, storage boxes and similar articles of a kind used in offices, shops or the like, of paper**		
17.21.15.50	17.21.15	Box files, letter trays, storage boxes and similar articles of paper or paperboard of a kind used in offices, shops or the like	4819 60	Filing products
17.23		Manufacture of paper stationery		
17.23.12	**17.23**	**Envelopes, letter cards, plain postcards and correspondence cards of paper or paperboard; boxes, pouches, wallets and writing compendiums of paper or paperboard, containing paper stationery**		
17.23.12.30	17.23.12	Envelopes of paper or paperboard	4817 10	Envelopes
17.23.12.50	17.23.12	Letter cards, plain postcards and correspondence cards of paper or paperboard	4817 20	Writing products
17.23.12.70	17.23.12	Boxes, pouches, wallets and writing compendiums of paper or paperboard,	4817 30	Filing products

NACE code		Description	Comext code	Macro category (presenting market analysis)
		containing an assortment of paper stationery		
17.23.13	**17.23**	**Registers, account books, binders, forms and other articles of stationery, of paper or paperboard**		
17.23.13.13	17.23.13	Registers, account books, order books and receipt books, of paper or paperboard	4820 10 10	Writing products
17.23.13.15	17.23.13	Notebooks, letter pads, memorandum pads, of paper or paperboard	4820 10 30	Writing products
17.23.13.17	17.23.13	Diaries, of paper or paperboard	4820 10 50	Writing products
17.23.13.19	17.23.13	Engagement books, address books, telephone number books and copy books, of paper or paperboard (excluding diaries)	4820 10 90	Writing products
17.23.13.30	17.23.13	Exercise books, of paper or paperboard	4820 20	Writing products
17.23.13.50	17.23.13	Binders, folders and file covers, of paper or paperboard (excluding book covers)	4820 30	Filing products
17.23.13.70	17.23.13	Manifold business forms and interleaved carbon sets, of paper or paperboard	4820 40	Writing products
17.23.13.80	17.23.13	Albums for samples, collections, stamps or photographs, of paper or paperboard	4820 50	Filing products
17.23.13.90	17.23.13	Blotting pads and book covers, of paper or paperboard	4820 90	Writing products
17.23.14	**17.23**	**Other paper and paperboard, of a kind used for writing or printing or other graphic purposes, printed, embossed or perforated**		
17.23.14.00	17.23.14	Other paper and paperboard, of a kind used for writing or printing or other graphic purposes, printed, embossed or perforated	4823 90 40	Other writing and printing products

The market features of pulp and paper industry are also shortly addressed in the following chapter given that paper manufacturing (basic substrate) is the previous step to the product conversion. The following industrial activities are therefore required:

i. Pulp and paper manufacturing;
ii. Converting process which involves mechanical processes (cutting, guillotining, collating, gathering, folding, assembling, binding and punching) and other processes including the use of chemicals (laminating, gluing, varnishing and printing). Printing might also be included in this category as long as this is not the main purpose of the product i.e. logo printing on envelopes.

The converter might or might not manufacture the materials used in the final product. Accordingly, the industry represents a heterogeneous group of business. In fact, the converter often purchase the necessary materials, such as i.e. uncoated paper and paper board from paper/paper board mills and plants, and then proceeds to convert the base paper products into stationery materials like die-cut paper, tablets, office paper, envelopes, or a range of other goods. Complexity of the production process is related to the complexity of the final product. The converted paper product resulting from such processes are sold to retailers and wholesalers, as well as large corporations. Stationery wholesalers provide services to the manufactures and other end user, due to which the wholesalers gain the cost on the paper goods that they distribute in order to generate a profit[19].

3.2 Pulp and Paper Industry: Facts & Figures

The pulp and paper sector is a mature industry characterised by different segments and geographic realities. In 2016, the world production of pulp reached the 180 million tonnes mark (+1% on 2015), with North America and Asia leading production locations. There was a shift in sales from mature, fibre-rich western markets towards emerging markets. Emerging markets, in particular Latin America, have gained an upper hand due to several competitive advantages, related to lower costs (Pöyry, 2017a).

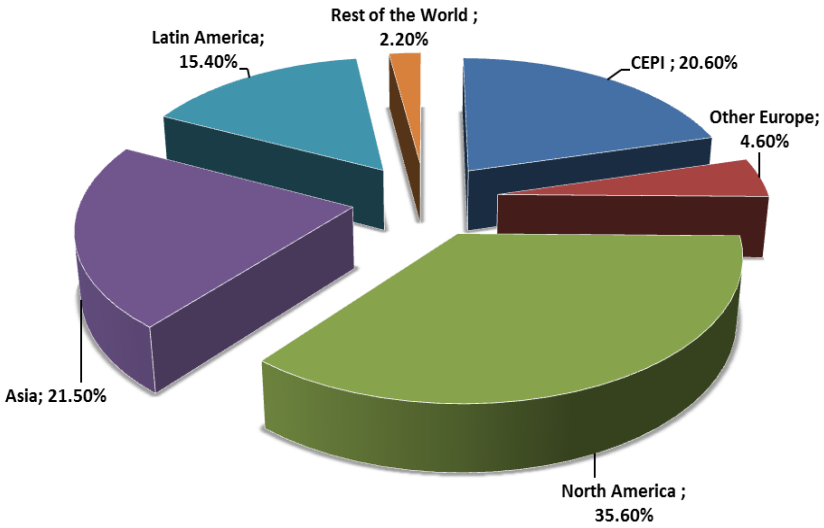


Figure 6. World Total Pulp production by Region (CEPI, 2016)

[1]Integrated pulp + Market pulp

For the pulp and paper industry, world output increased about +0.8% to 410 million tons in 2017, according to recent data from Euler Hermes. Asia accounts for the bulk of the market with near half global output (Euler Hermes, 2018). China has maintained the top country position for both production and demand of the total paper and board production since 2009 with the US following at a distance (Statista, 2017).

Following information presented on Figure 7, an overall paper production in Europe registered a slight increase, while some categories are facing a decrease in production volumes, e.g. newsprint. In 2016, the decline was in the region of 4%, and further lowering of production of similar magnitude is expected within the upcoming years.

[19] https://www.marketresearchreports.com/stationery

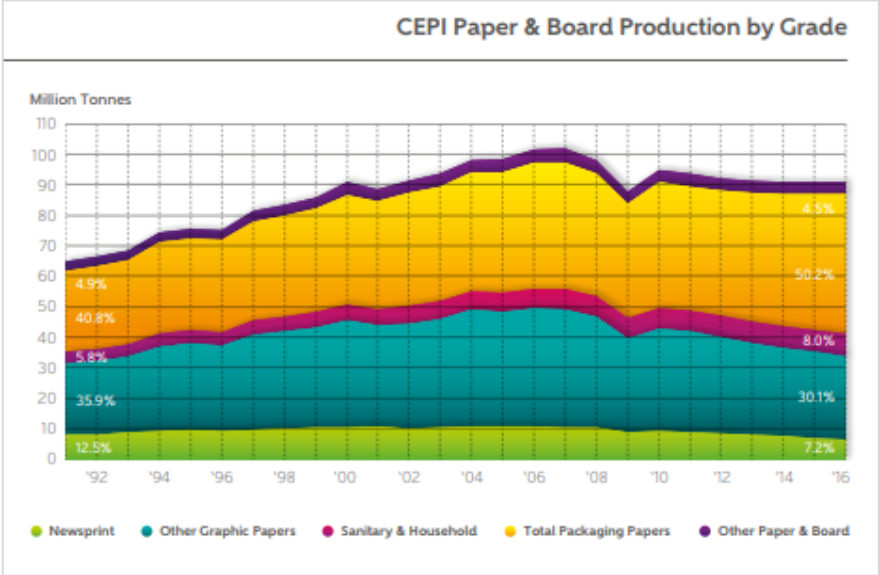


Figure 7. Paper and board production by grade in CEPI (CEPI, 2016)

3.3 Converted paper products global market structure

The global market for converted paper products manufacturing was valued at around $490 billion in 2017. Asia Pacific was the largest region in the converted paper products manufacturing market in 2017, accounting for more than 45% market share, with China accounting for around 25% market share [20]. This is mainly due to the increased demand for corrugated paper boxes, stationery and sanitary paper products in countries such as China and India. Additionaly, India and China have expected significant growth due to some key factors such as growing population, expanding base of professionals, increasing literacy rates, and government initiatives to improve the education sector (Future Market Insights, 2018). The Americas were the second largest region, accounting for 26% market share, followed by Europe with 23% market share. Africa was the smallest region accounting for around 4% market share.

Asia Pacific region is expected to observe the fastest growing of the converted products market during the period of 2017 to 2025[21]. Between 2018 and 2022, annual average GDP growth in emerging markets and developing economies is expected to be double than that of advanced economies. The Middle East and Africa are expected to observe considerable growth rates in the envelope market in the near future whereas North America and Europe are relying on a high standard of living and increasing disposable incomes to boost the envelope sector despite registered decline in recent years.

The profitability of individual companies depends on efficient operations, as products are sold mainly based on price. Big companies have advantages in distribution and can supply large customers. Small companies can compete successfully by making specialty products or serving a small geographical market[22].

Major companies worldwide include Kimberly-Clark, Packaging Corporation of America, and WestRock (all based in the US), as well as Mondi (UK), Rengo (Japan), Smurfit

[20]https://www.thebusinessresearchcompany.com/report/converted-paper-products-manufacturing-global-market-report-2018
[21]List of profitable small business ideas in manufacturing of school and stationery products: https://www.entrepreneurindia.co
[22]https://www.firstresearch.com/Industry-Research/Converted-Paper-Products-Manufacturing.html

Kappa Group (Ireland), and Svenska Cellulosa (Sweden). Most of these companies have average annual turnovers that range from 1-15 million euros. In the US, the converted paper industry is concentrated with the top 50 companies accounting for about 60% of industry revenue (Industry Intelligence Report by First Research, 2018). The Japanese Rengo has been reporting average sales of 4 billion euros in recent years. This turnover is likely due to the extended business activities of Rengo which also deals with machinery manufacturing besides converted paper products.

On the whole, envelope sale is declining due to alternative means of transmitting information such as electronic mail, fax machines, the internet, voice mail message and other electronic communication system. However, one of the significant factors that is expected to act as an incentive of the envelope market is the growth of the e-commerce that requires versatile packaging to deliver goods. Another factor is related to the parcel delivery industry where providers of overnight delivery services such as Express mail or Federal Express, purchase envelopes and offer them free of charge to the customers for the mailing of goods. Envelopes occupy less storage space, are light weight, easily transportable, and recyclable, which is good for environment conscious customers, and also a major driver for the growth of the envelope market.

Main envelope producers include:

- Mayer-Kuvert-network GmbH (with close to 1800 employees)
- Bong AB (EUR 0.3 million turnover)
- Printeos Group (EUR 180 million turnover)
- LA Envelope (EUR 8 M million turnover)

Worldwide, stationery paper industry is a heterogeneous business which includes the paper industry as its primary segment. This industry has demands in schools, colleges, offices and any business irrespective of their industry natures. End users of stationery market are business users, small office & home office users, educational institutes and private users[23]. Following IBIS Report (IBIS World, 2018) , despite increases in business activity and growth in the number of businesses, the Office Stationery Manufacturing industry revenue has contracted - 4.8% of annual growth between 2013 and 2018. The rising use of electronic communication and storage has reduced demand for traditional paper stationery products such file folders. The decline in demand for stationery products forced companies to consolidate, and shut down inefficient facilities. The constant changing trends of the products and continuous innovative styles adapted by the manufacturers are keeping the industry competitive. North America and European countries represent the most market demand for the products. Besides these markets; the Asian Pacific markets indicate largest growth potentials and are projected to grow further in the nearing future, this region includes a group of growing economies and thus the sector is estimated to rise[23].

Major companies include Kimberly-Clark, Packaging Corporation of America, and WestRock (all based in the US), as well as Mondi (UK), Rengo (Japan), Smurfit Kappa Group (Ireland), and Svenska Cellulosa (Sweden).

Additionally, on the basis of product types the stationery market might be segmented as follows:

- paper based products;
- writing & drawing instruments;
- storage & filing products;
- office & desk accessories;
- presentation & planning materials;

[23] https://www.bharatbook.com/blog/global-stationery-market-to-be-worth-155-4-bn-by-2015

- bags & briefcases;
- envelopes.

For stationery paper products, some players of personalized items are Adveo Group International SA, Costa Inc. (Essilor International Group), Herlitz PBS AG, Groupe Hamelin, Canon U.S.A. Inc., Kokuyo Co. Ltd., Pilot Corporation, Newell Rubbermaid Inc., Richemont SA, Staples Advantage, and others.

For paper bags, the global market in 2017 was valued at around US$ 4.500 billion and is estimated to reach a value of approximately US$ 7 billion by the end of 2027 (Future Market Insights, 2017).

Carrier bags are mostly used in the retail sector and have various qualities and end-uses; from the basic flat handle carrier bags replacing plastic carrier bags, to the bespoke printed luxury bags promoting customer brands.

The global market for paper bags is segmented on the basis of product type, thickness, material type, end use and region, as follows (Future Market Insights, 2017):

- By **region**, Asia Pacific excluding Japan is expected to reflect high market attractiveness in the coming years. The paper bags market in this region is anticipated to grow at a higher CAGR and reach a valuation of more than US$ 2,200 Mn by the end of the year of assessment thus leading the global paper bags market.
- By **product type**, pinched bottom open mouth segment is poised to showcase largest market value and is projected to grow at a high value CAGR during the period of forecast. Sewn open mouth segment in this category is the second largest with respect to market share.
- By **thickness**, the <2 ply segment is expected to surpass other segments in the thickness category and is anticipated to dominate the global market. This segment is projected to grow at the highest value CAGR of 4.8% during the period of forecast.
- In the **material type category**, brown kraft is widely used as compared to white kraft. The brown kraft segment is projected to grow at a 4.5% value CAGR and is estimated to reach a value of above US$ 5 Bn by the end of the year of assessment.
- In the **end use category**, the retail segment dominates the global market followed by the food and beverages segment. The retail segment is expected to grow at a value CAGR of 4.3% during the period of forecast.

3.4 Converted paper products production and demand in Europe

For the European market analysis of converted paper products the following product categories were taken into account:

I. Envelopes

17231230	Envelopes of paper or paperboard

II. Stationary paper products

17231250	Letter cards, plain postcards and correspondence cards of paper or paperboard

17231270	Boxes, pouches, wallets and writing compendiums of paper or paperboard, containing an assortment of paper stationery
17231313	Registers, account books, order books and receipt books, of paper or paperboard
17231315	Notebooks, letter pads, memorandum pads, of paper or paperboard
17231317	Diaries, of paper or paperboard
17231319	Engagement books, address books, telephone number books and copy books, of paper or paperboard (excluding diaries)
17231330	Exercise books, of paper or paperboard
17231350	Binders, folders and file covers, of paper or paperboard (excluding book covers)
17231380	Albums for samples, collections, stamps or photographs, of paper or paperboard

III. Carrier bags

17211230	Sacks and bags, with a base width >= 40 cm, of paper, paperboard, cellulose wadding or webs of cellulose fibres
17211250	Sacks and bags of paper, paperboard, cellulose wadding or webs of cellulose fibres (excluding those with a base width >= 40 cm).

IV. Other paper and paperboard, of a kind used for writing or printing or other graphic purposes, printed, embossed or perforated- 17231400.

In Europe, it is expected to observe a growth of 3.13% during the period 2018-2022 (calculated on the base of revenue generated from the sales of office stationery products and supplies)[24]. One of the major drivers for this market is the continuous innovations in office stationery supplies. The latest trend gaining momentum in the market is the introduction of customized stationery supplies. Factors such as the evolution of new business industries and an increase in the rate of employment are contributing to the growth of the office stationery market in Europe.

The information on the trade value for the aggregated product categories in 2016 is presented on Figure 8. Import and export data are aggregated and include both intra- and extra- European trading. Apparent consumption was calculated as the sum of production and imports, minus export.

[24] https://www.businesswire.com/news/home/20180705005231/en/European-Office-Stationery-Market-Analysis-Trends-Forecasts

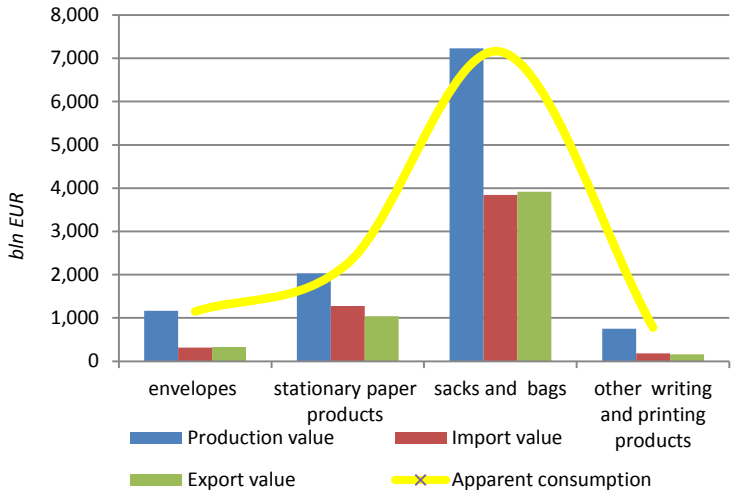


Figure 8 The EU market production, import, export and apparent consumption value for converted paper products: in 2016.

Key European producers of envelopes and other paper stationery products are listed below.

Envelope company	Average turnover (EUR million)
ACCO Brand	1.4
Hamelin	500
Clairefontaine	588
Unipapel (Adveo)	0.707
Grafoplast (3M)	35
Staples	18,146

3.4.1. Envelopes

Following information collected from Federation of Envelope Producers in Europe (FEPE) that represents about 75% of the European envelope production, there was a downward trend observed in sales volume since the 2007 (30% drop from 2010 to 2017), with slight improvement by about 5% in 2010 (FEPE, 2018) – Figure 8.

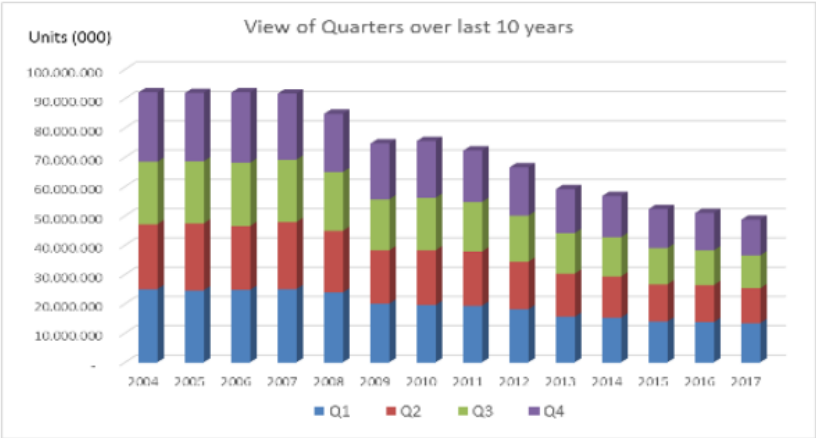


Figure 9. European statistics on envelopes delivery (FEPE)

According to EUROSTAT, the sold production value of envelopes reached a peak in 2011 after which a decrease was experienced up to 2014 (Figure 10). This was followed by an increase of about 30% in 2015-2016. This is not harmonised with the information on the envelope sector provided by FEPE. However, FEPE data that represents about 75% of envelope producers, considers the number of envelopes, whereas EUROSTAT refers to the product volume expressed as weight of envelopes (kg). FEPE data does not include envelopes for small parcels (2kg weight) delivered as letter, which have been experiencing growth due to flourishing e-commerce. Moreover, it is worth noting the almost flat trend from 2015 to 2016 in both cases.

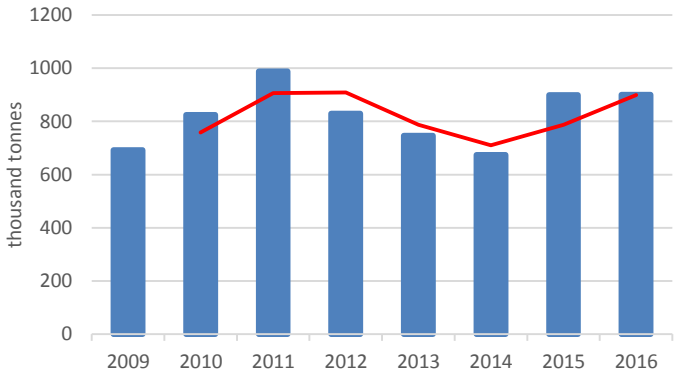


Figure 10 Envelopes sold production volume EU-28, 2016 (PRODCOM)

In 2016, Germany was the most important single market, sharing 35% of envelope production volume (equivalent to EUR 226 million) and 16% of apparent consumption volume. It is followed by United Kingdom and France (15, and 13% of volume market share, and 10 and 7% of volume apparent consumption, respectively). Poland, Italy, Spain, and Sweden represent together 24% of European envelope production market share, and 10% of apparent consumption volume (Figure 11).

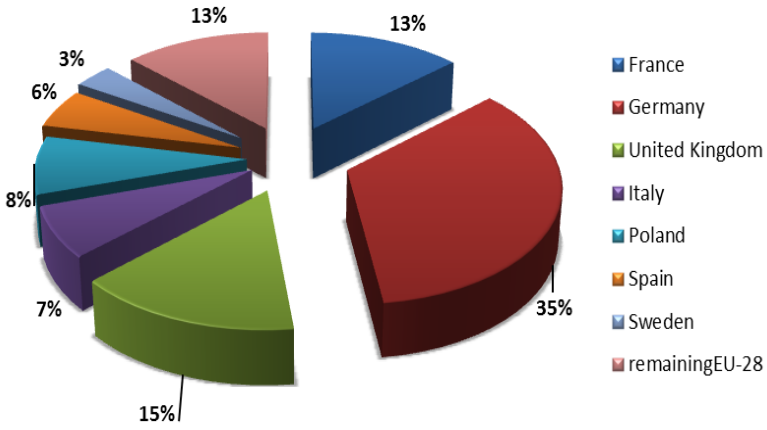


Figure 11. Structure of European envelopes sold production market volume per country in 2016

In 2016, Germany was also the leading country in the export value for envelopes with almost EUR 65 million followed by Poland (EUR 55 million), while the other countries, including France, fall below the EUR 25 EUR million. The top countries in production volumes, especially France and UK export low quantities (approx. 10 % of the EU-28 export volume), as most of the production is destined for the domestic market. By contrary, i.e. Poland mainly specialises in a supply of external market. Germany and Poland represent together close to 21% of European export volume (both intra- , and

extra- European). The highest import value of envelopes was reported for UK and Germany (approx. EUR 47 million, each), corresponding to approx. 17% of import volume. Figure 12 shows the apparent consumption share by country in volume (kg), in 2016. Germany, United Kingdom, France, and Italy were the main envelope consumer markets in Europe in 2016.

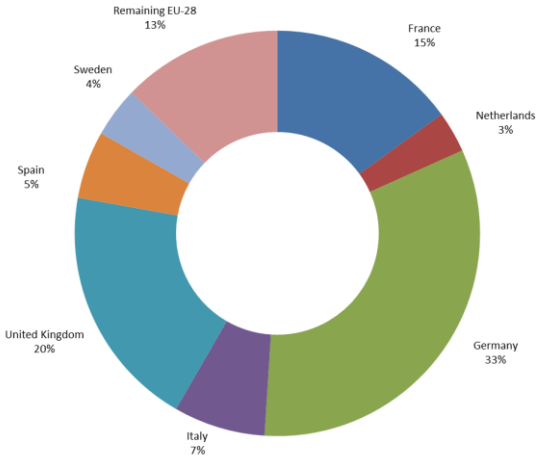


Figure 12. Envelopes apparent consumption (by volume), by country, 2016

3.4.2. Paper Stationery products

Economy is considered a driving force behind the consumption of paper, office supplies and stationery articles. In this sense, the growth in number of offices stimulates the consumption of paper stationary products. This trend has helped the market for paper, office supplies and stationery to stay almost stable in 2016 (Paperworld, 2017).

Production and trade data for stationery paper products, excluding envelopes, are presented under the macro categories 'writing products', 'filing products', and 'other writing and printing products'. The products included in these macro categories are those reported in Table 6. Note: *The market information should be treated with caution given the information gaps on sold production volume and value for several Member States.*

According to EUROSTAT, the sold production value of stationery paper products reached a peak in 2009 after which a decrease was experienced up to 2011, follow by the stable increase in the production volume (Figure 13).

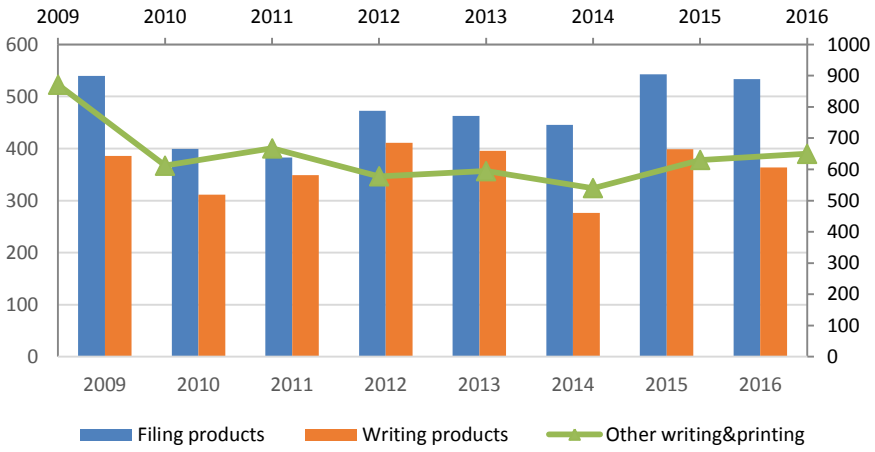
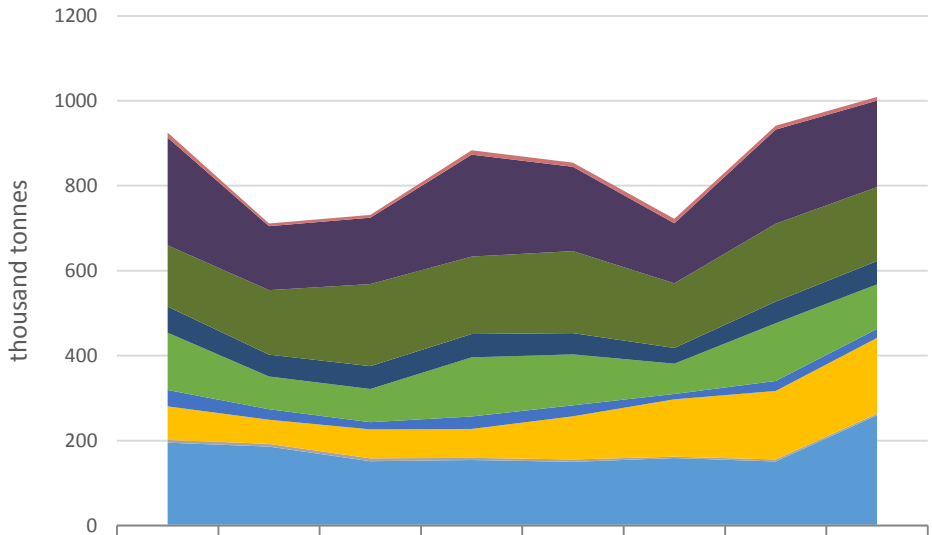


Figure 13. Stationery sold production quantities EU-28 countries (PRODCOM)

The product category *Other writing and printing products* (Other paper and paperboard, of a kind used for writing or printing or other graphic purposes, printed, embossed or perforated) is very huge (representing approximately one third of the entire production). Disaggregated data for this category is not available and could only be sourced at each Member State level. This information gap introduces some uncertainty in the reported figures which should be considered as an approximation. For the reason of the further analysis only filling products and writing product are taken into account, being considered representative for the current scope of stationery paper product, as defined in the EU Ecolabel for converted paper products.

Figure 14 indicates a trend of sold production volume for a type of product between 2009 and 2016. Binders and folders are key products in the stationery category, whereas letter/postcards represent the minor market share. All writing and filing articles show a decreasing trend from 2015 with the exception of boxes & wallets, diaries, boxfiles & letter trays and albums. In particular boxes & wallets have been registering increase of about 150% between 2010 and 2016.

The estimated market segmentation of sold production volume of stationery paper product in 2016 is additionally specified on Figure 15 (*Note: The market information should be treated with caution given the information gaps on sold production volume in some countries*). A breakdown of sold production (volume) reveals that the market is dominated (36%) by a miscellaneous group of "other paper and paperboard, of a kind used for writing or printing or other graphic purposes, printed, embossed or perforated". This is followed by box files (17%), binders (13%), boxes wallets (11%), and exercise books (11 %).



	2009	2010	2011	2012	2013	2014	2015	2016
Albums	12	6	7	10	10	11	9	9
Binders, folders	254	151	156	240	198	141	222	204
Exercise bks	144	152	193	182	193	152	183	174
Diaries	61	51	54	55	50	37	51	55
Notebks/pads	135	77	78	139	120	71	136	105
Registers, account bks	39	25	17	29	26	13	23	21
Boxes, wallets	79	57	68	68	102	135	161	178
Letter/postcards	7	6	7	5	6	3	5	4
Box files, letter trays	195	186	151	154	150	159	151	260

Figure 14. EU-28 Sold production of stationery paper products (PRODCOM)

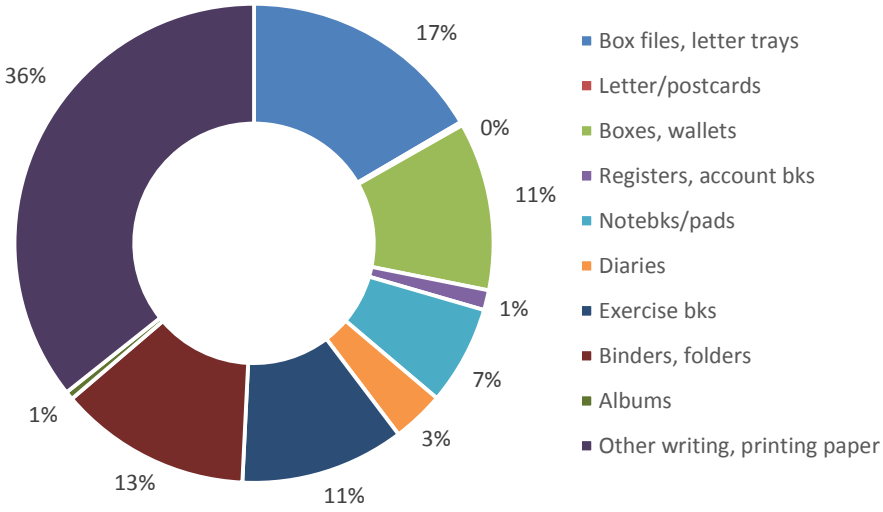


Figure 15. Market segmentation in 2016 per product type in volume (kg)

In 2016, Italy was leading a single sold production market, sharing almost 41% of stationery production volume (equivalent to EUR 948 million, or 31% of EU-28 sold production value), followed by France, Portugal and Poland with 10, 9, and 9% of the sold production market share, respectively. Italy specialises in sold production of storage or filling products (PRODCODE: 17211550), diaries (PRODCODE 17231317); and a miscellaneous category of other paper and paperboard products, of a kind used for writing or printing or other graphic purposes, printed, embossed or perforated – with a market share of share (PRODCODE 17231400); with 31%, 49%, and 56% of sold production volume market share, respectively.

In 2016, Germany was the main exporter of stationery paper products sharing 27% of volume export (corresponding to 22% export value), followed by Poland, the Netherlands, and Italy.

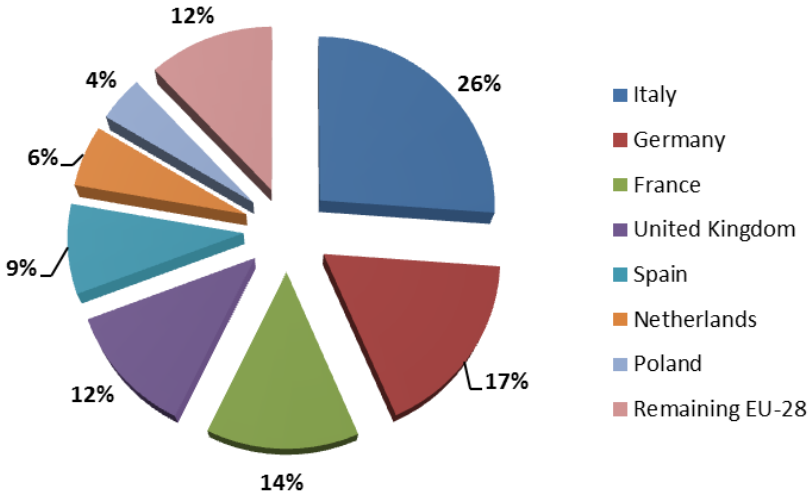


Figure 16. Stationery paper products apparent consumption (by volume), by country, 2016

Figure 16 shows apparent consumption of stationery paper products by country (based on monetary value. Italy, Germany and France represent together 57% of the European apparent consumption market.

3.4.3. Paper carrier bags

Major producers of carrier bags in Europe include:

- BillerudKosnas (Turnover: EUR 212 million)
- CEER Schisler (Turnover EUR 78 million)
- Papier Mettler (Employees:3900)
- Taffarello (Turnover: EUR 30 million)
- Valmisa (Employees: 210)

Following CEPI statistics, production of wrapping paper grades - used as a substrate for paper bags manufacturing - showed in 2016 an increase of around 1.2%[25]. Accordingly, sale of paper carrier bags (base width <40cm) has been experiencing a small but continuous increase starting with 2012. In 2016, the total sold production reached approx. million tonnes (EUR 2 billion in value), (Figure 17).

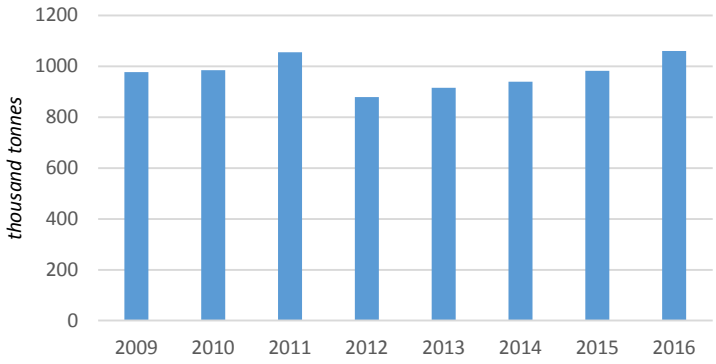


Figure 17. Paper carrier bags (base width<40cm) sold production quantities EU-28 countries (PRODCOM)

Among the EU-28, Germany, Italy, and France lead the sold production market of paper carrier bags (sharing approx. 60% of EU-28 market in sold production value and volume). Germany and Italy are the main European exporters (approx. 40% of the value market share), whereas France (EUR 233 million) is the key importer, followed by Germany (EUR 230 million) and UK (EUR 157 million). French, German Italian, and UK markets are also key consumers of paper bags (approx. 776 thousand tonnes) - Figure 18.

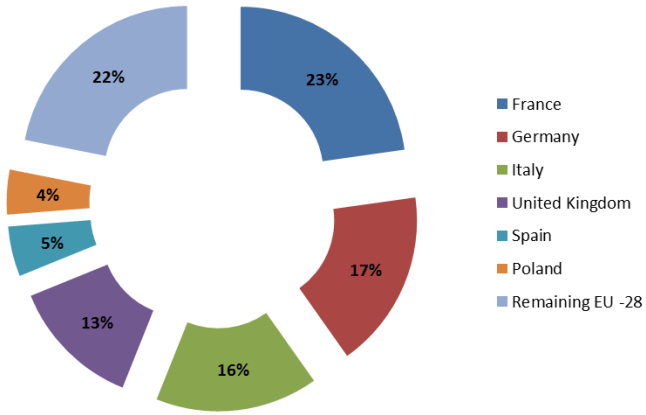


Figure 18. Apparent consumption in 2016 by volume (kg)

[25] CEPI, Preliminary statistics 2016

3.4.4 Challenges and opportunities

A forecast of sold production quantities of converted paper products has been elaborated on the basis of historical trends of converted products. The historical trends considered are those derived from EUROSTAT data. In particular, the production trends presented beforehand were used as the base for the market forecast up to 2021. In addition to reported trends, an estimation of the impact of factors identified in the SWOT analysis has also been considered.

Paper carrier bags are expected to increase in sold production volumes by about 50% in 2021. This takes into account the growth opportunities identified (approx. 3% yearly), in addition to the steady yearly growth, experienced in past years (approx. 8%). Analysts at Ceresana forecasted an overall sales volume of bags and sacks in Europe to amount to approx. 9.12 million tonnes in 2020. [26, 27] Factors like strong and growing retail sector in developed regions, rising preference for paper bags across regions and increasing penetration of retail outlets in emerging economies are expected to contribute to the growth of the global paper bags market. Due to increased concern over serious negative impact on the environment and agriculture caused by lightweight plastic bags, many countries have banned their use. Following Directive (EU) 2015/720, the mandatory charge applies to so-called "lightweight plastic carrier bags" (i.e. plastic carrier bags with a wall thickness below 50 microns). The reduction of the average consumption level of lightweight plastic carrier bags might to certain extend stipulates the use of paper carrier bags.

For envelopes and other paper stationery products, the effect of the competition from the digital sector and non-paper products, registered in past years is expected to continue with a slight counterbalance from growth opportunities in personalized consumption and e-commerce (2% for envelopes, 0,05% for stationery). This is estimated to result in a 20% to 26% decrease with respect to 2016 sold production quantities in 2021 for envelopes and paper stationery. The forecast for envelopes closely reflects studies from Copenhagen Economics, predicting a 34% decline by 2025 despite possible positive influences from e-commerce, Direct Mail and paper invoices preferences (FEPE, 2017).

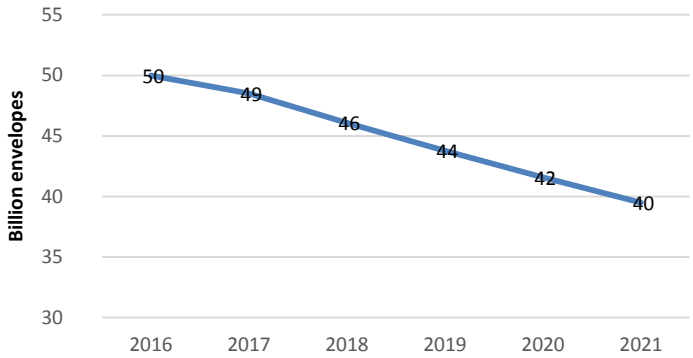


Figure 19 Envelope Delivery Forecast up to 2021

[26] Made of PE films, woven plastics, and paper
[27] Ceresena. Market Intelligence Consulting. Market Study: Bags and Sacks in Europe https://www.epda.com/wp-content/uploads/2014/06/Ceresana-Brochure_Market_Study_Bags-and-Sacks-Europe.pdf

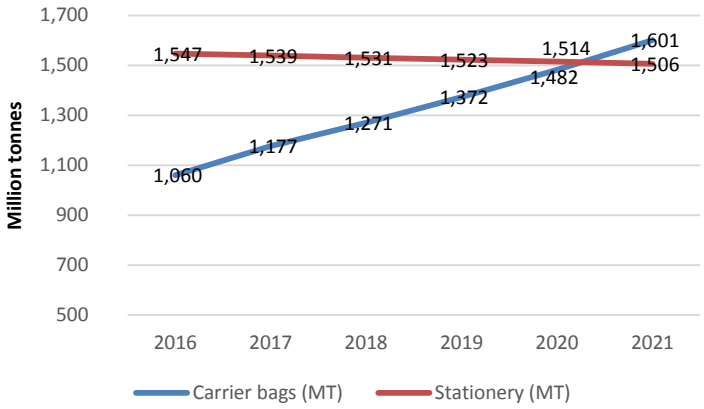


Figure 20. Stationery products and paper carrier bag sold production forecast up to 2021 excluding envelopes

The diminish revenue streams and future profits increases the uncertainty for the future of the industry. Reduction of investments might increase efficiency and decrease costs. Additionally, long-term contracts between paper manufacturers and their most important customers make the sector unattractive to new entrants who might encourage competition and/or use newer technology for production (Roth et al., 2016).

A strong increase in virgin fibre prices, significantly impacts costs which is not necessarily passed down to clients and retailers. Recovered paper price upsurge seen in recent years will likely increase following the Chinese ban on imported paper for recycling come 2018.

The pulp and paper industry is energy intensive. On a global scale, it is the fourth largest industrial consumer of energy - 5.6 % of total industrial energy demand (IEA, 2017). European paper manufactures are therefore exposed to the risk of both electricity price increases and price hikes. Furthermore, evolving European climate and energy goals will continuously require the pulp and paper sector to be highly energy efficient and innovative. There is also current competition with the European energy sector and potentially in the future with other sectors like transport for the same bio-energy resources.

Within the pulp and paper sector, implementing Best Available Technologies (BATs) offers emission reduction opportunities. It is estimated that upgrades to burners and burner controls could reduce emissions in the United Kingdom pulp and paper sector by 2.4% and have a modest payback period of around a year and a half (Roth et al., 2016).

The SWOT diagram summarises the factors affecting the converting paper products industry. Some of these factors are also common to the pulp and paper industry worldwide.

In the case of converted paper products, and in particular office supplies and stationery articles, the consumption in Europe is in line with the sector's mechanisms including the cost character with its system-relevant upper consumption and usage limits restricting the business success of the sector (Paperworld, 2017). To this must be added the digitalisation effect, which is reducing the use of traditional office material, such as paper, organisation and archiving, through electronic storage, for example in the cloud. Nevertheless, the experience of recent decades on the paperless office, shows that office communication paper is highly unlike to disappear in the future (Adobe Systems Incorporated, 2013).

Moreover, the recent growth of e-commerce and online business offers positive prospects for the envelope sector. According to the statistics of the UPU (Universal Postal Union), around 80% of e-commerce postal consignments weigh less than 2 kg and

padded envelopes are the ideal solution for this weight (Paperworld, 2017). It is conceivable that this development could counteract, to some extent, the ongoing decline in the standard envelope business.

Going green has also become an important trend for stationery, especially in developed countries. Green office products, including recycled paper are gaining popularity, thanks to the advancement in technology and manufacturing process that lower the cost in producing recyclable stationeries.

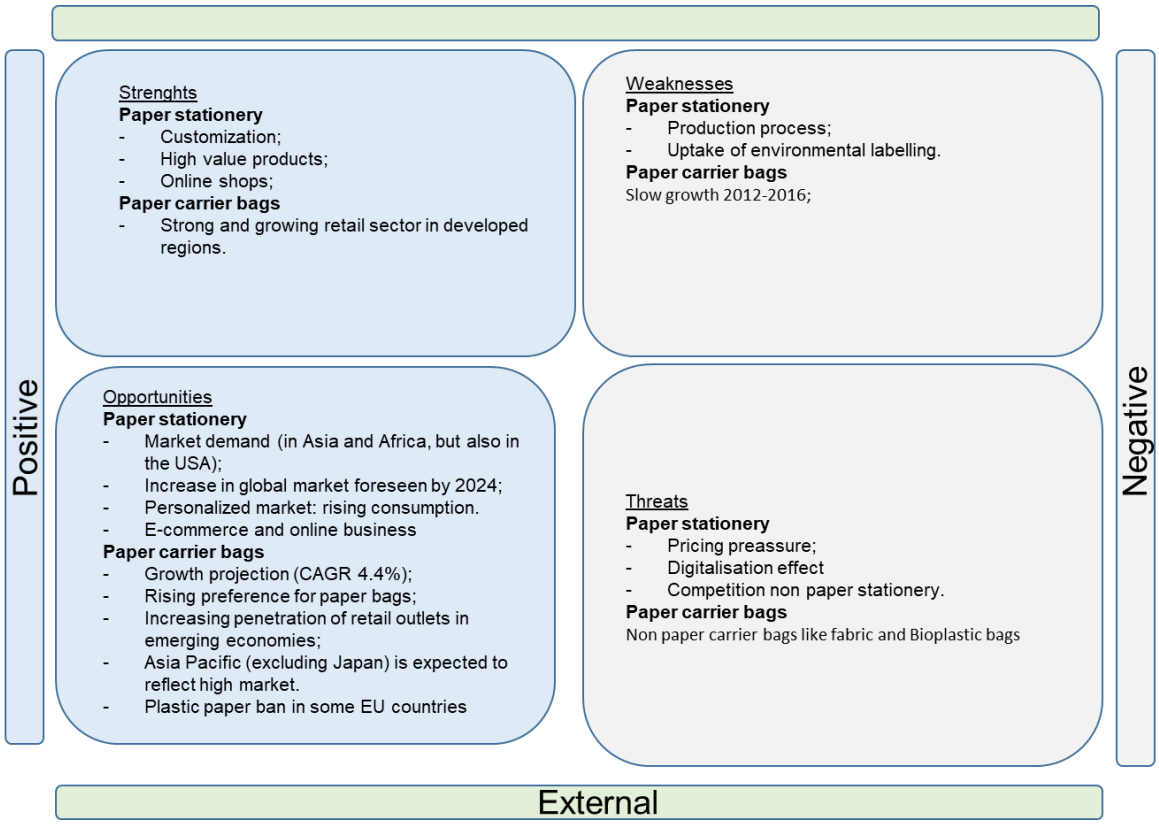


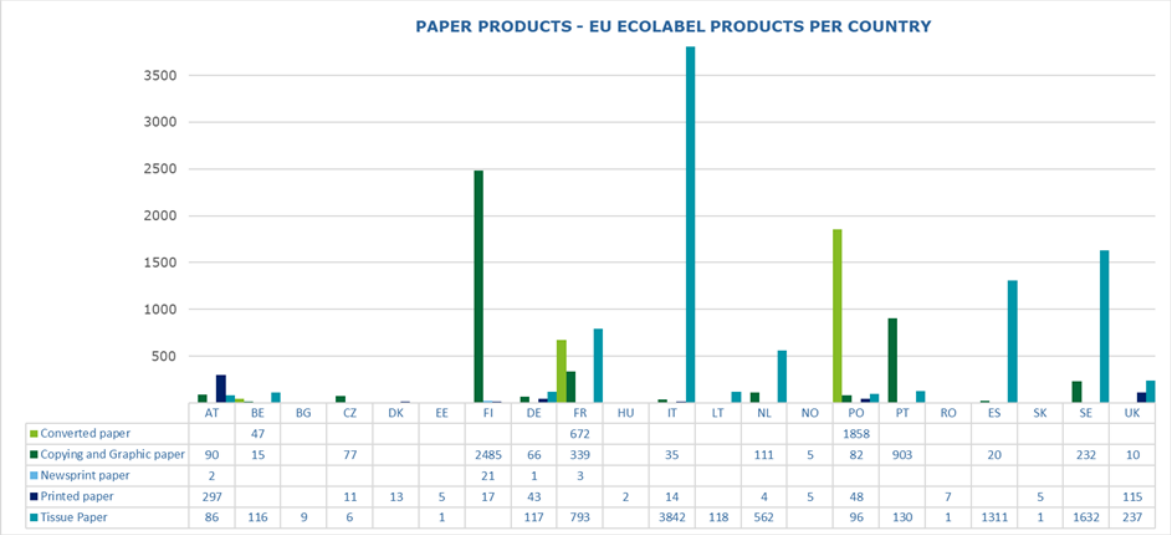
Figure 21. SWOT Paper stationery and Paper carrier bags

3.5 Market penetration of the EU Ecolabel for converted paper products

As to March 2018, there are six EU Ecolabel licenses for converted paper products: three in France, two in Poland, and one in Belgium. In total, 2577 products are awarded EU Ecolabel (close to 4% of all EU Ecolabel licensed products). 72% of licensed converted paper products originate from Poland.

Envelopes are the major group of certified products. There is one license holder for stationery paper products, whereas there are yet no licenses for paper carrier bags.

A comparative analysis with other paper products shows that the EU Ecolabel for converted paper products represents approx. 15% of all EU Ecolabel licenses for paper and paper-based products (as of March 2018); Figure 22. The raising trend in the development of number of licenses, and the related uptake of products can be observed on Figure 23.



	AT	BE	BG	CZ	DK	EE	FI	DE	FR	HU	IT	LT	NL	NO	PO	PT	RO	ES	SK	SE	UK
Converted paper		47							672						1858						
Copying and Graphic paper	90	15		77			2485	66	339		35		111	5	82	903		20		232	10
Newsprint paper	2						21	1	3												
Printed paper	297			11	13	5	17	43		2	14		4	5	48		7		5		115
Tissue Paper	86	116	9	6		1		117	793		3842	118	562		96	130	1	1311	1	1632	237

Figure 22. Paper products with the EU Ecolabel (EU Ecolabel, 2018)

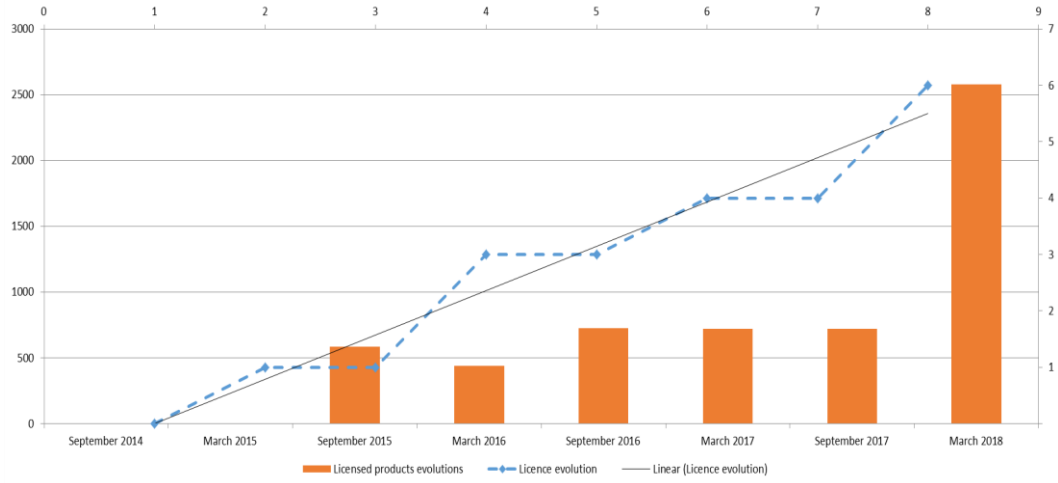


Figure 23. Trend in the development of number of licenses, and the related uptake of licensed products

Current revision of the EU Ecolabel is an opportunity to identify suitable deployment measures in order to further improve the market uptake. A tailored awareness strategy is certainly an effective approach to stipulate the number of licenses and increase its visibility among potential consumers

4. TASK 3: Life Cycle Assessment (LCA) evidence for converted paper products

The overall aim of this Task is to identify the stages in the product life cycle where the major environmental impacts occur. This task involves a review of relevant available evidence of the environmental impacts across the entire life cycle of the product (cradle to grave or cradle to cradle). Suitable information includes full LCAs, studies that focus on particular aspects of paper production process, and on environmental product declarations (EPDs). Results are considered in the context of any existing product category rules (PCRs), and each study is evaluated according to minimum quality requirements and scored according to the quality and degree of relevance to the EU Ecolabel criteria revision.

Life cycle assessment addresses the environmental aspects and potential environmental impacts (e.g. use of resources and environmental consequences of releases) throughout a product's life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e. cradle-to-grave).

According to the ISO 14040 (2006), there are four phases in an LCA study:

a) the goal and scope definition,
b) the inventory analysis (LCI),
c) the impact assessment (LCIA), and
d) the interpretation.

The goal and scope of an LCA, including system boundary and level of detail, depends on the subject and the intended use of the study. The depth and the breadth of LCA can differ considerably depending on the goal of a particular LCA.

The life cycle inventory analysis phase (LCI phase) is the second phase of LCA. It is an inventory of input/output data with regard to the system being studied. It involves the collection of the data necessary to meet the goals of the defined study.

The life cycle impact assessment phase (LCIA) is the third phase of the LCA. The purpose of LCIA is to provide additional information to help assess a product system's LCI results so as to better understand their environmental significance.

Life cycle interpretation is the final phase of the LCA procedure, in which the results of an LCI or an LCIA, or both, are summarized and discussed as a basis for conclusions, recommendations and decision-making in accordance with the goal and scope definition.

4.1 Literature review LCA-related information of converted paper products

The following documents, reports, guidance, and database were reviewed in order to identify potential sources of environmental information relevant for the product group (Table 7):

- PCRs
- LCA publications
- LCA studies in LCA databases e.g Ecoinvent, US Life Cycle Inventory

Table 7. List of LCA related documents identified

LCA study	*Author/Source*
Paper, freesheet, coated, average production, at mill	US Life Cycle Inventory
Paper, mechanical, coated, average production, at mill	US Life Cycle Inventory
Paper, mechanical, uncoated, average production, at mill	US Life Cycle Inventory
Kraft paper (EN15804 A1-A3)	Industry
Comparative study of virgin fibre based packaging products with competing plastic materials	Industry
A comparative LCA study of various concepts for shopping bags and cement sacks	Company
Screening Life Cycle Assessment Hot spot assessment (v2) FILING PRODUCTS	Industry
Screening Life Cycle Assessment Hot spot assessment (v2), NOTEBOOKS AND PAPER SHEETS	Industry
A comparative LCA study of various concepts for shopping bags and cement sacks	Scientific publication
An Exploratory Comparative Study on Eco-Impact of Paper and Plastic Bags	Scientific publication
GHG Calculation Tools for Pulp & Paper Mills	WBCSD
Available and emerging technologies for reducing greenhouse gas emissions from the pulp and paper manufacturing industry	US EPA
2010- Life Cycle Assessment and Forest Products: A White Paper Source: Forest Products Association of Canada (FPAC) and PricewaterhouseCoopers (PwC)	Forest Products Association and PWC
Paper, bag and sack, unbleached kraft, average production, at mill	US Life Cycle Inventory
Paper, woodfree, coated at integrated mill	Ecoinvent
Kraft paper, bleached	Ecoinvent
Paper, woodfree, coated at non-integrated mill	Ecoinvent
Paper, woodfree, uncoated at non-integrated mill	Ecoinvent
Paper, woodfree, uncoated at integrated mill	Ecoinvent
RFO, combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory
TDF, combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory
Bituminous coal, combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory
Diesel, combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory
Fuels, burned at coated mechanical paper, average production, at mill	US Life Cycle Inventory
Fuels, burned at unbleached kraft bag sack paper, average production, at mill	US Life Cycle Inventory

LCA study	*Author/Source*
Fuels, burned at uncoated mechanical paper, average production, at mill	US Life Cycle Inventory
Gasoline, combusted in equipment, at pulp and paper mill	US Life Cycle Inventory
Hog fuel, pur., combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory
Hog fuel, self-gen., combusted in ind. boiler, at pulp and paper mill	US Life Cycle Inventory
LPG, combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory
Natural gas, combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory
Tall oil (refinement from paper manufacturing)	Industry
Colophony / tall oil resin (estimation from paper production)	Industry
Starch glue (for paper/cardboard)	Industry
Starch glue (for paper/cardboard)	Industry

The findings of the literature review have been summarised in the following subsections following the structure required in the ISO Standard 14040/44 (2006) on LCAs.

4.1.1. LCA Converted paper products: goal and scope definition

4.2.1.1 Goal

The main goal of an LCA analysis for converted paper products is to identify the stages/processes in the life cycle where the major environmental impacts occur and the relative best practices and front runner so that the EU Ecolabel criteria can be defined related to these hotspots. The LCA is also expected to provide relevant information to help identifying opportunities to improve the environmental performance of converted paper products at various points in their life cycle.

4.2.1.2 Scope

Functional unit and System boundary

The EU Ecolabel is based on multiple criteria that correspond to the entire life cycle of the product under study, and address the most significant environmental impacts and the net environmental balance between the benefits and burdens of products (Regulation EC 66/2010). The reference unit against which the quantified performance of the converted paper products is evaluated depends on the product type and the LCA study or primary data reviewed. Hence, the different functional units are provided in the specific sections dedicated to LCA studies of the various product types.

The scope of the LCA for converted paper products covers the following life cycle stages in the system boundary:

- Raw material extraction/acquisition (including paper making);
- Transportation raw materials to converting plant;
- Converted product manufacturing (converting processes after paper making);
- Distribution of converted paper products;
- Use of converted paper products;
- End-of-life.

A general illustration of the life cycle stages of a converted paper product is provided in Figure 24.

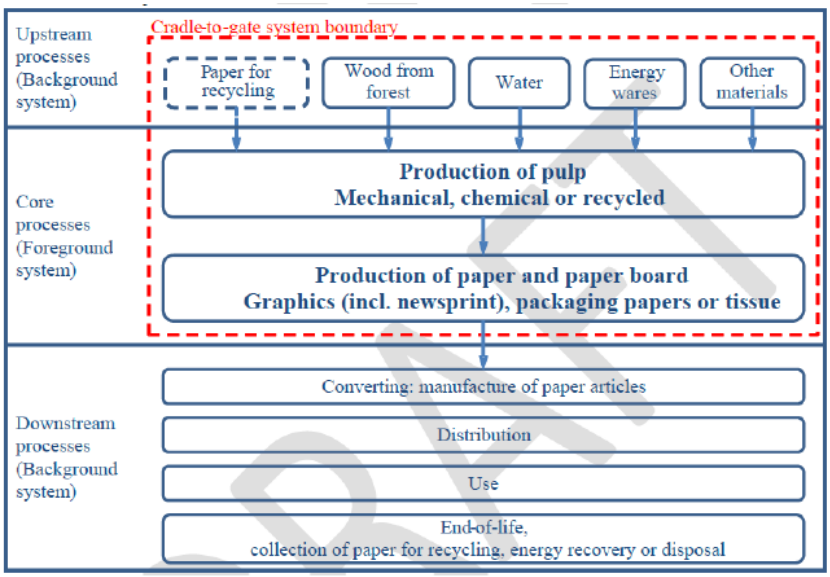


Figure 24. Lifecycle stages of converted paper products (PEFCR, 2016)

Converted paper products are manufactured from intermediate paper products (CEPI, 2013). Following the classifications of various paper grades, graphic uncoated woodfree paper is used for office paper products such as business forms and stationery paper products. Paper intended to be used for envelopes is usually made from kraft pulp.

Converting processes for envelopes, filing products and paper carrier bags include mechanical processes (cutting, guillotining, collating, gathering, folding, assembling, binding and punching) and other processes (laminating, gluing, varnishing and printing) which often involve the use of chemical substances. A detailed description and related flowcharts of the manufacturing process of the converted paper products under the scope of the Commission Decision 2014/256/EU are provided in the further sub-sections.

***Envelopes manufacturing*.** The envelope machine is designed to allow a continuous manufacturing process with a production capacity of up to 1,600 envelopes per minute.

Figure 25. Envelope Machine high volume production (FEPE, 2018))

The process starts with a reel of paper, of the correct width and paper weight being mounted at the rear of the machine. The paper web goes through a series of sections including simultaneous printing of one or both sides via flexible plates, scoring to aid folding further down, cutting into the desired shape and cutting of the window aperture, gluing of the plastic window film of the right size (if applicable), folding and cutting and separating of the individual envelopes from the web. The separated envelopes are

referred to as the blank. Waste paper and film from the cutting sections are collected and sent for recycling.

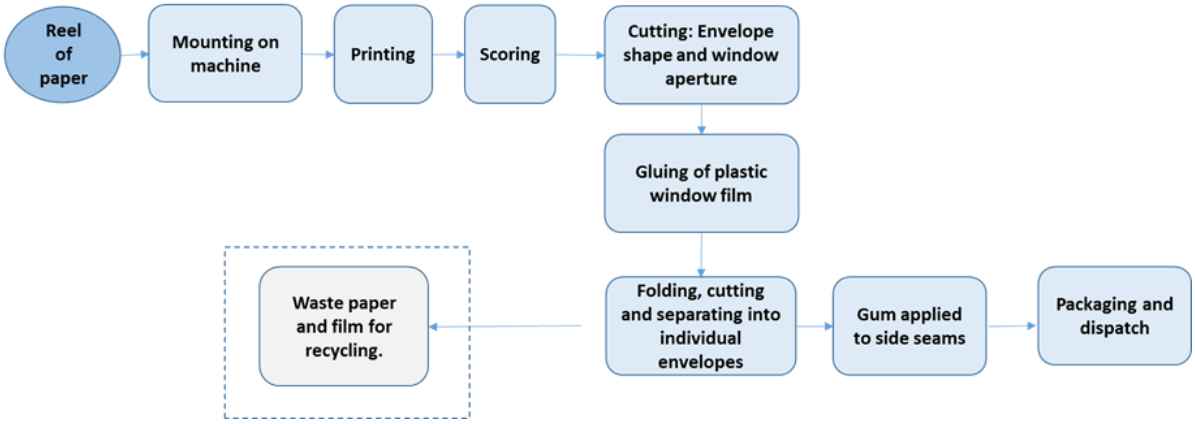


Figure 26. Envelope manufacturing process (FEPE,2018)

The adhesives used during envelopes manufacturing are frequently referred as "gums" seal because of the common use of gum arabic (made from sap extracted from two particular species of acacia trees). The combination of long starch chains and natural "glue" proteins makes gum arabic an appropriate binder that is water soluble. Only gummed envelopes are suitable for automatic machine inserting and the sealing is performed automatically by the mailing machine. Gums seals are known as a "*remoistenable*" glues because they dry non-sticky but can be reactivated after the introduction of water. Typical formulations for remoistenable front seals are blends of two main raw materials, i.e. modified corn or potato starch (dextrin) or synthetic resin emulsion (dextrin seal gum, resin/dextrin blend and resin seal gum).

Self- seal envelopes usually have a strip of latex on each flap, forming a bond when pressed together. The *peel & seal* envelope (also known as super seal, strip seal & peel & stick) has one of the most secure ways of sealing. It consists of peeling away the strip that protects adhesives. There are two types of adhesives that are typically used: water-based and hot melt. Water-based is derived from synthetic resin, usually acrylic. Hot melt is derived from synthetic rubber and is applied in solid form and applied molten. (EMSA, 2016, EMA Guide)[28][29]: The fastener attached to some envelopes is made of aluminium or other metals while string attached to other envelopes is made of cotton or other fibres.

Printing the inside of the envelope or interior opaque, as it is known, is designed to enhance the security of the contents. This is almost exclusively restricted to white envelopes. Most often, interior opaques are printed in shades of blue or grey. For windows, there are several types available, including cellophane, glassine, polystyrene, polypropylene, polyester, acetate, colored film, and PLA (Polylactic Acid). Glassine is a vegetable-based material that contains cellulose fibres and is also used as material for envelop windows.

Paper stationery manufacturing. Techniques employed by the stationery industry include among others: embossing, letterpress printing, engraving and thermographic printing. Overall, the stationery market is most often employed for office stationery and

[28]The EMA Guide to Envelopes and Mailing,
[29]EMSA Envelope Standards, Version 1.5 DRAFT March 2016

special occasion programs. A typical flow diagram of a notebook production process is provided in Figure 27.

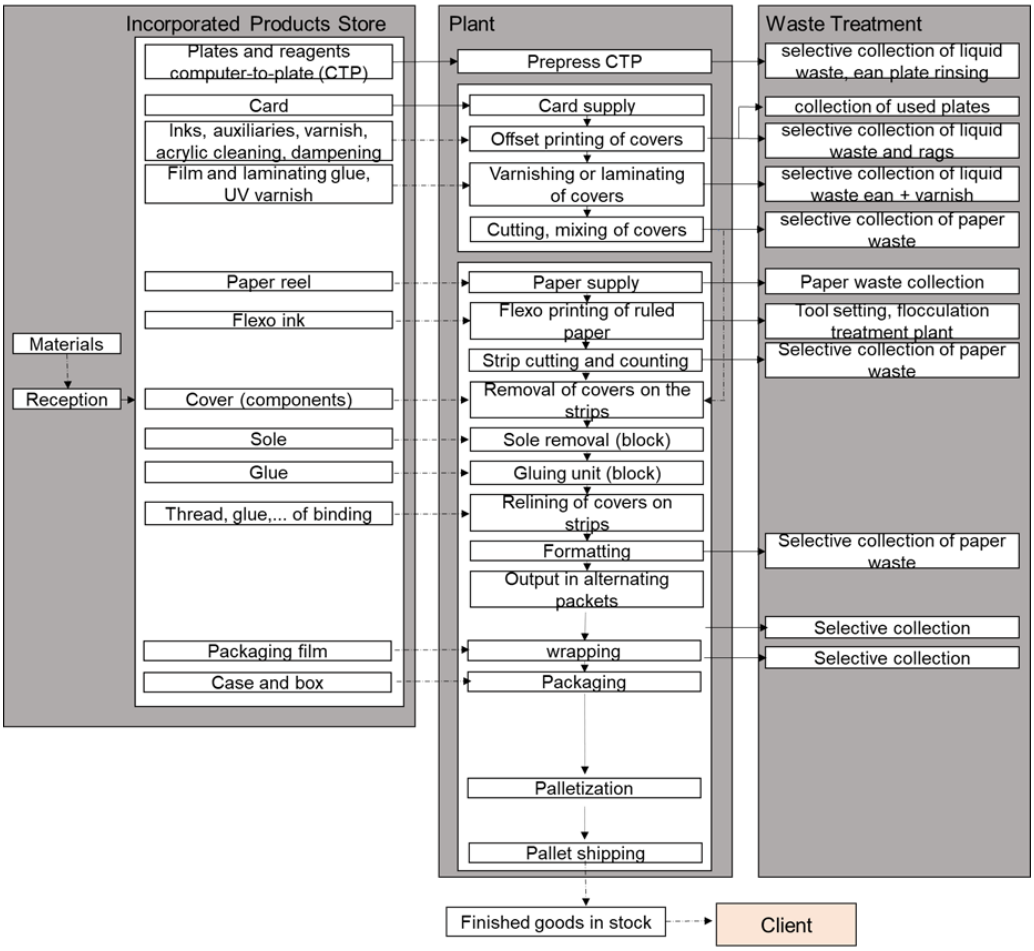


Figure 27. Notebook manufacturing process (Hamelin Brand, 2018)

Paper carrier bags manufacturing Most of the converting machines for paper carrier bags are roll-fed. There are several types of papers that can be used for carrier paper bag converting:

- Sack paper: made out of bleached or unbleached softwood kraft pulp or recycled fibre typically OCC; basic weights 60-150 g/m2; usually un-calendared; typically used for paper sacks but can also be used for paper carrier bags
- Machine-finished kraft paper: made out of unbleached softwood pulp or bleached softwood/hardwood pulp; basic weights 50-150 g/m2; usually calendared to provide better printability; dominant grade for paper carrier bags, getting more popular for small paper bags
- Machine-glazed kraft paper: made out of bleached or unbleached softwood kraft pulp; basic weights 14-170 g/m2; machine glazed for high print quality; dominant grade in small paper bags, used in the high-end carrier bags

Paper manufacturers for carrier bags include Aralar, BillerudKorsnäs, Burgo, Heinzel Group, Lucart Group, Mondi, Nordic Paper, Saci Group, Sappi, Stora Enso

Figure 28 shows the various steps from paper making through converting to delivery of paper carrier bags to consumers.

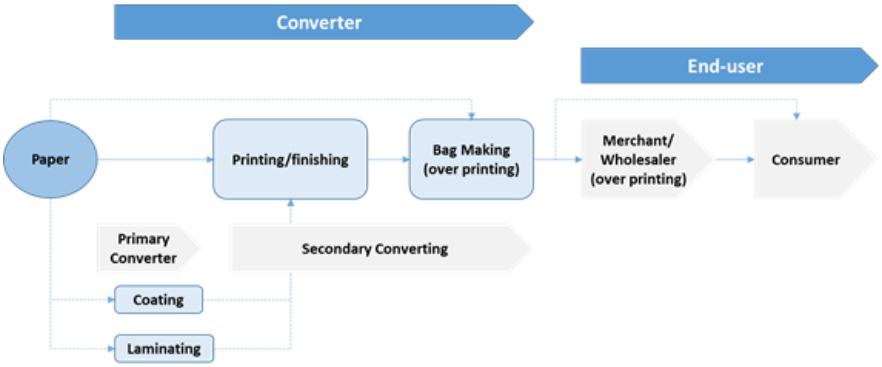


Figure 28. Paper carrier bag manufacturing process (Pöyry, 2018)

Flexo printing is the most common printing technique, given that it can be used on paper rolls or on the readymade bags as over printing. For better printing quality usually offset printing is used.

Coating and laminating provide improved barrier properties or better appearance of a product. The process is performed on separate/independent machines than bag making machines. Coated or laminated paper can be purchased either from independent primary converters or from paper manufacturers with coating and laminating capabilities.

4.2.1.3 Key impact categories

The following PCRs were identified through a search of various EPD Program Operators and PCRs published under the ongoing Product Environmental Footprint (PEF [30]) development process:

- International EPD System: Pulp, paper and paper products; printed matter and related articles, Containers of paper and paperboard, not elsewhere classified
- EU PEF: Intermediate Paper Products (Final Draft - v. 0.2)

EU Product Environmental Footprint Category Rule (PEFCR) addresses intermediate paper products which do not include converted paper products covered by the EU Ecolabel (Fontanella, Nucci, & Ioannidis, 2016). The term "intermediate" is used to make a difference between "paper substrate" and "paper product"; where the latter refers to final products such as envelopes which are the products of further conversion of paper substrate. However, the PEFCR is considered in the findings presented in the following sections due to the fact that intermediate paper products are part of the converted paper product system. The definition of converted paper in the EU Ecolabel refers to at least 70% paper content. This implies that a significant percentage of impacts related to the paper grades will be transferred to the corresponding converted paper products. PEFCR could therefore provide valuable information in understanding the environmental relevance of converted paper products.

Table 8 provides a summary of impact categories requested for converted paper products in reviewed PCRs.

[30] Product Environmental Footprint Category Rules Guidance Version 6.3–May 2018 http://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR_guidance_v6.3.pdf

Table 8. Existing PCRs for converted paper products and related impact categories

PCR	*Pulp, paper and paper products; printed matter and related articles*	*Containers of paper and paperboard, not elsewhere classified*	*Intermediate Paper Products (Final Draft - v. 0.2)*
Environmental Impacts			
Climate Change	kgCO2eq.	kgCO2eq.	kgCO2eq.
Ozone Depletion	kgCFC-11eq		kgCFC-11eq.
Ecotoxicity			CTUe
Human Toxicity (Respiratory Effects)			CTUh
Particulate Matter /Respiratory inorganics			kgPM2.5eq.
Ionising radiation			kgU235eq.
Photochemical Ozone formation potential	kgC2H4eq.	kgC2H4eq.	kgNMVOCeq.
Acidification	kgSO2eq.	kgSO2eq.	mol H+ eq.
Eutrophication	kgPO4eq.	kgPO4eq.	mol N eq./kgPeq./kgNeq. (Terrestrial, acquatic, marine)
Resource Depletion			kgSbeq./m³ water use related to water scarcity (water, mineral&fossil)
Land use			kg (defict)

Analysis of existing PCRs identified at least five common impact categories to be addressed in LCAs for converted paper products, namely:

- *Global Warming*
- *Ozone Depletion*
- *Photochemical Ozone Formation*
- *Acidification*
- *Eutrophication*

These impact categories are therefore included in the set of impact categories for the further analysis in the identified LCA and EPD studies.

However, the PEFCR requires all default impact categories (16 impact categories) to be addressed and classifies them according to overall robustness. The categories are prioritised based on normalised and equally weighted results. In particular, according to the PEFCR pilot LCA studies for graphic paper, the most relevant impact categories for paper substrate are those linked to human health, human toxicity and climate change (Figure 29).

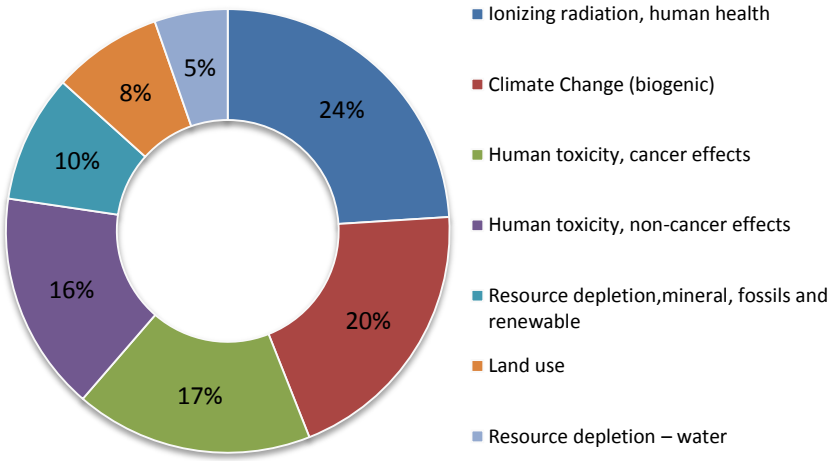


Figure 29. PEFCR Relevance of impact categories for graphic paper (%)

4.2.2. Converted paper products: life cycle impact assessment

The analysis was focused on existing studies for converted paper products covered by the current scope and definition of the product group. Hence, the first step was to collect relevant information and LCA studies whose scope includes at least the supply of raw materials and converted paper products manufacturing. Documents that pass this test were then analysed and scored according to: data quality and representativeness, impact assessment methods, and usefulness of information in identifying environmental hotspots. For the screening process a guiding framework was elaborated, adapted from a study carried out on furniture products (Cordella and Hidalgo, 2016).

LCA studies and related documents were sourced from LCA databases, scientific publications and from various internet search engines. The table below provides a list of analysed LCA studies.

Table 9. List of LCA studies screened

LCA study	Sourced	Study scope of interest	Geographical scope
Paper, freesheet, coated, average production, at mill	US Life Cycle Inventory	Paper making	North America
Paper, mechanical, coated, average production, at mill	US Life Cycle Inventory	Paper making	North America
Paper, mechanical, uncoated, average production, at mill	US Life Cycle Inventory	Paper making	North America
Kraft paper (EN15804 A1-A3)	Industry	Cement bags	Europe
Comparative study of virgin fibre based packaging products with competing plastic materials	Industry	Paper and plastic bags	Europe
A comparative LCA study of various concepts for shopping bags and cement sacks	Indudtry	Paper and plastic bags	Europe
A comparative LCA study of various concepts for shopping bags and cement sacks	Scientific publication	Paper for Shopping and cement bags	World

An Exploratory Comparative Study on Eco-Impact of Paper and Plastic Bags	Scientific publication	Shopping bags	World
GHG Calculation Tools for Pulp & Paper Mills	WBCSD	Paper making	World
Available and emerging technologies for reducing greenhouse gas emissions from the pulp and paper manufacturing industry	US EPA	Paper making	US
2010- Life Cycle Assessment and Forest Products: A White Paper Source: Forest Products Association of Canada (FPAC) and PricewaterhouseCoopers (PwC)	Forest Products Association and PWC	Paper making	US
Paper, bag and sack, unbleached kraft, average production, at mill	US Life Cycle Inventory	Paper making	US
Paper, woodfree, coated at integrated mill	Ecoinvent	Paper making	Europe
Kraft paper, bleached	Ecoinvent	Paper making	World
Paper, woodfree, coated at non-integrated mill	Ecoinvent	Paper making	Europe
Paper, woodfree, uncoated at non-integrated mill	Ecoinvent	Paper making	Europe
Paper, woodfree, uncoated at integrated mill	Ecoinvent	Paper making	Europe
RFO, combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory	Paper making	North America
TDF, combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory	Paper making	North America
Bituminous coal, combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory	Paper making	North America
Diesel, combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory	Paper making	North America
Fuels, burned at coated mechanical paper, average production, at mill	US Life Cycle Inventory	Paper making	North America
Fuels, burned at unbleached kraft bag sack paper, average production, at mill	US Life Cycle Inventory	Paper making	North America
Fuels, burned at uncoated mechanical paper, average production, at mill	US Life Cycle Inventory	Paper making	North America
Gasoline, combusted in equipment, at pulp and paper mill	US Life Cycle Inventory	Paper making	North America
Hog fuel, pur., combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory	Paper making	North America
Hog fuel, self-gen., combusted in ind. boiler, at pulp and paper mill	US Life Cycle Inventory	Paper making	North America
LPG, combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory	Paper making	North America
Natural gas, combusted in industrial boiler, at pulp and paper mill	US Life Cycle Inventory	Paper making	North America
Tall oil (refinement from paper manufacturing)	Industry	Paper making	SE

Colophony / tall oil resin (estimation from paper production)	Industry	Paper making	US
Starch glue (for paper/cardboard)	Industry	Paper and cardboard making	Europe
Starch glue (for paper/cardboard)	Industry	Paper and cardboard making	Germany

The LCAs that address cardboard and papermaking do not include manufacturing stage of any converted paper product. They do not satisfy the inclusion criteria being therefore excluded from the further screening and scoring.

Due to the past and ongoing debate on the ban/levy on plastic shopping bags, some comparative studies between paper and plastic paper bags were found. In particular, "*A comparative LCA study of various concepts for shopping bags and cement sacks*" and "*An Exploratory Comparative Study on Eco-Impact of Paper and Plastic Bags*" were identified as relevant ((Muthu, Li, Hu, & Mok, 2009) (Dahlgren & Stripple, 2016)). These studies are focused on paper carrier/shopping/grocery bags, therefore include the converting processes involved, and some provide information related to the end-of-life stage.

For stationery products two LCA studies commissioned by the Sustainable Office European Association (SOFEA) were identified; Screening Life Cycle Assessment Hot spot assessment (v2) *Filing products* (SOFEA, 2013) and Screening Life Cycle Assessment Hot spot assessment (v2), *Notebooks and paper sheets* (SOFEA, 2016). A more detailed analysis of Muthu et al. revealed that though it is a comparative LCA of two different product types, the main input to the paper bag product system is total energy consumed and pollutants emitted during manufacturing. The study is based on secondary data which was obtained from life cycle energy-only analysis comparisons of paper and plastic bags available in literature. On the other hand, Dahlgren & Stripple (2016) was commissioned by BillerudKorsnas, a major paper bag producer based in Sweden. Hence, data is related to paper bag production by BillerudKorsnas. Likewise, the SOFEA LCA screenings were carried out by Société Générale de Surveillance (SGS) to identify the significant environmental aspects (hotspots) contributing to the impacts of a particular product category based on primary data provided by SOFEA members.

From the scoring exercise Muthu et al. (2009), Dahlgren & Stripple (2016), SOFEA (2013) and SOFEA (2016) scored 10, 16, 16, and 16 respectively. These studies, in particular Dahlgren & Stripple and the SOFEA LCA screenings form the basis for further analysis and extraction of relevant information to reach the practical objectives of identifying environmental hotspot areas and improvement options for converted paper products in the scope of the EU Ecolabel criteria definition process. A focus on the raw material acquisition lifecycle stage is carried out for a representative product type for paper stationeries, using Ecoinvent datasets to identify environmental hotspots. This choice stems from findings of the SOFEA LCA screenings which identify the raw material acquisition phase of stationery products as the most impacting.

The LCA literature review did not identify LCA studies for envelopes. Consequently, an LCA was conducted using information collected from envelope manufacturers (FEPE).

In order to provide a base of comparison for various impacts from paper grades mainly used in converted paper products under study, the LCA results of graphic woodfree uncoated paper (virgin and recycled) and unbleached solid board are also presented. These LCAs are based on datasets from the Ecoinvent database, version 3.

4.2.2.1 Paper carrier bag LCIA

Muthu et al. addresses most of the impact categories provided in the PEFCR, however, the study focuses on a comparison to plastic bags, thus providing no specific values for paper bags. It was therefore not feasible to identify environmental hotspots from this study. Consequently, findings related to paper carrier bags presented in this section are extracted from Dahlgren & Stripple.

Dahlgren & Stripple study focuses on information and results related to the shopping bags made up of virgin fibre while the recycled paper bag contains 15% virgin fibre.

The boundary system considered is a cradle-to-customer assessment and the environmental impact categories are: *Global Warming Potential* (GWP), *Acidification Potential* (AP), *Eutrophication Potential* (EP), *Photochemical Ozone Creation* Potential (POCP) and *Primary Energy Demand*. The characterization factors are from CML2001 (2013) (Centre of Environmental Science of Leiden University).

The functional unit selected for the study is *1 paper bag of 31 litres* with characteristics specified in Table 10 *(Dahlgren & Stripple, 2016).*

Table 10. Material, product weight, and place of conversion (packaging manufacturing), as well as place of end-of-life for the system expansion for the shopping bag

Material	Product weight (g)	Virgin paper content (%)	Material origin	Place of conversion
Kraft paper	74	100	Billerudkorsnäs	Germany
Recycled paper	74	15	European average	Germany

The examined life cycle stages are as follows:

- *Material production*: Raw material acquisition including paper manufacturing in Sweden
- *Material transport*: Upstream transport of raw materials including paper to bag production site in Germany
- *Packaging production*: Manufacturing phase of paper bag in Germany (the packaging)
- *Packaging transport*: Distribution of the paper bag from Germany to London

Table 11. Energy consumption for the paper recycling process and paper machine (BREF, 2015)

Energy consumption	Paper recycling process	Paper machine
Electricity [kWh/ton]	**250**	**550**
Thermal energy [MJ/ton]	**-**	**3380 (4020)**

The first impact category considered is the primary energy use for shopping bags during their life cycle from raw material to a final product at the customer (cradle-to-consumer). Energy data involved in the life cycle are considered as reported in Table 11. The share of renewable energy use for the bags during their life cycle is 71%. Renewable energy resources such as hydro, wind and solar energy, come from electricity production.

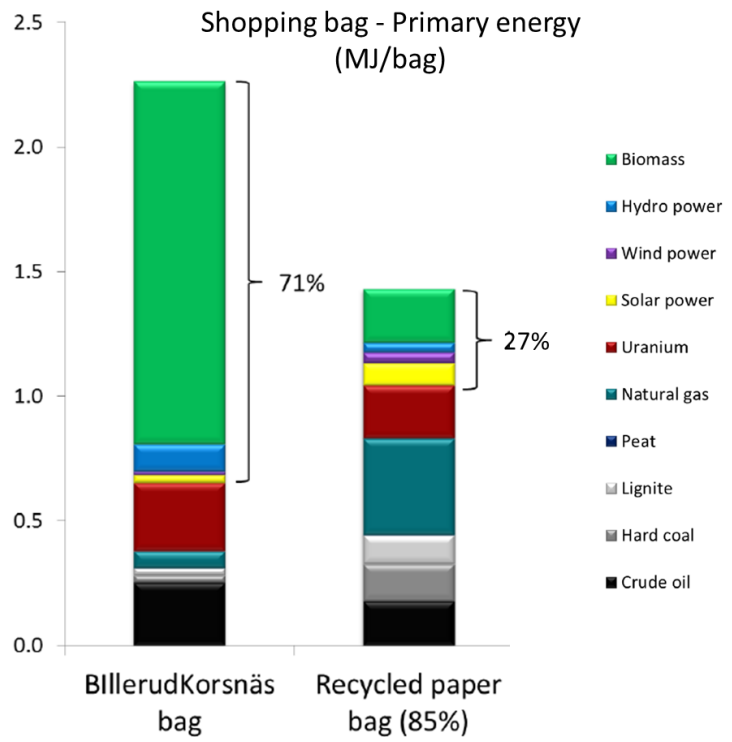


Figure 30. Primary energy sources for virgin and recycled paper bag production (Dahlgren & Stripple, 2016)

The largest source of Primary energy is biomass used in the paper manufacturing process, mainly from the black liquor recovery. The recycled paper bag also has some input of biomass which originates from biomass used as energy in the production of the virgin material (15% content). Uranium comes mainly from the electricity mix used during conversion (German mix) and the BillerudKorsnäs bag uses somewhat more uranium due to the high amount of nuclear power in the Swedish electricity mix used at the mill. The recycled paper bag also requires a great amount of natural gas in the recycling process. However, the Primary energy linked to recycled paper bag is 36.8% less than that for virgin paper bag. This confirms the general notion that recycling of a renewable material, like paper, normally requires less energy than production of comparable renewable material from virgin feedstock (Harris, Staffas, Rydberg, & Eriksson, 2018).

Relative contributions to impacts of the various life cycle stages of the paper carrier bag are illustrated in Figure 31.

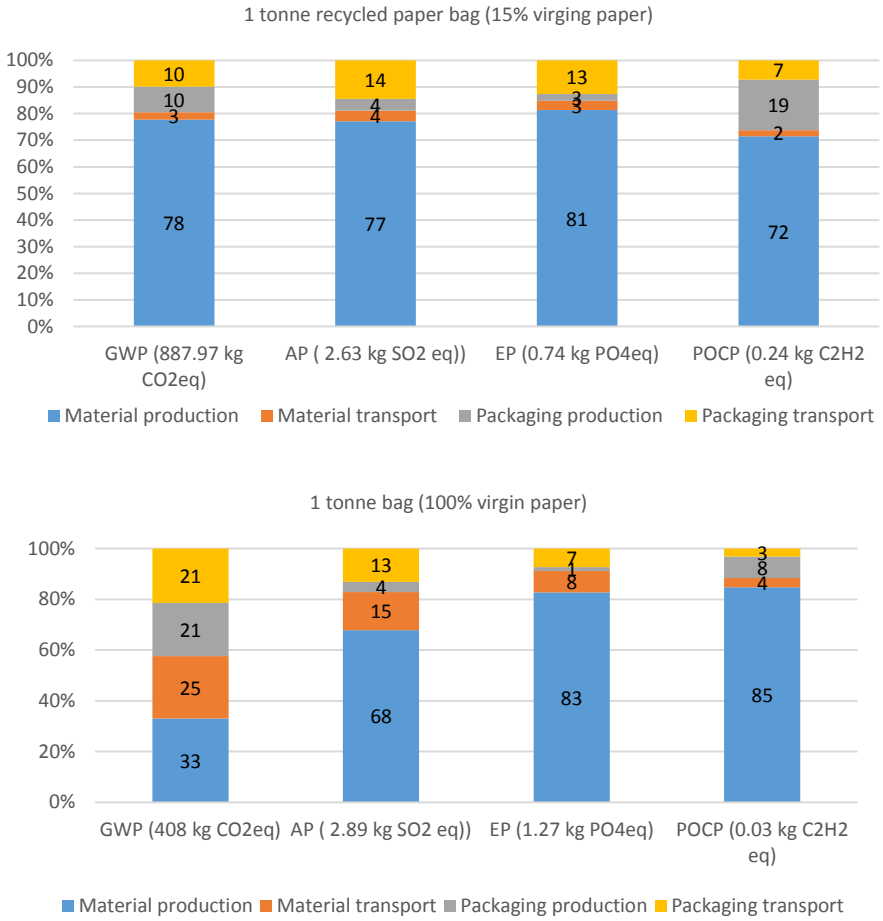


Figure 31. Virgin and Recycle paper bag- Impacts of life cycle stages (Dahlgren & Stripple, 2016)

Material production is, in general, the most important factor in the life cycle of paper bags, with a significant contribution to all analysed impacts. The bag manufacturing stage (conversion process) has a lower impact, contributing 4%, 1% and 8% to AP, EP and POCP respectively. However, for climate change, a share of impact from the bag manufacturing stag is 21%. A comparison between virgin and recycled paper bag shows similar results except for GWP, where climate change impact for recycled paper bag doubles that of virgin fibre. This is due to the modelling choices for the paper recycling process. Data used was based on information contained in BREF, (Suhr et al., 2015), for pulp and paper. For the recycling European average electricity mix was used, which is more impacting than Swedish and German mix used for the virgin paper bag. Accordingly, the impact strongly depends on the electricity mix, thus the two studies are not fully comparable (use of different electricity mix).

A report published by the Swedish Environmental Research Institute (IVL), analysed LCA studies on recycled renewable materials concluding that they normally require less energy than production of comparable renewable material from virgin feedstock, with typical reductions of 0.5 kg CO2e per kg of product in the case of paper and board (Harris et al., 2018). The greenhouse gas (GHG) emissions leading to climate impact are largely linked to energy use in the product lifecycle.

Figure 32 provides more detailed picture of the climate impact distribution during recycled paper bag manufacturing. The high contribution from the paper machine is due to the fossil origin of energy used.

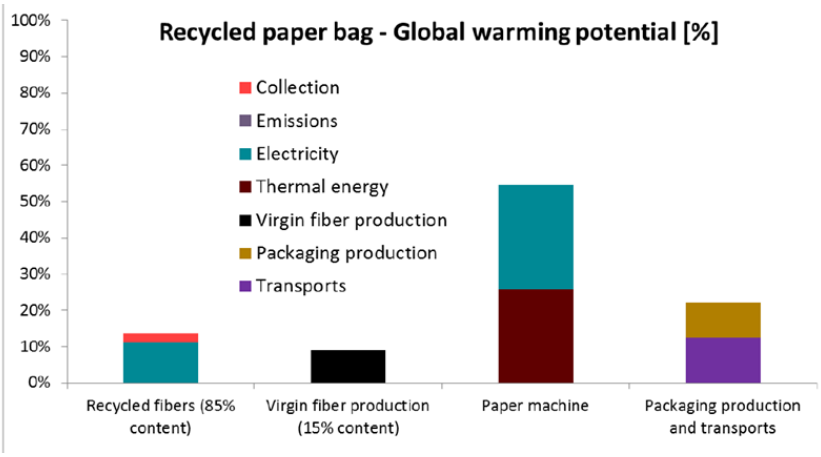


Figure 32. Contributions to GWP for recycled paper bag (Dahlgren & Stripple, 2016)

The use of great quantities of biofuel also causes direct emissions such as nitrogen oxide, sulphur dioxide, and ammonia from the burning of the biomass content (Irish Bioenergy Association, 2016). These emissions affect the acidification potential and lead to almost the same AP for both virgin and recycled paper bag. For the latter, the 15 % virgin fibre content contributes to 24 % of the total acidification impact.

EP stems from COD and nitrogen oxides emissions from the mills. Paper manufacturing is associated with emissions to water, such as nitrogen, phosphate, BOD and COD, which affects the EP. For the recycled paper bag, 48 % of the total eutrophication impact is due to the 15 % virgin fibre content, which is added to the paper mass to reach desired quality. Meanwhile, 23 % is due to the recycling process (Dahlgren & Stripple, 2016).

22% contribution to POCP for recycled paper bag is due to the 15% virgin fibre content, compared to the 20 % of the total impact related to the recycling process (85 % recycled fibre content).

4.2.2.1.1. Material production (Paper making)

Unbleached kraft paper is commonly used for paper bags manufacturing. Figure 33 shows the relative contributions of various life cycle stages of kraft process to selected impact categories. The life cycle stages considered are defined as follows:

- *"Forestry"* refers to emissions generated during activities in the forest, which are required for generating wood such as production of seedlings, silviculture, logging and forwarding.

- *"Energy (upstream)"* refers emissions generated during production (upstream) of external energy (production of electricity and fuel oil) that is used in the manufacturing process. Note that the emissions released during combustion of the fuel oil are included in "*Direct emissions from mill*".

- *"Chemicals (upstream)" refers to* emissions generated during production of the chemicals used in the production of paper. Hence, these emissions are not emitted at the mill, but where the production of the chemical takes place.

- "*Transports*" refers to transports of all commodities (forest, chemicals and fuels (oil, diesel, gasoline)) to the mill, as well as emissions from internal transports at the mill that have a very small impact.

- *"Direct emissions from mill" refers to* emissions from the mill during the normal operation process (pulp and paper manufacturing).

- *"Waste"* refers to the waste generated during pulp and paper production and also transport of the waste to waste management facility.

Emissions released during paper manufacturing (direct emissions) are the largest contributor to all considered impact categories, except for GWP, for which the upstream commodities, mainly chemicals, are most important. Emissions associated with forestry are most relevant for GWP and EP and less for AP or POCP.

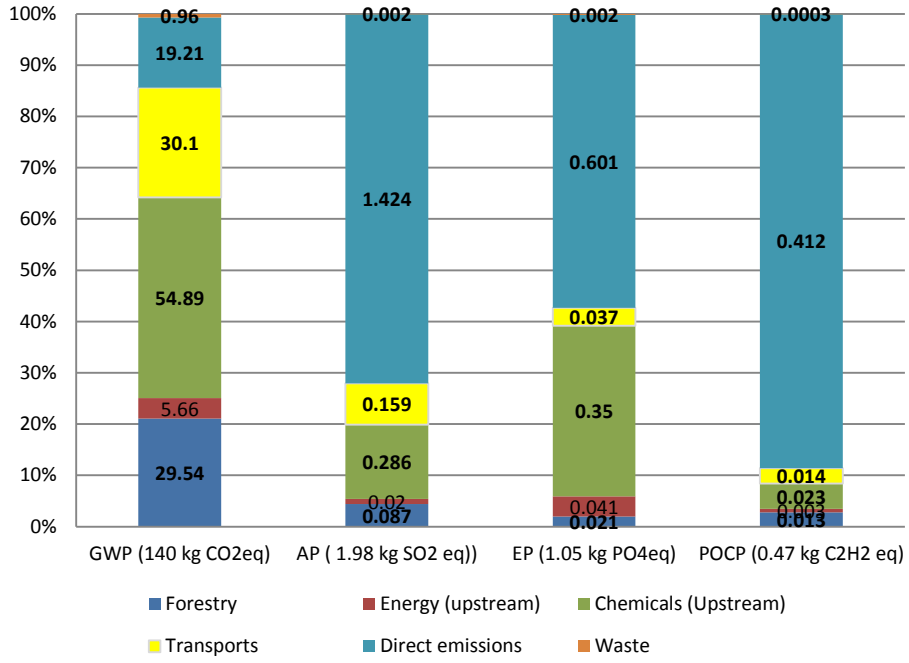


Figure 33. Impacts of life cycle stages of 1 tonne unbleached Kraft paper (Dahlgren & Stripple, 2016)

Table 12 indicates contribution of analyzed life cycle stages to selected impact categories; for paper (substrate material) and bag manufacturing. Direct emissions and manufacturing shows the highest impact share.

Table 12. Percentage contribution to impacts from paper making stages

	Forestry		**Energy (upstream)**		**Chemicals (Upstream)**	
	Paper prod	Bag prod	Paper prod	Bag prod	Paper prod	Bag prod
GWP	21%	7%	4%	1%	39%	13%
AP	4%	3%	1%	1%	14%	10%
EP	2%	2%	4%	3%	33%	28%
POCP	3%	2%	1%	1%	5%	4%
	Transports		**Direct emissions**		**Waste**	
	Paper prod	Bag prod	Paper prod	Bag prod	Paper prod	Bag prod
GWP	21%	7%	14%	5%	1%	0%
AP	8%	6%	72%	49%	0%	0%
EP	4%	3%	57%	47%	0%	0%
POCP	3%	3%	89%	75%	0%	0%

Use of chemicals during production process contributes to the climate impact. The most GWP impacting chemicals are assumed to be the flocculation/thickening agents (35%) and sodium hydroxide (30%). Forestry and transport related activities are also significant contributors (Figure 34).

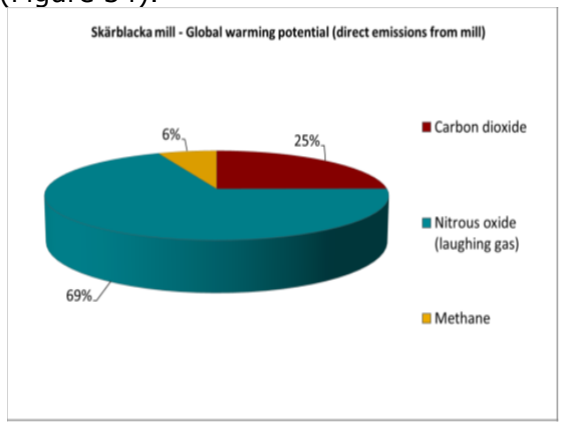


Figure 34. Breakdown of GWP into direct emissions from paper mill of 1 tonne of kraft paper (Dahlgren & Stripple, 2016)

In this specific study, energy efficiency measures resulted in the relatively low CO_2 emissions, and higher of nitrous oxide. This is because the Skärblacka mill, uses a great share of biofuels in its production, the mill also utilises energy excess from the mill both for heat and electricity generation which is used internally, meanwhile the electricity which is bought from grid has a relatively low impact (Vattenfall, 2016).

The main contribution from manufacturing to AP and EP and also to some extent POCP is due to nitrogen oxides emitted to air (Figure 35). NMVOC are the main contributors of POCP (85%) which is mainly from terpene emissions released during production and handling of wood chips.

A significant contribution to EP can be additionally observed from the upstream chemical production, mainly due to flocculation/thickening agents (74%) and Sodium hydroxide (15%). The high impact from the upstream production of the flocculation/thickening agents is due to high emissions of ammonia to water.

The above results show that emissions from the mills are an important factor for all impact categories, but also, use of chemicals especially for GWP and EP. Hence, how and where the chemicals are used might be an essential aspect for the environmental performance of the mills.

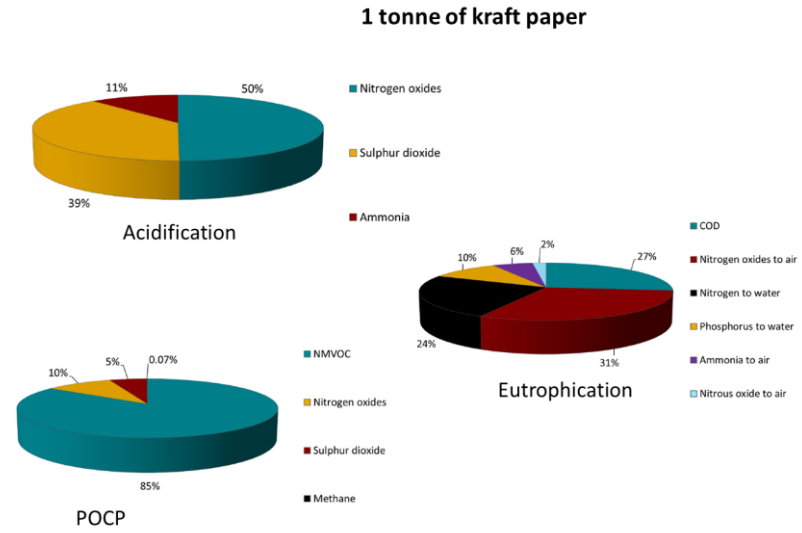


Figure 35 . Breakdown of AP, EP and POCP into direct emissions from paper mill of 1 tonne of kraft paper

4.2.2.2. Stationery products LCIA

SOFEA commissioned SGS to carry out **screening LCA studies** for stationery paper products. The screening LCAs was conducted in line with Life Cycle Assessment principles as described in ISO 14040, and 14044. The study was intended for internal use, hence no external reviewing was done.

The functional unit was selected to reflect the actual intended use of the paper stationery product type i.e. writing area or filing capacity (Table 13), which differs from the mass-based functional unit declared in LCA studies of the related paper grades. If the paper substrate is not characterised, as in the case of the SOFEA LCA, comparison between different studies is quite difficult (or not feasible). The LCIA results provided are related to the entire LCA of the converted paper product without a breakdown into contributions of each life cycle stage.

Table 13: Scope of LCA study

Product type	**Functional Unit**
Notebook and paper sheet	
Paper Sheets	*1 m^2 writing area*
Fiber Cover Notebook Spiral Bound	
Polypropylene Cover Notebook Spiral Bound	
Polypropylene Cover Notebook Glue Bound	
Filing products	
Suspension File	*Storage/filing of X sheets of paper in each product*
Lever Arch File (LAF),	
Archive Box	

For all product types the study covers following stages:

- production of the raw material and packaging,
- transport of these materials to the manufacturing site,

- manufacturing process,
- product distribution,
- use phase
- product end of life.

The impact categories and characterization factors were selected from the RECiPe LCIA method, and the results are reported only in end-point impact categories as in Table 14

Table 14. Impact categories analysed for stationery products according to the RECIPE method

Impact category	Units
Climate change Human Health	*DALY*
Ozone depletion	*DALY*
Human toxicity	*DALY*
Photochemical oxidant formation	*DALY*
Particulate matter formation	*DALY*
Ionising radiation	*DALY*
Climate change Ecosystems	*species yr*
Terrestrial acidification	*species yr*
Freshwater eutrophication	*species yr*
Terrestrial ecotoxicity	*species yr*
Freshwater ecotoxicity	*species yr*
Marine ecotoxicity	*species yr*
Metal depletion	*$*
Fossil depletion	*$*

The data collection was obtained via questionnaire. For each stage of the product's life cycle, manufacturers attempted to indicate minimum and maximum values in order to reflect the variety of designs existing for these products. In some cases, data on a range of representative products were used instead of the absolute min and max. However, in the LCA report, details of these datasets or choices are not provided.

Considering the goal of this study, the quality of the data provided is not robust, but it is sufficient to transfer a good understanding of the relative impacts within each addressed product category. The analyses are aimed at identifying relevant information on relative impacts and hotspots related to the life cycle of the products.

4.2.2.2.1 LCIA Notebook & Paper sheet

Free/loose sheets and various notebook types were selected to represent writing stationery products. The functional unit is based on the writing area. The products selected are characterised by different features allowing for an evaluation of their contribution to overall impact results. These include type of material used for notebook cover (paper fibre *vs* polypropylene), and type of binding (metal rings *vs* glueing).

The transport of raw materials to the facilities across Europe was modelled as 1000km (by truck); whereas for Asia a fixed value of Ocean freight was added, where applicable. For transport related to the final product distribution, as manufacturing was located in Europe, fixed value of km covered by Truck was assumed. For the end-of-life phase, it was assumed that: 70% of product is recycled, 15% landfilled and 15% sent for incineration. The analyses provided in the following sections are to be understood considering these assumptions.

Comparisons of impacts of one product against the others were carried out as reported in the following paragraphs.

Comparing paper sheets with notebooks, paper sheets present lower impacts as they do not include glues, metals or covers (fibre or PP), as is the case with notebooks. Paper sheets related impacts are about 10 times less in the case of the Metal depletion impact compare to spiral bound notebooks.

Table 15. Comparison of paper sheets against notebook stationeries (% variation of impacts)

Impact category	Units	Fiber Cover Spiral Bound	Fiber Cover Glue Bound	PP Cover Spiral Bound	PP Cover Glue Bound
Climate change Human Health	DALY	19%	14%	44%	16%
Ozone depletion	DALY	13%	13%	10%	-2%
Human toxicity	DALY	18%	13%	14%	-4%
Photochemical oxidant formation	DALY	19%	12%	65%	19%
Particulate matter formation	DALY	32%	13%	61%	11%
Ionising radiation	DALY	11%	10%	11%	-8%
Climate change Ecosystems	species yr	19%	14%	44%	16%
Terrestrial acidification	species yr	20%	14%	57%	11%
Freshwater eutrophication	species yr	16%	12%	17%	-2%
Terrestrial ecotoxicity	species yr	52%	13%	48%	15%
Freshwater ecotoxicity	species yr	62%	13%	67%	-2%
Marine ecotoxicity	species yr	50%	16%	47%	8%
Agricultural land occupation	species yr	12%	13%	-3%	9%
Urban land occupation	species yr	17%	11%	3%	12%
Natural land transformation	species yr	35%	14%	31%	-4%
Metal depletion	$	1100%	15%	1343%	1%
Fossil depletion	$	16%	13%	77%	32%

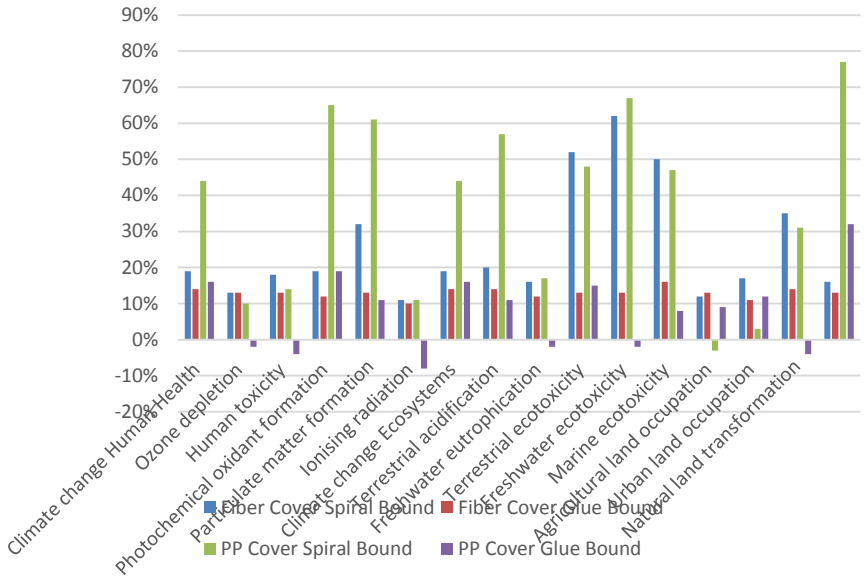


Figure 36. Comparison of impacts between paper sheets and notebooks

A comparison of results for various notebooks, considering fiber cover spiral bound as baseline, shows higher impacts of spiral (metal) over glue binding systems. Besides, the increase of more than 9 times of the Metal depletion, due to spiral binding is observed for Ecotoxicity impact categories, ranging from 29%-43%. The more impacting nature of metal binding is confirmed also in the case of notebooks with PP cover, where the gap between spiral and glue bindings is larger (Table 16).

Table 16. Comparison of Fiber spiral bound against other notebooks (% variation of impacts)

Impact category	Units	Fiber Cover Glue Bound	PP Cover Spiral Bound	PP Cover Glue Bound
Climate change Human Health	DALY	4%	-18%	2%
Ozone depletion	DALY	1%	3%	16%
Human toxicity	DALY	5%	4%	23%
Photochemical oxidant formation	DALY	6%	-28%	0%
Particulate matter formation	DALY	17%	-18%	19%
Ionising radiation	DALY	1%	0%	20%
Climate change Ecosystems	species yr	4%	-18%	2%
Terrestrial acidification	species yr	5%	-23%	8%
Freshwater eutrophication	species yr	4%	-1%	19%
Terrestrial ecotoxicity	species yr	35%	3%	32%
Freshwater ecotoxicity	species yr	43%	-3%	65%
Marine ecotoxicity	species yr	29%	2%	39%
Agricultural land occupation	species yr	0%	16%	3%
Urban land occupation	species yr	5%	14%	5%
Natural land transformation	species yr	18%	3%	40%
Metal depletion	$	945%	-17%	1090%
Fossil depletion	$	3%	-34%	-12%

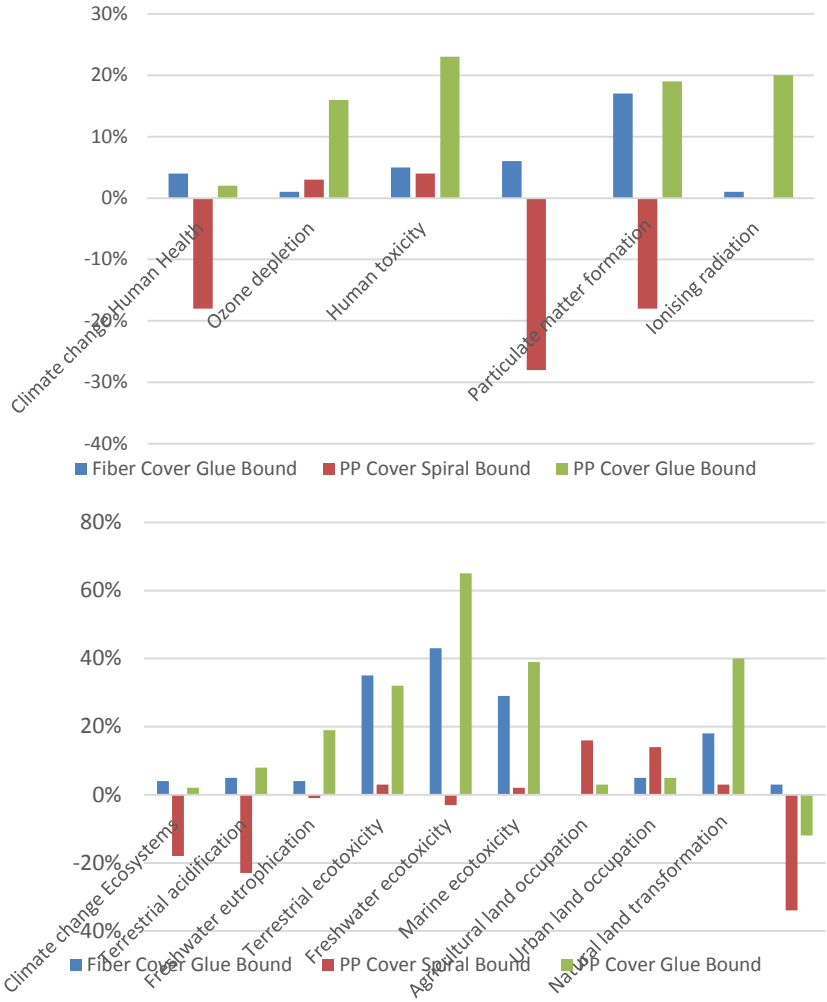


Figure 37. Comparison of impacts of fibre cover spiral bounded notebooks against other notebooks

Table 16 also highlights the impact difference between the use of fibre covers versus PP covers in notebooks. The use of PP covers leads to higher impacts especially in the case of Fossil depletion (34%) and POCP (28%). This trend is more evident in the case of glue binding probably due to the fact that more glue is needed to support the weight of the PP cover than the fiber cover (
Table 17).

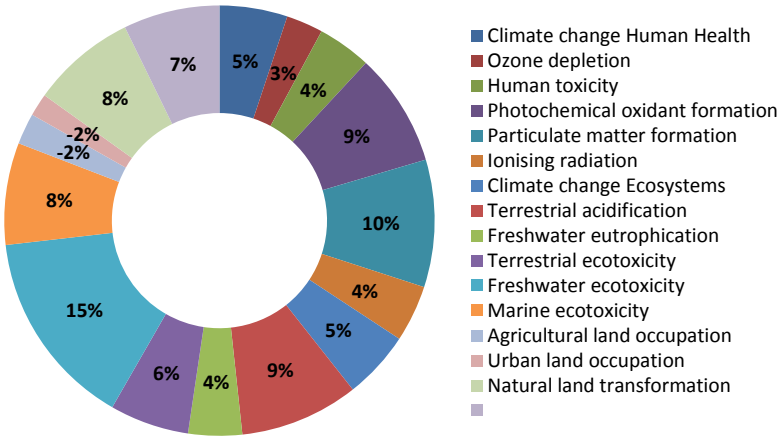


Figure 38. Comparison of PP Cover Spiral Bound against PP Cover Glue Bound (% of differences for each impact category)

Table 17. Comparisons between fibre cover with glue binding and PP cover glue binding (% variation of impacts)

Impact category	Units	PP Cover Glue Bound
Climate change Human Health	DALY	-21%
Ozone depletion	DALY	2%
Human toxicity	DALY	-1%
Photochemical oxidant formation	DALY	-32%
Particulate matter formation	DALY	-30%
Ionising radiation	DALY	-1%
Climate change Ecosystems	species yr	-21%
Terrestrial acidification	species yr	-27%
Freshwater eutrophication	species yr	-4%
Terrestrial ecotoxicity	species yr	-24%
Freshwater ecotoxicity	species yr	-32%
Marine ecotoxicity	species yr	-21%
Agricultural land occupation	species yr	17%
Urban land occupation	species yr	8%
Natural land transformation	species yr	-13%
Metal depletion	$	-92%
Fossil depletion	$	-36%

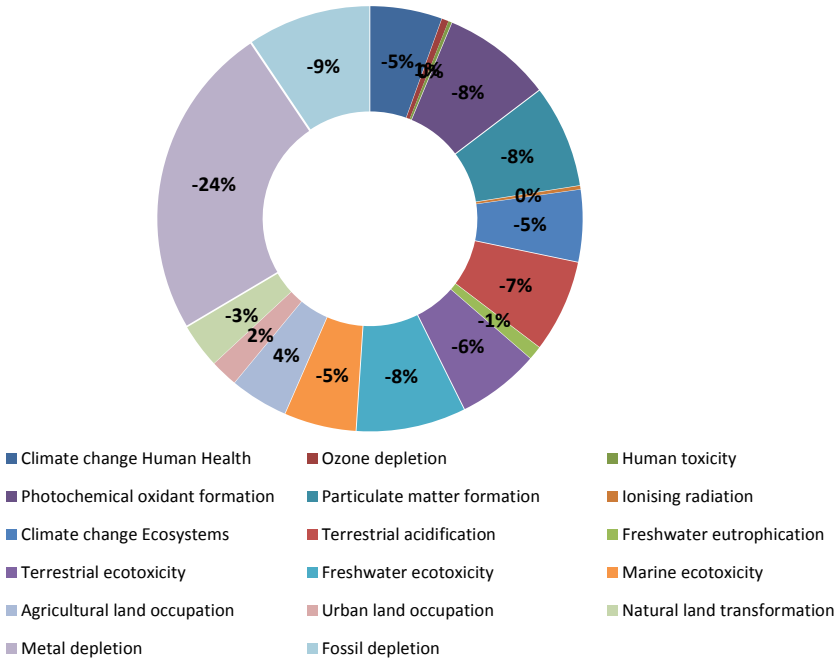


Figure 39. Comparison of impacts of fibre cover glue binding against PP cover glue binding

4.2.2.2.2 LCIA Filing products

Suspension files, archive boxes and lever arch files (LAF) were selected as representative filing products. The LCA study is based on the entire filing product able to store a fixed number and type of sheets. The impacts are therefore related to a particular storage capacity.

The SOFEA LCA report for filing products does not provide inventory or background data. The following information were derived from the study:

- All recycled plastics were modelled based on energy required to shred, clean and process waste plastic. Electricity mix used in recycled model varied by country.
- For transport related issue and the distribution of finished products, manufacturing was taking place in Europe, therefore a distance covered of 1000km by Truck was assumed.
- For end-of-life phase 50% landfill and 50% incineration were considered, except in the case of Archive Box where 80% of recycling,10% landfilling, 10% incineration was assumed.

The analyses provided in the following sections are to be understood considering these assumptions.

Overall, impacts of LAF are the highest followed by those of Archive boxes. This is due to the metal and plastic content in these product types as compared to suspension files. It is probable that the suspension files included in the study refers to the universal type of product. The percentage of fibre in this type of suspension file is about 75%, however, the metal weight is below 40gr and plastic content does not exceed 6%.

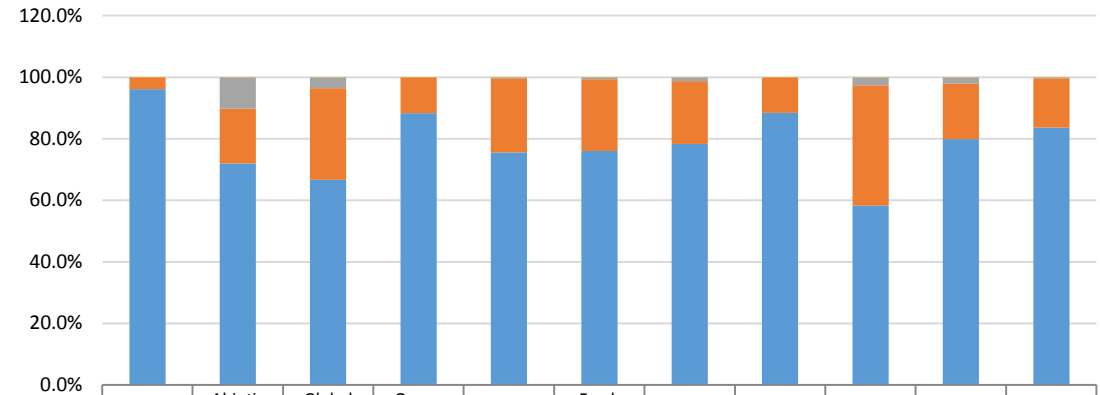
Further analysis of the LAF were carried out to understand the source of impacts related to the raw material acquisition phase, which according to the SOFEA Report contributes the most to the single score.

Also in this case, high contribution to all impacts comes from the paper board ranging Table 18.

Table 18. Environmental impacts of raw materials acquisition phase (LAF)

Impact category	Unit	LAF	Board	Metal	Plastic	Chemical
Abiotic depletion	kg Sb eq	3E-06	2E-06	1E-07	4E-10	5E-11
Abiotic depletion (fossil fuels)	MJ	5E+00	4E+00	9E-01	5E-01	3E-04
Global warming (GWP100a)	kg CO2 eq	4E-01	3E-01	1E-01	2E-02	1E-05
Ozone layer depletion (ODP)	kg CFC-11 eq	4E-08	4E-08	5E-09	9E-12	1E-12
Human toxicity	kg 1,4-DB eq	2E-01	2E-01	5E-02	8E-04	4E-06
Fresh water aquatic ecotox.	kg 1,4-DB eq	2E-01	1E-01	4E-02	1E-03	3E-06
Marine aquatic ecotoxicity	kg 1,4-DB eq	5E+02	4E+02	9E+01	6E+00	9E-03
Terrestrial ecotoxicity	kg 1,4-DB eq	2E-03	1E-03	2E-04	1E-06	1E-08
Photochemical oxidation	kg C2H4 eq	2E-04	1E-04	7E-05	5E-06	9E-09
Acidification	kg SO2 eq	2E-03	2E-03	4E-04	5E-05	4E-08
Eutrophication	kg PO4--- eq	1E-03	1E-03	2E-04	4E-06	1E-08

The figure below highlights the various contributions of selected materials to impact categories as reported in Table 18.



	Abiotic depletion	Abiotic depletion (fossil fuels)	Global warming (GWP100a)	Ozone layer depletion (ODP)	Human toxicity	Fresh water aquatic ecotox.	Marine aquatic ecotoxicity	Terrestrial ecotoxicity	Photochemical oxidation	Acidification	Eutrophication
Chemical	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Plastic	0.0%	10.2%	3.6%	0.0%	0.4%	0.7%	1.2%	0.1%	2.6%	2.1%	0.4%
Metal	3.9%	17.8%	29.7%	11.7%	24.1%	23.3%	20.4%	11.5%	39.1%	18.0%	16.0%
Board	96.1%	72.0%	66.7%	88.3%	75.5%	76.0%	78.3%	88.4%	58.2%	79.9%	83.6%

Figure 40. Percentage contribution to Impacts of LAF raw material acquisition phase

When excluding impacts from board, metals are the major contributor to the majority of impact categories (followed by plastics). The contribution of metals ranges from 64% (ADP fossil) to 100% in ADP elements and ODP.

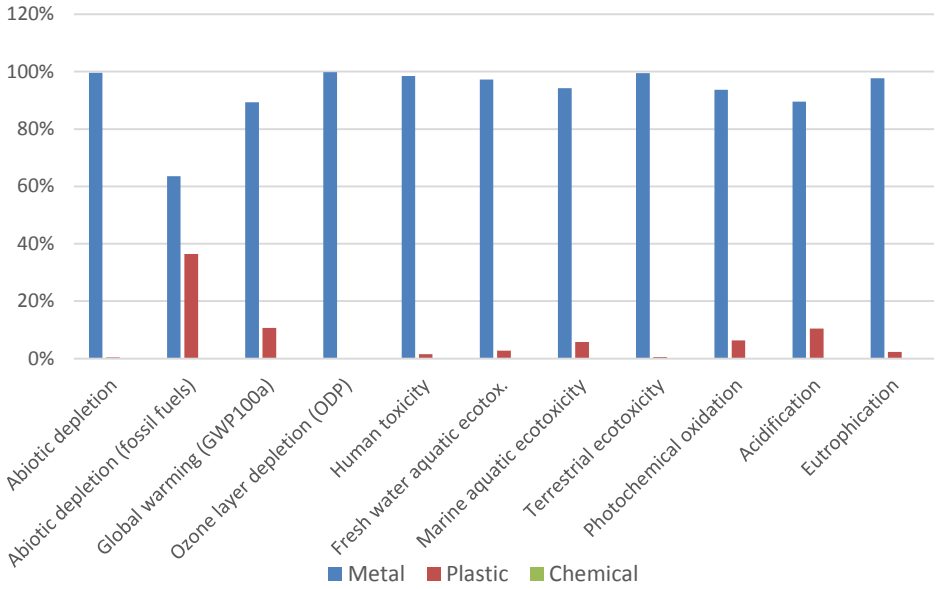


Figure 41. Percentage contribution to impacts of LAF raw material acquisition phase (excluding paper board)

Sensitivity analysis

The simulation of the percentage of different materials content in the final product shows that for LAF containing 15% of plastic, change in the total plastic quantity by 20% has a slight decreasing effect on all impacts (less than 2% average reduction) except for GWP and ADP with 5.5% and 11% reduction respectively (Table 19). The same variation in a LAF with 16% metal content leads to 6.2%, and 8% reduction for GWP and POCP with smaller changes for all other impacts. No significant change was registered for variations of plastic or metal content lower than 20%.

Table 19. Effect of plastic and metal quantity reductions

Impact category	% variation for 20% less plastic (LAF with 15% plastic)	% variation for 20% less metal (LAF with 16% metal)
Abiotic depletion	0.03	0.75
Abiotic depletion (fossil fuels)	10.93	4.73
Global warming (GWP100a)	5.52	6.20
Ozone layer depletion (ODP)	0.04	2.26
Human toxicity	0.72	4.72
Fresh water aquatic ecotox.	1.23	4.60
Marine aquatic ecotoxicity	2.21	4.11
Terrestrial ecotoxicity	0.12	2.24
Photochemical oxidation	4.46	7.90
Acidification	3.50	3.74
Eutrophication	0.70	3.15

When excluding paper, the variation in metal and plastic content yields higher reductions for all impacts. In the case of metals, most impacts are reduced by 19% except ADP which is reduced by 17%.

An analysis was done replacing virgin with recycled plastic. It was seen that the use of recycled plastic has a positive effect on impacts except in the case of GWP where electricity use and the recycling process contributes more (Table 20). However, in LAF containing less than 5% plastic, the use of recycled plastic brings lesser benefits and results in higher impacts for some categories.

Table 20. Effect on substituting primary with recycled plastic in LAF (% variation of impacts)

Impact category	Unit	15 % plastic content	5% plastic content
Abiotic depletion	kg Sb eq	-268	0
Abiotic depletion (fossil fuels)	MJ	68	10
Global warming (GWP100a)	kg CO2 eq	47	3
Ozone layer depletion (ODP)	kg CFC-11 eq	39	-1
Human toxicity	kg 1,4-DB eq	20	-1
Fresh water aquatic ecotox.	kg 1,4-DB eq	1	-5
Marine aquatic ecotoxicity	kg 1,4-DB eq	-3	-6
Terrestrial ecotoxicity	kg 1,4-DB eq	34	-1
Photochemical oxidation	kg C2H4 eq	43	2
Acidification	kg SO2 eq	45	2
Eutrophication	kg PO4--- eq	37	-1

4.2.2.3. Envelope LCA

The LCA literature review did not identify any LCA studies for envelopes. Consequently, an LCA was conducted using information collected from envelope manufacturers (FEPE).

Due to different types and dimensions of envelopes, 1 kg of envelope was selected as a functional unit.

The LCA study refers to the cradle to grave, from raw material acquisition to envelope manufacturing and the end-of-life. The use phase was assumed as negligible, thus not taken into consideration: The FEPE members provided data on input types and quantities, such as energy consumption, paper, plastic, glue, inks and other chemicals used. Transport data for delivery of raw materials to envelope production site was not considered. The waste paper produced was assumed to be recycled as it is the most practised treatment method in Europe according to EUROSTAT (98,5%) (EUROSTAT, 2018).

The LCA is based on primary data referring to production years 2016 and 2017. Missing information was additionally identified, namely: internal transport and chemistry of glue type. Potato starch datasets from Ecoinvent database were considered to represent glue. No data for on-site emission was provided.

Representative processes were selected from the Ecoinvent database ver 3.3, both the CML2001 (2013) and ILCD methods were applied in the LCIA. The results according to these two methods are not directly comparable due to the different impact categories involved and different units of measurement. The only exception is ODP which is evaluated with the same indicator in both CML and ILCD methods. Climate change in ILCD differs from GWP of CML because of the net negative impact due to the correction flows for biogenic carbon.

Table 21. Environmental impact of 1 kg envelope

Impact category	*Unit*	*Total*	*Envelope paper*	*Plastic*	*Printing ink*	*Glue*	*Chemicals*	*Electricity Europe*	*Paper (waste treatment)*
CML 2001 method									
Abiotic depletion	**kg Sb eq**	2.6E-06	2.7E-06	2.1E-08	8.9E-08	1.6E-07	3.5E-08	1.4E-07	-5.2E-07
Abiotic depletion (fossil fuels)	**MJ**	1.6E+01	1.1E+01	2.9E+0	4.0E-01	1.1E-01	2.1E-01	3.1E+00	-1.7E+00
Global warming (GWP100a)	**kg CO2 eq**	1.4E+00	1.0E+00	1.4E-01	3.0E-02	1.2E-02	7.6E-03	2.9E-01	-1.4E-01
Ozone layer depletion (ODP)	**kg CFC-11 eq**	1.3E-07	1.2E-07	5.9E-10	3.2E-09	1.1E-09	3.2E-10	2.9E-08	-1.7E-08
Human toxicity	**kg 1,4-DB eq**	7.1E-01	6.1E-01	1.4E-02	9.8E-03	9.8E-03	1.8E-03	1.3E-01	-6.5E-02
Fresh water aquatic ecotox.	**kg 1,4-DB eq**	1.2E+00	1.1E+00	1.8E-02	1.0E-02	5.5E-03	1.1E-03	1.7E-01	-7.2E-02
Marine aquatic ecotoxicity	**kg 1,4-DB eq**	5.6E+03	5.3E+03	9.3E+01	1.8E+01	1.6E+01	3.9E+00	5.1E+02	-3.2E+02
Terrestrial ecotoxicity	**kg 1,4-DB eq**	1.0E-02	7.6E-03	2.7E-05	2.0E-03	2.0E-04	5.2E-06	8.6E-04	-3.7E-04
Photochemical oxidation Potential (POCP)	**kg C2H4 eq**	6.3E-04	5.8E-04	2.8E-05	1.2E-05	2.4E-06	7.6E-06	5.5E-05	-5.0E-05
Acidification Potential (AP)	**kg SO2 eq**	6.3E-03	5.3E-03	4.6E-04	9.4E-05	1.1E-04	2.7E-05	1.4E-03	-1.1E-03
Eutrophication Potential (EP)	**kg PO4--- eq**	4.0E-03	3.3E-03	3.9E-05	4.6E-05	1.0E-04	6.2E-06	9.5E-04	-3.9E-04
ILCD impact categories									
Climate change	**kg CO2 eq**	-3.9E-02	-7.9E-01	1.3E-01	2.2E-02	-1.2E-02	9.4E-03	2.9E-01	3.1E-01
Ozone depletion	**kg CFC-11 eq**	1.3E-07	1.2E-07	5.9E-10	3.2E-09	1.1E-09	4.0E-10	2.9E-08	-1.7E-08
Human toxicity, non-cancer effects	**CTUh**	1.7E-06	1.6E-06	3.5E-09	1.9E-09	7.2E-08	1.7E-09	8.8E-08	-6.6E-08
Human toxicity, cancer effects	**CTUh**	8.2E-08	6.4E-08	3.5E-09	1.0E-09	1.3E-09	2.9E-10	2.3E-08	-1.1E-08
Particulate matter	**kg PM2.5 eq**	2.9E-03	3.4E-03	5.3E-05	1.9E-05	8.1E-06	4.1E-06	1.2E-04	-6.6E-04
Ionizing radiation HH	**kBq U235 eq**	3.0E-01	1.6E-01	2.6E-04	2.6E-03	1.3E-03	4.1E-04	1.5E-01	-1.3E-02
Ionizing radiation E (interim)	**CTUe**	7.9E-07	4.8E-07	1.4E-09	1.0E-08	3.8E-09	1.3E-09	3.4E-07	-5.2E-08
Photochemical ozone formation	**kg NMVOC eq**	5.0E-03	4.7E-03	3.9E-04	7.3E-05	4.1E-05	3.7E-05	5.7E-04	-8.4E-04
Acidification	**molc H+ eq**	7.9E-03	6.7E-03	5.5E-04	1.2E-04	1.8E-04	4.0E-05	1.6E-03	-1.3E-03
Terrestrial eutrophication	**molc N eq**	1.9E-02	1.8E-02	9.5E-04	2.3E-04	7.2E-04	5.9E-05	2.4E-03	-3.0E-03
Freshwater eutrophication	**kg P eq**	8.8E-04	6.4E-04	2.0E-06	7.0E-06	7.7E-06	1.5E-06	2.8E-04	-5.6E-05
Marine eutrophication	**kg N eq**	2.2E-03	1.9E-03	8.9E-05	5.2E-05	1.4E-04	5.5E-06	2.5E-04	-2.8E-04
Freshwater ecotoxicity	**CTUe**	1.4E+01	1.1E+01	2.9E-01	1.8E-01	6.3E-01	4.0E-02	3.0E+00	-1.2E+00
Land use	**kg C deficit**	1.4E+01	1.6E+01	1.2E-02	2.4E-01	2.6E-01	5.0E-03	1.9E-01	-2.7E+00
Water resource depletion	**m3 water eq**	8.2E-03	6.5E-03	3.1E-04	2.9E-05	3.8E-05	1.4E-05	2.1E-03	-8.1E-04
Mineral, fossil & ren resource depletion	**kg Sb eq**	4.8E-05	5.1E-05	2.7E-07	2.1E-06	1.9E-06	9.3E-07	3.0E-06	-1.2E-05

The LCIA results are analysed considering CML impact categories to be in line with CML related results from reviewed studies in the sections above.

Paper substrate represents the main source of impacts for all categories, followed by energy consumption (considering the European electricity mix) - Figure 42. The choice of recycling as paper waste treatment brings additional benefits for all categories: up to 10% for Abiotic depletion (elements and fossil), GWP, ODP, AP and EP. Contributions from printing inks are lesser than 3% for all impacts apart from Terrestrial toxicity (19%). The glue of potato starch contributes less than 3% for all impacts except abiotic depletion elements (6%).

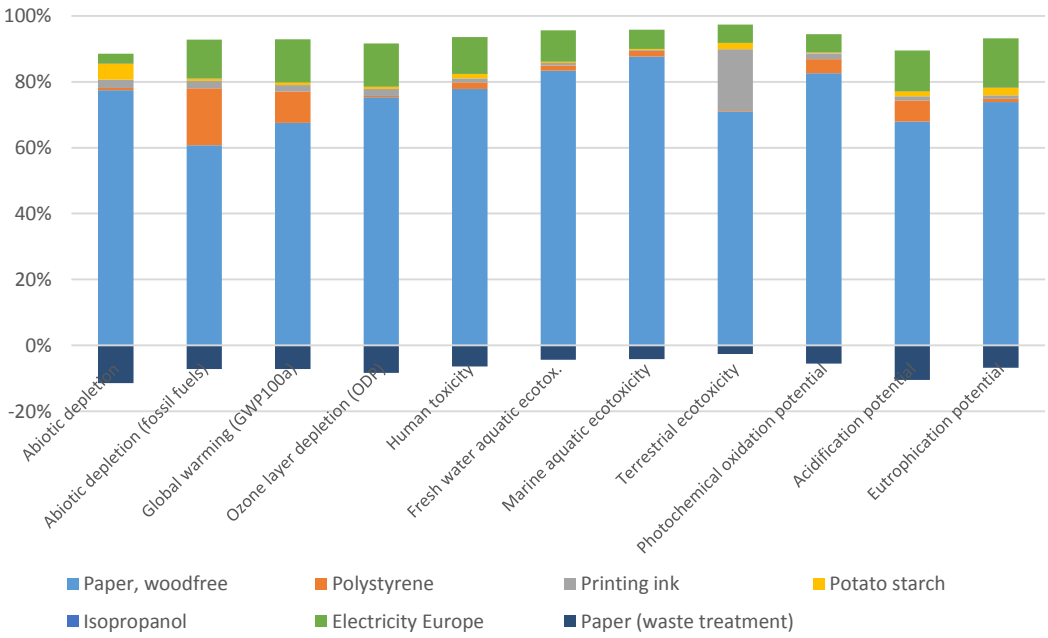


Figure 42. Environmental impacts of 1 kg of envelope

Figure 43 illustrates the environmental impacts of 1 kg of envelope without the contribution of paper. Categories considered are: plastic, inks, glue, chemicals, electricity and waste. This focus on relative contributions from non-paper provides information on how to prioritize in order to reduce overall impacts.

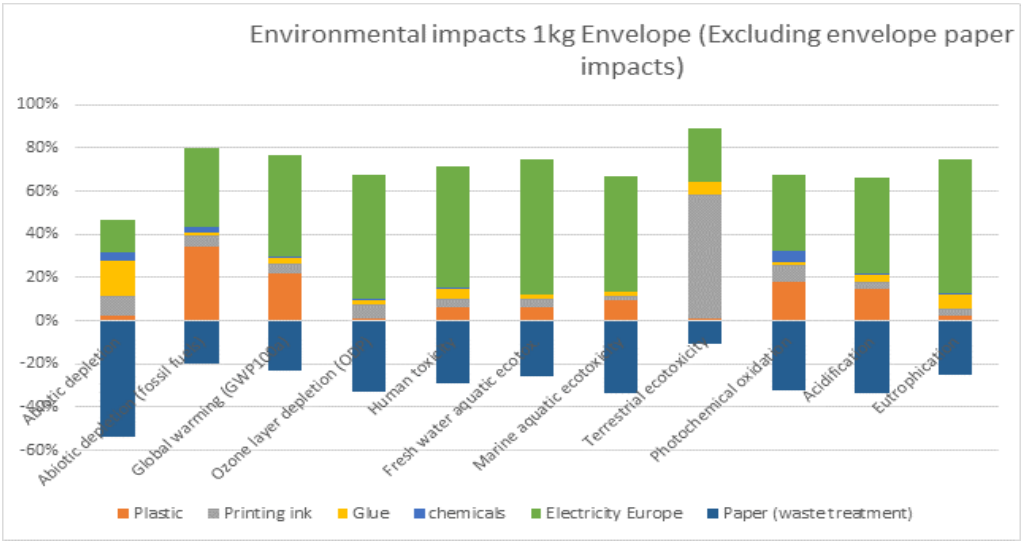


Figure 43. Environmental impacts of 1 kg of envelope without the contribution of envelope paper grades.

The use of window plastic affects mainly Abiotic depletion and GWP. However, window plastics generally represent only about 3% of the total envelope weight.

Another important component with a lower contribution is the printing ink. In fact, without considering the paper contribution, it has a significant impact on the Terrestrial Ecotoxicity, (more than 70% contribution), POCP (22%), and ODP (18%), respectively.

For glues, the highest contribution is observed for ADP, whereas lower impacts are observed for Eutrophication, Human toxicity and Terrestrial ecotoxicity (about 18%)

Sensitivity analysis

To understand the environmental relevance of plastic used in the envelope window, a simulation that considers 50% reduction of plastic quantity was performed. The variation is provided with and without paper substrate. All in all, reductions in impact categories when considering the impacts from paper are: 9% for fossil ADP, 5% for GWP, while the other impact categories are of comparable magnitude (Table 22). However, when excluding paper contribution, the effect of plastic content reduction by 50% becomes more relevant. Impacts are reduced by 29%, 26%, 23%, 21% for ADP fossil, POCP, AP, and GWP, respectively. Therefore, if the reduction of plastic used in the envelope window is technically and functionally feasible e.g. reducing the thickness of the plastic film, this could achieve significant reduction of impacts from the conversion process.

Table 22. Effect of 50% reduction of Envelope plastic content

Impact category	Total envelope impacts	Impact with the exclusion of paper contribution.
Abiotic depletion	0.4	16.4
Abiotic depletion (fossil fuels)	9.2	29.1
Global warming (GWP100a)	5.0	20.6
Ozone layer depletion (ODP)	0.2	1.7
Human toxicity	1.0	7.3
Fresh water aquatic ecotox.	0.8	6.7
Marine aquatic ecotoxicity	0.8	14.5
Terrestrial ecotoxicity	0.1	0.5
Photochemical oxidation potential (POCP)	2.2	25.8
Acidification potential (AP)	3.7	22.8
Eutrophication potential (EP)	0.5	2.6

4.3. LCA of related paper grades

As previously mentioned, converted paper products might be made of various paper grades. A comparison of the associated impacts was done considering unit mass (1 kg) (Table 23).

Table 23. Environmental impacts from main paper grades used in converted paper products

Impact category	Unbleached solid board	Graphic woodfree uncoated
Abiotic depletion	7.2E-06	2.2E-06
Abiotic depletion (fossil fuels)	1.1E+01	8.9E+00
Global warming (GWP100a)	8.8E-01	8.5E-01
Ozone layer depletion (ODP)	1.1E-07	9.4E-08
Human toxicity	4.5E-01	5.0E-01
Fresh water aquatic ecotox.	3.5E-01	8.7E-01
Marine aquatic ecotoxicity	1.0E+03	4.3E+03
Terrestrial ecotoxicity	4.1E-03	6.2E-03
Photochemical oxidation	3.2E-04	4.7E-04
Acidification	6.0E-03	4.3E-03
Eutrophication	2.9E-03	2.7E-03

Results show a significant difference between the board and graphic paper for toxicity, ADP, AP and POCP (Figure 44). The main sources of these differences stem mainly from the electricity and fuel use, consumption of chemicals and emissions during the manufacturing stage. The difference in Abiotic depletion fossil fuel and Acidification are more relevant reaching 19% and 29% respectively. The differences observed stem most probably from the use of bleaching stage for the graphic grade.

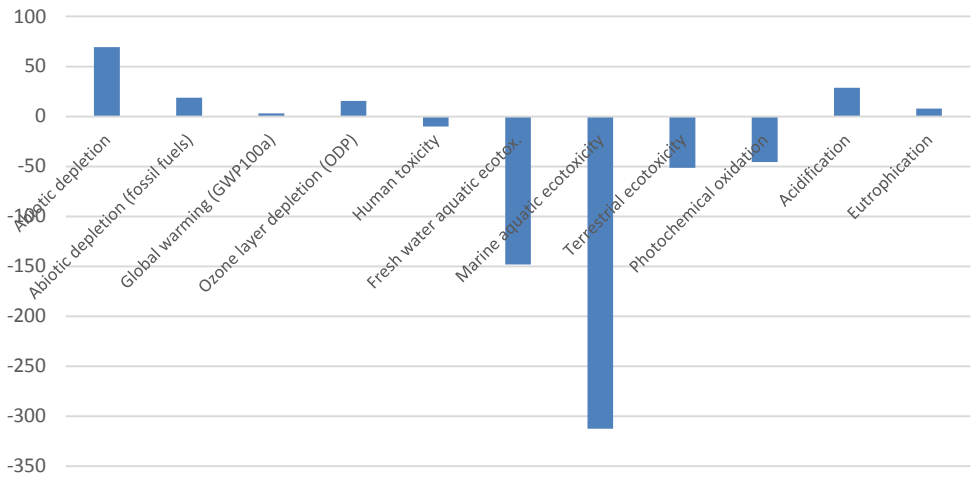


Figure 44. Differences in environmental impacts between unbleached board and graphic uncoated woodfree paper

Sensitivity analysis

A comparison between virgin and recycled graphic paper was carried out using the Ecoinvent datasets for Europe (

Table 24). For recycled graphic paper, results show an average of 90% reduction in all impact categories except Abiotic depletion.

Table 24. Comparision of environmental impact between recycled and virgin graphic paper

Impact categories	Virgin Graphic paper	Recycled Graphic paper	% difference Virgin vs Recycled
Abiotic depletion (elements)	2.20E-03	4.69E-02	-2034
Abiotic depletion (fossil fuels)	8.90E+03	4.20E+02	95
Global warming (GWP100a)	8.49E+02	4.12E+01	95
Ozone layer depletion (ODP)	9.39E-05	3.18E-06	97
Human toxicity	4.97E+02	1.41E+02	72
Fresh water aquatic ecotox.	8.69E+02	7.56E+01	91
Marine aquatic ecotoxicity	4.28E+06	1.62E+05	96
Terrestrial ecotoxicity	6.21E+00	2.78E-01	96
Photochemical oxidation	4.70E-01	2.19E-02	95
Acidification	4.29E+00	5.11E-01	88
Eutrophication	2.66E+00	1.96E-01	93

The Figure 45 shows the percentage reduction of impacts when substituting virgin by recycled graphic paper. The increase of ADP elements is excluded from the figure in order to improve the visibility.

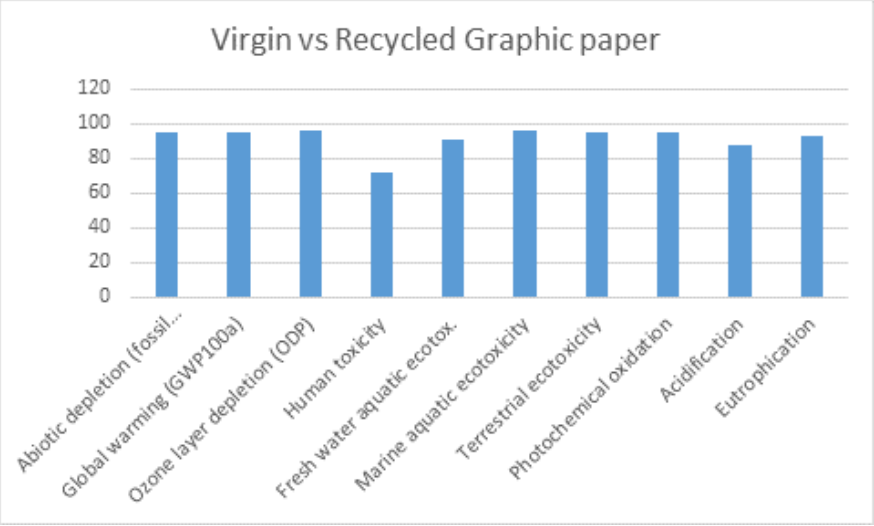


Figure 45. Percentage reduction of impacts replacing virgin with recycled graphic paper

In the case of paper carrier bags the 85% recycled content leads to 38.6% less primary energy consumption when compared to virgin paper bags. Also in the case of Acidification and Eutrophication potential, and POCP - 15% of virgin fibre contributes to 24%, 48% and 22% of impacts, respectively.

4.4. Annual impacts at EU level considering a production based approach

To estimate the global impact of delivering analysed goods at European level, a scale up of the climate and energy related impacts has been carried out applying calculated

impacts of representative product types to the annual production of selected product categories:

- Envelopes
- Virgin paper bag is representative of paper carrier bags with base width <40cm

Notebooks have not been considered, given that the LCA studies identified as well as the related LCIA results refer to writing area as functional unit. The production data available in EUROSTAT are provided in mass unit (kg). Thus, scaling up without introducing a very high degree of uncertainty is not possible..

The scaled-up impacts are presented in Table 25 below.

Table 25. 2016 Impacts of Envelopes and Paper carrier bags EU-28 sold production

Impact category	Envelopes	Paper carrier bags
GWP kgCO_2/t	1.24E+09	4.33E+08
Abiotic depletion fossil (MJ/t)	1.44E+10	3.22E+10

The results have to be considered as an estimation of potential impacts related to energy consumption and Climate change, translated into sold production quantity following information provided by EUROSTAT in 2016.

4.5. Transferring of LCA findings into the EU Ecolabel criteria

LCA related data provided in the previous sections are necessary to identify the stages where the environmental impacts occur. The analyses provides an estimate of the improvement potential to support discussions and consultation related to the on-going revision of the EU Ecolabel criteria for converted paper products. The overall goal of this Task is to highlight possible environmental improvement related to the hotspots identified. This is mainly performed through best practice analysis and front runner identification.

It is worth mentioning that the greatest constrain of this section is limited availability of LCA studies with transparent inventory data. As seen from the result of the screening exercise, a narrow number of studies were identified for paper carrier bags and for stationery products. Due to the non-availability of related published studies primary data for envelopes were collected from industry stakeholders in order to carry out an LCA study. This allowed for a more detailed analysis and conclusions. On the other hand, the LCA study on paper bag represents the production reality of only one company while it would have been more preferable to base our conclusions on an industry led study. The LCA screening study for stationery products represents data from stationery product manufacturers but the aggregation of inventory data makes it difficult to identify environmental hotspots.

The following section includes indications on how to incorporate the LCA findings into the revision of the EU Ecolabel criteria.

Non-paper content

Non-paper components of converted paper products are mainly metals and plastics. Their content might range from 0% in some paper carrier bags to more than 40% for metal, and 16% plastics in ring binders, or 30% for metals and 13% for plastics in LAF (lever arch file).

Among the non-paper components, the highest contribution to most impacts comes from metal elements. In particular, for the case of LAF, the contribution to impacts from

metals is significantly higher than those from the plastic. Plastics contribute at most to 10% of impacts (ADP fossil) while most impacts related to metals are in the 11%-40% range. Moreover, following results of a sensitivity analysis conducted, varying the percentages of metals and plastics content proportionate significant variations in impacts related to metal content, while in the case of plastics the variations are minor. The 20% variation in plastic content leads to less than 2% of average reduction of impacts except for GWP and ADP (5.5% and 11% reduction, respectively). Meanwhile, the same variation of metal in a LAF with 16% of metal content leads to 6.2% and 8% reduction for GWP and POCP with smaller changes for all other impacts. Further comparison between existing LAF products with 10% and 13% of plastic content, considering only the raw materials acquisition stage, shows that the reduction of the plastic content is usually accompanied by an increase in paper content thus the overall impacts of the product increases.

From the above findings, the objective of reducing environmental impacts associated with the use of non-paper content of converted paper product can be better achieved by focusing more on reducing the metal content rather than that of plastic.

Recycled material content

There has been a clear progress observed towards reaching the 2020 target of the European Declaration on Paper Recycling - 74% paper recycling. In 2016, 72.5% of all paper consumed in Europe was recycled. Relative to 2015, the collection of paper for recycling increased by 0.9%, reaching 59.5 million tons (EU Pled*ge, 2016*). Moreover, LCA findings show an average of 90% reduction of impacts replacing virgin with recycled graphic paper for all impact categories except Abiotic depletion.

In the existing EU Ecolabel, the use of recycled paper or fibre is mentioned in Criterion 2, without indicating any threshold on recycled content. The above considerations point to the feasibility and environmental benefit of pushing for an increase in the use of recycled paper in paper products and this could be reflected by determining a threshold in revising the EU Ecolabel. In setting this threshold, high impact of ADP elements should be taken into account by limiting the use of Zinc concentrate or equivalent metals in the recycling process of paper. A threshold on recycled content would also depend on the availability of recycled paper in the EU and the fact that the maximum potential would soon be reached, since 22% of paper consumption can neither be collected nor recycled.

Additionally, LCA findings identify possible environmental benefits when substituting virgin with recycled plastic. This provides a good base for the introduction of criteria that reward those converted paper products, especially folders and binders that seek to include recycled plastics in these products. However, in defining such criteria the negative effects on GWP should be considered, by controlling electricity consumption and other emissions related to the recycling process.

Emissions to air and water

Emissions to air and/or water addressed in the existing EU Ecolabel criteria include COD, Sulphur, NOx, Phosphorus and CO_2 emissions. GWP, POCP, AP and EP are the main LCA impact categories influenced by emissions to air and water.

From the LCA perspective in the case of kraft paper production, Nitrous oxide is the most significant emissions for GWP while Nitrogen oxides dominate for AP and EP. COD and Nitrogen are also important contributors to EP. In the case of POCP the NMVOC contribute the most. These findings are in line with criteria included in the existing EU Ecolabel except in the case of nitrous oxide, which would need to be additionally addressed alongside overall CO_2 emissions.

Use of chemicals

Besides the use of inks and glues in the converting process of most converted paper products, paper manufacturing process encompasses a significant use of chemicals. The LCA studies identified show more than 30% of GWP impacts from the use of

fluocculating/thickening agents such as aluminium sulphates and terpene which are also used in deinking processes. The influence of the production of these chemicals increases in EP. The revision of the EU Ecolabel could further improve the environmental performance of papermaking mills by addressing how these chemicals are manufactured i.e. electricity consumption.

Impacts related to the manufacture of inks and glues used in envelope making, show minor contributions to all impact categories with the exception of Terrestrial ecotoxicity where inks contribution accounts to 20%.

Waste management

The waste management criterion for waste paper generated during the conversion process addresses the need to have a system of waste handling and to reduce waste paper production so as not to exceed a certain percentage for each product type. However, the criterion does not specify any preferential waste treatment practice for waste paper generated. LCA findings indicate positive environmental benefits when recycling is chosen as waste paper treatment method. In the case of envelopes, this leads to a reduction of impacts by up to 10%.

Consequently, to enhance the environmental performance of the product group, a list of waste management best practices could be provided and the feasibility of requiring that a certain minimum percentage of paper waste that is sent for recycling or similar waste treatment could be further evaluated.

4.6. Improvement potential and conclusions

The analysis indicates that the bulk of impacts for all categories, apart from GWP, for all converted paper products, will occur at the upstream materials production phase, mainly at the paper mill. It confirms the importance of establishing requirements (thresholds) for paper substrate production. Continuity in this direction including more stringent requirements would yield major environmental benefits related to converted paper product as a whole.

In some cases where increased use of biomass for energy occurs, these energy efficiency measures implemented in the paper mill leads to relatively low CO_2 emissions which results in nitrous oxide becoming a more dominant contributor to GWP. Thus, the criteria on CO_2 emissions could be modified to account for N_20 introducing a threshold based on CO_2e.

Impacts related to recycled paper are significantly lower (90% average) than those of virgin paper with the exception of ADP elements. Results also show that the addition of virgin pulp to recycled paper, brings along increased impacts. For example, 15% virgin content in paper carrier bags contributes to AP (24%), EP (48%) and POCP (22%).

4.6.1. Envelopes.

As previously mentioned, paper substrate represents the main source of overall environmental impact for all categories.

The second important contributor is the electricity used during envelope manufacturing (considering the EU electricity mix). It could be improved by increase of process efficiency or by reducing the impact of each kWh of electricity by use of renewable energy sources. However, the latter depends on the nature of national grids in each Member State, thus might be too complex to be required under EU Ecolabel criteria

Further components that have a meaningful impact on the envelop performance are plastic windows and printing Ink, if used.

The plastic window contributes mostly to ADP fossil (18%), GWP (10%) and to Acidification (7%). Contributions from printing ink are less than 3% for all impacts apart from Terrestrial toxicity (19%). Without the contribution of the envelope paper, these two components are among those contributing significantly to impacts.

Plastic has an impact on ADP fossil (58%), POCP (51%), AP (45%), GWP (41), ADP elements (32%). Printing Ink also has a significant impact on the Terrestrial Ecotoxicity, (more than 70% contribution), on POCP (22%) and ODP (18%).

Moreover, a significant reduction of impacts is registered if paper scraps from envelopes manufacturing process are sent for recycling. Indeed, in this case it brings environmental credits and allows a reduction in several impact categories, up to 10% for Abiotic depletion (elements and fossil), GWP, ODP, AP and EP.

According to those results a reduction of envelop plastic windows or the use of another plastic such as bioplastic or even reducing the thickness should be explored together with the reduction of the use of printing inks.

4.6.2. Stationery paper products

Stationery products often contain plastic and/or metal parts which tend to increase the overall environmental impacts. This can be observed in the comparison of impacts between paper sheets with notebooks that contain metal or plastic (PP) elements. Impacts related to paper sheets are much lower than those of notebooks, especially for metal depletion and Fossil depletion (more than 70%).

When comparing different types of notebooks, metal components, besides Metal depletion impact, increase Ecotoxicity impact categories by 29-43%. Notebooks with fibre covers generally have lower impacts than those with PP covers and this difference is increased for notebooks which have glue binding. The use of PP covers leads to higher impacts especially in the case of Fossil depletion (34%) and POCP (28%)

In the case of Filing products, LCA results show the overall highest impacts for LAF, followed by Archive boxes. This is due to the higher metal and plastic content in these product types as compared to suspension files.

Considering LAF as a representative filing product, an investigation on the raw material acquisition phase shows that impacts from paper board are the most relevant, reaching 96% for ADP. However, a focus on the non-paper board components reveals that metal highly contributes to all impacts (up to 100%). Results show that about 20% of impacts of the non-paper components could be reduced by reducing the metal content of 20%, a 1:1 ratio. This represents an important opportunity in applying thresholds on metal content which is in line with the existing EU Ecolabel criteria for converted paper products.

Further analysis on the use of plastics shows that substituting virgin with recycled plastic could lead to the positive effects for all impact categories, except GWP for which electricity consumption and other emissions related to the recycling process have a negative effect. The positive benefits of using recycled plastic in LAF decrease in filling products with low plastic content. In fact, for LAF containing less than 5% plastic, the use of recycled plastic brings lesser benefits and results in higher impacts for some categories. In other words, this imply that a substitution of virgin plastic with recycled one makes sense only for LAFs with a plastic content higher than 5%.

4.6.3. Paper carried bag

The largest impact is related to the primary energy consumption. However, about 70% of primary energy comes from renewable source including biomass. This contribution is strongly reduced in the case of recycled paper bag. In fact, the primary energy of recycled paper bag (with 15% virgin content) is 36.8% less than that for virgin paper bag. This confirms the general notion that recycling of a renewable material, like paper, normally requires less energy than production of comparable renewable material from virgin feedstock (Harris, Staffas, Rydberg, & Eriksson, 2018).

As mentioned before, the raw material production (mainly paper) is the most important factor in the life cycle of paper bags with a significant contribution to all impacts, likewise for all the converted paper products. However, in the case of paper carrier bags, their manufacturing stage has a significant contribution to GWP (21%).

A focus on paper production for paper bags reveals that process chemicals such as flocculating/thickening agents (mainly Terpene), and sodium hydroxide contribute significantly to impacts, Nitrous oxide is the most significant emissions for GWP while nitrogen oxides dominate for AP and EP. COD and are also important contributors to EP. In the case of POCP, the NMVOC contribute the most. Only in the case of GWP, forestry and transport activities become relevant contributors that need to be addressed.

All in all, it is expected, that the bulk of converted paper product impacts (>70%) will occur at the upstream materials production phase, that is the paper mill. This high impact is almost always traceable to the production of chemicals used and emissions during the paper manufacturing stage. Consequently, setting criteria on the converting process would be targeting about 30% of impacts related to the entire lifecycle of the converted paper product. An exception to this is seen for GWP where the material production phase contributes about 30 %, while the paper bag converting phase contributes about 20%.

The above trend is confirmed in paper bags containing recycled paper, with higher contribution to impacts from the paper production phase. In fact, for all impacts addressed, except for GWP and POCP, converting process contributes at most 10%. The converting process weighs 20% of POCP.

5. Task 4: Technical analysis

Converted paper products involve the application of various techniques to paper or board. These can be purely mechanical, as cutting or folding, or could involve the use of chemicals such as inks in printing. The recyclability of converted paper products is influenced by design, materials used, manufacturing processes applied and use phase, among others. Other environmental aspects complementing LCA related results that should be considered are related to the following areas:

1. Sustainable supply of raw materials
2. Consumption of chemicals
3. Recyclability

The objective of this section is to highlight the technical aspects related to converted products manufacturing, and their use, with the aim of identifying improvement measures, best practices and further hotspots that are not related to the life cycle assessment.

5.1 Material resource conservation

The goal of this section is to consider the sourcing of the non-paper content of converted paper products, highlighting issues that have an environmental relevance and possible improvement measures.

According to the current scope and definition of the product group, the non- paper content of converted paper products can attain 30% w/w for metal elements. Issues pertaining to the sustainable fibre sourcing were extensively discussed during the revision of the EU Ecolabel criteria for graphic paper, results of the analysis can be found on the project website[31].

5.1.1 Use of Plastics

The wide range of plastic materials can be classified as thermoplastics and thermosets (Table 26). The key difference between the two categories consists mainly on the way the polymer chains are linked together. Thermoset plastics, are formed when their macromolecular chains are cross-linked permitting no further deformation or shaping. In thermoplastics macromolecular chains are not cross-linked but held together by Van der Waals forces, and therefore can be reversibly re-melted by heating, and re-solidified by cooling, without altering much their mechanical properties.

Table 26. Plastic types

Thermoplastics	Thermosets
Polyethylene Terephthalate (PET)	Polyurethane (PUR)
Polypropylene (PP)	Epoxy resins
Polystyrene (PS)	Acrylic resins
Polyvynyl-chloride (PVC)	Silicone

[31] http://susproc.jrc.ec.europa.eu/Paper_products/documents.html

Plastics are used in various components of converted paper products including PP covers of notebooks, PP and PS envelope windows, plastic coating of spiral metal of notebooks and parts of the lever arch files or ring binder mechanisms. Given the predominantly fossil origin of these plastics, an increase in the use of recycled plastics in these products would lead to the conservation of the limited fossil resources and exploit the environmental impacts reduction potential of recycled plastics. To better understand issues related to the use of recycled plastics, an overview of the recycling process is presented in the following subsection.

5.1.1.1 Recycling of plastics

The Commission is launching an EU-wide pledging campaign to ensure that by 2025, ten million tonnes of recycled plastics are used in new products on the EU market (EU, 2018a).

Plastic recycling is the term used for reprocessing post-consumer and pre-consumer plastic waste (manufacturing scrap) into useable products. The plastic products are broken down into their component materials which are then used to manufacture new products. According to ISO 15270, material recovery of plastics waste encompasses three distinct recycling routes: mechanical recycling, feedstock or chemical recycling, and biological or organic recycling (ISO, 2008).

Table 27. Terminology used in different types of plastics recycling and recovery.

ISO 15270	Other equivalent terms
Mechanical recycling	Primary recycling, closed-loop recycling
Mechanical recycling	Secondary recycling, downgrading
Chemical recycling	Tertiary recycling, feedstock recycling

Biodegradation is also a viable option for the treatment of certain types of plastics (organic or biological recycling). The plastic can be digested in commercial composting facilities producing CO2, water and compost with no differences in terms of quality parameters compared with conventional compost comprising solely green waste and had the same positive effects on soil and plant characteristics (Klauss & Bidlingmaier 2004).

In general, the recycling rate - the amount of any type of plastic that is recycled in a period of time - is directly related to the price of virgin resins for that type of plastic, which is related to the price of oil (Rudolph, Kiesel, & Aumnate, 2017). Low oil prices result in low costs for the virgin resins, hence preference over too expensive recycled resins. Therefore, the goal of any sustainable growth in recycling should be the maximization of efficiency of energy utilization in every step of the process, from the initial production of plastic goods to the disposal or recovery of plastic wastes.

Some technical aspects linked to mechanical and chemical plastics recycling influence their use in new products. The additives used may give a specific property to the plastic or else serve as a processing aid. A nonexclusive list of additives that are commonly used in plastics would include: antiblocking agents, antifogging agents, antioxidants, antistatic agents, blowing agents, colorants, coupling agents, crosslinking agents, curing agents, fillers, flame retardants, heat stabilizers, hydrolytic stabilizers, impact modifiers, lubricants, pigments, plasticizers, release agents, thermal stabilizers, UV stabilizers, viscosity depressants, and so on. During the use phase and reprocessing of the plastic material, these additives may degrade and would need to be reintroduced or revived in order to meet the demands of the application. On the other hand, the additives may also affect their recyclability either directly or by promoting their degradation; whereas a range of hazardous substances (e.g. toxic metals, volatile organic compounds (VOCs),

phthalates, polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers (PBDEs), polybrominated dibenzo-p-dioxins and furans (PBDD/F)) may either be released during reprocessing contributing significantly to environmental pollution, or partially retained in the recycled plastic affecting its end-use (Hahladakis et al., 2018).

Many coatings or adhesives are thermoset materials. Thermosets do not blend well with thermoplastics resulting in preventing the recycled plastic from being used to manufacture parts requiring a high visual quality.

Plastics recyclers must comply with the REACH obligations of Manufacturers (for Substances and Mixtures) or Article Manufacturers if they make themselves an article directly out of the waste. This is particularly relevant when considering the use of additives, coatings and adhesives in plastics and in the recycling process, which can be released or stay in plastics, hence come in contact with consumers.

All in all, it can be observed that promoting innovation and investment in the plastic recycling industry, is a multifaceted task that requires a multidimensional evaluation. Moreover, any conclusions should only be made when sorting and recycling (downstream) is assessed including use of recycled plastics, in combination with aspects faced at the design, use, and collection stages (upstream) of the supply chain.

5.1.1.2 Bioplastics

Bioplastics can be made entirely or partially from a renewable, plant-based material. According to European Bioplastics, a plastic material is defined as a bioplastic if it is either bio-based, biodegradable, or features both properties. There are three groups of bioplastics, each with their own characteristics:

- Biobased (or partly biobased), non-biodegradable plastics, such as biobased polyethylene (PE), polyethylene terephthalate (PET) (so-called drop-in solutions), biobased technical performance polymers, such as numerous polyamides (PA), or (partly) biobased polyurethanes (PUR);
- Biobased and biodegradable plastics, such as polylactic acid (PLA), polyhydroxyalkanoates (PHA), polybutylene succinate (PBS), and starch blends;
- Plastics that are based on fossil resources and biodegradable, such as polybutylene adipate terephthalate (PBAT), but that may well be produced at least partly biobased in the future

Typically, biodegradable plastics can be made from renewable raw materials such as polysaccharides (e.g. starch, cellulose, lignin and chitin), proteins (e.g. gelatine, casein, wheat gluten, silk and wool) and lipids (e.g. plant oils and animal fats). Natural rubber as well as certain polyesters either produced by micro-organism/plant (e.g. polyhydroxyalkanoates and poly-3-hydroxybutyrate) or synthesized from bio-derived monomers (e.g. polylactic acid (PLA)) fall into this category.

Interest in the use of biodegradable plastic in converted paper products arises primarily from their use of renewable raw materials (crops instead of crude oil) and their end-of-life waste management by composting or anaerobic digestion to reduce landfilling (Murphy & Bartle 2004). In view of resource conservation, plastics from renewable sources should be promoted in converted paper products such as in envelope windows.

5.1.2 Adhesives and glues

An adhesive is a compound that adheres or bonds two or more substrates together. Adhesives can be of natural or synthetic origin. In terms of value, the major end-use markets for adhesives and sealants in Europe are: building and construction, paper and board, industrial assembly and transportation (European Adhesive and Sealant Industry (FEICA), 2014).

Bonding may occur either by mechanical means, in which the adhesive works its way into small pores of the substrate, or by chemical bonding between adhesive and substrate or through intermolecular forces (like van der Waals). The moisture-aided diffusion of the glue into the substrate, followed by hardening requires good wetting of the surface.

Adhesives are used in various steps of converted paper products manufacturing. Glues are applied to the sides of envelopes and also to the flap to enable sealing. They are used during lamination to bind the multilayers of board paper, and also most notebooks are glue bound.

In most cases, and in particular for converted paper products, adhesives are used in thin films or beads to bond or seal materials. Their use might cause problems to the recycling of the products and remanufacturing systems. This aspect is further addressed under the subsection dedicated to the product recyclability.

Glues used for notebooks and envelopes are usually of natural origin. Most of them are starch-based, water based and hot-melt adhesive formulations used for paper, boards and labels. There is an ongoing research on replacing conventional fossil-based products with bio-based resources in adhesive production (Gadhave, Mahanwar, & Gadekar, 2017). For example, Polyurethanes are synthesized from vegetable oils obtained from various plant seeds such as castor, jatropha, palm, soybean. Adhesive applications have been produced from biopolymers of renewable resources like wood. The biopolymers are crosslinked with cyclic carbonates to obtain thermosets. Depending on the degree of cross-linking and the tensile shear strength, the obtained materials are suitable for adhesive applications such as wood-based panels, packaging and insulation materials.

5.1.3 Use of metals

Metals are used in converted paper products for binding and fastening purposes. Metal spirals (usually iron) are used to bind exercise books and calendars while steel is used in the ring binder or lever arch mechanisms. The metal parts are usually coated with polymers or undergo surface treatments (with nickel or zinc) to enhance their resistance to wear.

Metals like iron are produced from extracted ores in mining operations. Steelmaking is usually based on the combination of sintered ore and coke fed in a blast furnace, where the iron oxides in the ore are reduced to metal. The hot metal tapped from the blast furnace is almost saturated with carbon from the coke. Subsequent reactions with oxygen reduce the carbon content to about 0.05 % C left in the steel.

Global demand for steel production quadrupled between 1960 and 2010 and has now reached 1500 million t/yr, equivalent to about 200 kg/yr for every person alive on the planet. EUROFER recorded an EU steel demand growth of 1.3% in 2017 to 159 million tonnes, in line with a rising EU economy and the trend of recent years (European Steel Association (EUROFER), 2018). As saturation of steel stocks in use occurs, the fraction of steel production based on scrap can and will increase. In 2050, the share of steel produced from scrap has been estimated at about 80% (Pauliuk, Wang, & Müller, 2012). Manufacturing steel goods from scrap rather than ore leads to around half the total GHG emissions per product, and the cost benefit of this energy saving provides sufficient commercial motivation for recycling without the need of legislative stimulus (Allwood, 2014). The separation of scrap steel from waste streams is also facilitated by the ferromagnetic properties of steel.

The recycling of steel from steel scraps faces some technical issues. Steel is produced in a large number of different alloy compositions containing different amount of alloying elements like Cr, Mn, Nb, B, V, etc. Also the share of zinc coated steel produced is

globally increasing. Therefore, the scrap used in steel making has a complex composition and in particular, the presence of copper leads to quality issues of recycled steel and hence limits its use in some applications. Secondary steel is widely used for producing reinforcing bars, and other bars and sections while the higher grade applications of steel are entirely made from virgin metal(Allwood, 2014).

Besides quality issues, steel production and metal recycling results in the presence of so called tramp elements which are those elements that are present in steel, intentionally or not intentionally added, for example Co, As, Mo, Cu, Ni, Cr. These are difficult to refine from the steel, and pose health problems.

According to the Regulation on the Classification, Labelling and Packaging (CLP) of substances and mixtures, nickel, which is also used in metal surface treatment, is classified as Carcinogenic (Category 2, suspected to have Carcinogenic potential for humans) by inhalation, as a skin sensitizer and as specific target organ system toxicant. The latter is more relevant for converted paper products as the former refers to metal in its powder form. Likewise, cobalt is only characterised as presenting a risk if inhaled in pure, powdered form but a proposal has been tabled to establish cobalt in all forms as Carcinogenic (C) category 1B H350 (all routes of exposure) with a Specific Concentration Limit (SCL) of 0.01%, Mutagenic (M) category 2 (H341), and Reprotoxic (R) category 1B (H360F).

5.2. Printing processes

Note: *for more detail information regarding printing technologies, please see the website of the project EU Ecolabel revision for printed paper products, available at: http://susproc.jrc.ec.europa.eu/Printed_paper_products/*

Printed paper is currently manufactured in Europe by conventional and digital printing technologies. The value chain for conventional printing is based on three steps: pre-press, press (or printing itself) and post-press (or finishing), while for digital printing pre-press is not needed.

- **Pre-press** is the common expression for a range if operations done before the actual printing (presswork). In general, pre-press, does not involve the use of organic solvents or other emissions to air. Emissions to water from the pre-press process can be silver compounds in the rinsing water, used developer, or fixer and chromium compounds from cleaning chemicals. However, the manufacturing of image carrier such as plates (for offset printing and flexography), engraved cylinders (for rotogravure printing) or stencils (for screen printing) also involves the use of chemicals that can be potentially hazardous for the environment. For instance, chemicals used for cleaning (surfactants), etching (acids), anodizing and printing (UV curing inks) images onto aluminium plates for off-set and flexography should be used for companies manufacturing these products. Copper, chromium and/or ceramic compounds are used in general for engraving cylinders for rotogravure printing, which can be done by printed paper companies or by their external providers for engraved cylinders. These compounds, particularly solved metals, are restricted by legislation of wastewaters and, therefore, generally controlled by specific wastewater treatment in industrial plants. Some detailed emissions of pre-press process will be discussed further for the different printing technologies relevant for printed paper products described in the next section.
- **Printing** is the process to transfer the image to paper with an ink. There are different types of printing in function of the type of printing paper (e.g. newsprint, magazine paper, book paper, office paper, graphic paper, high quality inkjet

paper)[Error! Bookmark not defined.], the run-print, quality and economics. The different printing technologies are indicated in Table xxx.

- **Post-printing** encompass tasks from finishing to folding. It consist oncoatings, foils treatments (cutting, folding, stamping, sewing, stapling) and finally binding. Post-printing processes that could present a significant impact on the environment are laminating, glueing and varnishing.

Developments in the printing industry have different pathways depending on the type of ink used. Inks range from high viscosity inks made up of low-volatility raw materials to low viscosity and high volatility ones. The former generally known as 'paste' or 'oil' inks while the latter are termed 'liquid inks'.

Letterpress and litho printing use high-viscosity inks, the flexo and gravure processes use low viscosity inks and screen printing inks generally are of intermediate viscosity (International Agency for Research on Cancer (IARC), 1996). Ink manufacturers tend to specialize in one of these three areas, with only the largest companies covering a broader field. The main printing processes are provided in Table 28 with their main characteristics.

Table 28. Printing processes (IARC, 1996)

Printing process	Description	Typical applications
Offset (lithography)	Printing plate with non-image hydrophilic areas image öleophilic areas (readily wetted by oil-based inks). ink film is transferred from the printing plate onto a rubber blanket and then offset onto the substrate. Water and solvent based inks. Sheet-fed, web fed(heat set and cold set)	All general print
Rotogravure	Recessed cells engraved in a metal image cylinder which runs directly in the ink duct. Both the cells and the surface of the cylinder are flooded with ink. Surplus ink removed from the non-image surface of the cylinder. Same ink types as flexo with hydrocarbon solvent options. Large and small web, sheet-fed	Magazines, packaging, notebooks
Screen	No transfer of ink from an image surface to the substrate. Ink passes through the image, which is the stencil on the screen. Evaporation, oxidation, chemical curing and UV curing for drying. Water based and UV inks of increasing use.	Labels, point of sale displays
Letterpress (flat bed press)	Image area is inked before being brought into direct or indirect contact with the substrate to be printed. Inks used very similar to those used for lithography. Offset available through rubber blanket.	Self-adhesive materials, labels
Flexography (rotary press)	Type of letterpress printing technique. Image area raised above non-image area. An inking roller is positioned in an ink duct and runs in contact with an engraved metering roller known as the 'anilox'. This controls the amount (film weight) of ink that is transferred to the surface of the printing plate. Solvent and water based inks. Narrow and wide web	Flexible packaging, envelopes, sacks

5.2.1. Printing inks

Note: *for more information regarding inks used in for different printing technologies, please see the website of the project EU Ecolabel revision for printed paper products, available at: http://susproc.jrc.ec.europa.eu/Printed_paper_products/*

Printing inks are mixtures of three basic types of ingredients: pigments, vehicles and additives (Pekarovicova & Husovska, 2016).

Pigments determine the colour of the ink, and also affect physical properties, such as flow characteristics (rheology). Pigments used in printing inks include both inorganic and organic pigments. Inorganic colour pigments are generally complex mixtures of inorganic salts or minerals, manufactured to meet colour, and other specifications for the particular application. Generally, inorganic pigments are cheaper; many times they do not provide as saturated colour as organic pigments, and they may be more abrasive than their organic counterparts. The most widely used inorganic pigments are titanium dioxide, iron oxides, iron blue, zinc yellow, or carbon black. Organic pigments are used more by printing industry than any other sector. About 50% of synthetic organic pigments are used as printing inks, 25% in architecture paints and 25% for textiles and other sectors. These pigments are synthetized from petroleum, natural gas, or many other carbon-containing raw materials such as azo, anthraquinone and triarylmethane dyes, phthalocyanines and vat dyes. Organic pigments are characterized by their high colouring strength, pure shades and transparency. However, as with the inorganic pigments, they are rarely used as pure chemicals and are classified by colour rather than by chemical composition.

Vehicles serve as carriers for the pigment during the printing process and bind the pigment to the substrate. The drying of printing inks is accomplished in most cases by absorption, evaporation, precipitation, oxidation, quick-setting, radiation curing or a combination of these. In flexography alcohols, acetate or water are used while Gravure ink vehicles include toluene (publication gravure), ethyl acetate and alcohols.

Additives may include any of a large number of ingredients needed to incorporate desired technical properties to the ink. Their content usually do not exceed 5%. Additives are mostly waxes, found in a range of inks from offset lithography to inkjet. Others are very specific to the ink and the process, such as wetting agents, surfactants, defoamers, metal dryers, or plasticisers.

The European Printing Inks Association Exclusion Policy identifies raw materials that have to be excluded from printing inks based on hazard classification and/or toxicological evidence, to protect the health of workers within the printing ink industry and customer facilities as well as to ensure the safe use of printed matter (EUPIA, 2016). These raw materials are components of pigments, colorants, dyes and solvents. The list is in line with chemicals and substances covered by the REACH management of risks from chemicals regulation.

The presence of VOCs in inks is one of the reasons for excluding some inks and printing related chemicals or mixtures. VOCs are a group of organic, readily vapourable fluids, including hydrocarbons, alcohols, ethers, esters, etc. that may be used as solvents and diluents in certain printing inks. VOCs are also present in varnishes and adhesives, as well as in washing agents. Solvent-based printing inks usually contain mineral oils. Mineral oils are liquids produced by refining of crude oil and characterised by their content of paraffinic, naphthenic and/or aromatic structures. Mineral oils are considered to be made up of more than 50% VOCs and in the case of heatset inks, the Nordic Swan criteria requires that the printing company must assume that 85% of the mineral oil content of the printing ink is converted into VOC in the heatset kiln (Ecolabelling, 2011).

VOCs in the atmosphere contribute to the formation of tropospheric ozone that is an important greenhouse gas. Secondary organic aerosols (SOA), a major component of fine particulate matter (PM2.5) in cities around the world, form through oxidation of volatile organic compound (VOC) precursors. Oxidation of VOCs in the presence of nitrogen oxides also contributes to tropospheric ozone (O_3), which increases risks of

mortality from respiratory diseases. A recent epidemiological study suggests that adverse human health effects occur below current U.S. standards for PM2.5 and O_3 (McDonald et al., 2018). Sensitive people may suffer irritation of the throat and eyes, as well as respiratory difficulties. Inhalation of solvent vapour can cause respiratory tract irritation, effects on the nervous system and very high exposures may cause unconsciousness and even death (European Solvent Industry Group (ESIG), 2015).

Hence, preference is given to printing inks, varnishes, toners and inks which are vegetable or water-based. Vegetable printing inks and varnishes contain maximum 2.0% by weight of solvents which are mineral oil based.

Mineral oils classified as carcinogenic are not used by EuPIA members in accordance with the EuPIA Exclusion Policy (EUPIA, 2016). Moreover, EuPIA identifies sheet fed offset low migration inks and standard inks with 0.1% mineral oil content as ink options based on vegetable oils, vegetable oil esters or, in case of UV curable sheet fed inks, are based on synthetic reactive diluents and resins (EUPIA, 2015). The EUPIA guidance also identifies Flexographic inks for paper and board as inks which are usually water soluble and UV curable, so free of mineral oils.

5.3. Finishing

Finishing processes for converted paper products usually includes operations such as gluing, varnishing and lamination. These processes usually require the use of some chemical substances whose nature and formulation can pose problems to health for workers and consumers.

Lamination is the process where a plastic film is applied to the printed surface by wet or dry adhesives on one side of the sheet. This is achieved by extrusion or hot melt lamination. Extrusion coating consists of heating together a mixture of two different polymer granules or pellets. The combined polymers are extruded (pushed through a die of a specific cross-section) as a single product which is a multilayer web of plastic film. Cast extrusion and blown extrusion, are the two extrusion methods usually considered. Laminating, traditionally was done with solvent-based systems, where the adhesive-coated film was passed through an oven to drive off the solvent before being pressed onto the printed surface. Nowadays, two-component adhesives are used, often of the epoxy type containing solvents such as ethanol and ethyl acetate, or of the urethane type. The emissions from this process are significant. In some places, the vapours are incinerated or recovered for reuse. Water-based and solvent-free adhesives or UV curing laminating adhesives are also applied**Error! Bookmark not defined.**.

VOC control options include 1) use of coatings that are not solvent-based or that required reduce quantity of solvent and 2) "end-of-pipe" approaches in which evaporated solvent is incinerated to carbon dioxide and water vapour (Dunn, 2015). Reformulating options include increasing the volume percent of solids in the adhesive as applied on a laminator, high solids adhesives and using a non-VOC solvent (e.g., water). However, incinerating evaporated VOCs adds capital investment and operating costs to a laminating process.

Water-based adhesives present operational challenges in converting equipment related to the energy input. The heat of vaporization of water exceeds that of most solvents traditionally used. This implies that water requires more energy input before evaporating.

Both lamination film and adhesives are from synthetic origin and the waste treatment of excess thermoplastic glue is usually incineration.

Varnishing (also the terms coating and overprinting varnish can be used) is a colourless, transparent printing ink formulation without pigments. It is spread over the printed surface for protection or decoration. Overprint varnishes dry by evaporation, oxidation or by UV curing, and can be applied in line on the press or on a separate machine**Error! Bookmark not defined.**, **Error! Bookmark not defined.**.

Varnishes and adhesives can be water-based, high-solids, UV-curable or solvent free (i.e. two-component formulations)**Error! Bookmark not defined.**. All chemicals and materials applied in the pre-press (e.g. cleaning agents, UV curing inks), press (e.g. printing inks, toners, washing agents, dampening solution, algaecides and other additives), and post-press (e.g. laminates, varnishes, adhesives) that are relevant for printed paper products will be further described in the next section.

5.4 Recyclability

Converted paper products, as defined under the current scope and definition, contain at least 70% paper alongside metals and plastics. The recyclability of these materials offer attractive opportunities in closing the life cycle loop of the products thus, contributing to the circularity of the EU economy.

The European paper recycling rate reached 70.4% as announced by the European Recovered Paper Council (ERPC) in their annual monitoring report. The report shows that the total amount of paper collected and recycled in the paper sector remains stable at 58 million tonnes. In addition to the quantitative progress, much qualitative work has been done to establish an eco-design towards improved recyclability and in the area of waste prevention. The results include pioneering work to give recycling solid and scientific support, such as the adoption of scorecards to assess the recyclability of paper-based products.

The new challenge is to 'make recycled fibre interchangeable with virgin fibre with respect to product quality and economics'. Now, more than ever, recycled fibre directly competes with virgin fibre on all metrics: availability, strength potential, quality (uniformity and minimal contamination), performance and cost. The two areas where targeted technology can be expected to facilitate the competitiveness of recycled fibre are improved quality and quantity of recovered paper delivered to paper mills, and improved mill processes including the development of next-generation fibre evaluation and decontamination technologies. The quality of paper made from secondary fibres is approaching that of virgin paper. Its manufacture is much more eco-friendly than the one with virgin paper (90% average reduction for all impacts except ADP). Some paper and board grades produced can use recycled fibres exclusively such as corrugating medium and test liner, or newsprint while other grades use blends of recycled and virgin fibres.

One of the largest problems of paper recycling is the need to remove ink and/or toner from a printed product by means of a deinking process. Additional chemicals must be used as to aid deinking process. It generates large quantity of wastewater. Current flotation technologies target the removal of hydrophobic printing inks like conventional offset and gravure printing inks. Digital and UV printing inks are hardy deinkable (International Association of the Deinking Industry (INGEDE), 2015) (WORRELL & REUTER, 2014) .

Another barrier to the recycling of converted paper is the presence of sticky components/adhesives and other thermoplastic residues. Pressure-sensitive adhesives or self-adhesives are used on labels and sticky notes, as well as peel-and-stick stamps. A variety of adhesives are also used in laminating paper-to-paper or paper-to-plastic film as is the case in book covers or notebooks. Lamination process involves the use of adhesives alongside plastic films. Some processes require solvent or water-based additives while others used solvent-free additives. These adhesives do not dissolve in

water during the paper recycling process but rather fragment into smaller particles, which deform under heat and pressure and can become lodged on papermaking equipment, creating weak spots in the final paper product or causing pieces of finished paper to stick together. Paper mills are facing difficulties with insufficient re-pulping due to the presence of wet-strength agents and laminations in paper.

A good recyclability would therefore require the low adhesives content and use of "removable" inks and varnishes. These are the objectives of the ERPC expressed in the guidance document on optimum recyclability and assessment scorecards for deinkability and removability of adhesive applications (ERPC, 2017a, 2017b).

In the case of envelopes, recyclability can be also enhanced if envelope window is made up of biodegradable plastics. Among possible biodegradable plastics, PVOH stands out for its application in water soluble films such as plastic envelope windows. It has been proven to be non-toxic to marine life and if recovery for recycling is not required, the material is fully dissolvable in water treatment processes and can be washed away safely with wastewater. This implies that it can be easily washed away if envelope is treated in paper recycling process without having to deal with plastic residues in the wastewater. However, the biodegradability of plastics has to be demonstrated through standardized tests ensuring complete biodegradation under composting conditions or in the open environment or in marine environment in a reasonable time (EU, 2018b).

ANNEX I

Overview of the scopes of other Ecolabels that refers to converted paper products

Ecolabel type	Includes	Excludes
Nordic Swam		
Nordic Swam	Wood –based and wood free unconverted copying and printing paper that is made from chemical pulp and/or recycled fibre for writing, printing and copying. The following boards made from chemical and/or mechanical pulp and/or recycled fibre can also be Nordic Ecolabelled. Cardboard: solid bleach board (SBB), solid bleached sulphate (SBS) and solid unbleached board (DUB) Folding boxboard (FBB) White lined chipboard	Only paper with a distinct trade name can be ecolabelled. Paper with a trade name that may appear on both ecolabelled and non-ecolabelled paper is not eligible for Nordic Ecolabelling.
Printing companies, printed matter, envelopes and other converted paper products	The product group encompasses printing companies, printed matter, envelopes and other converted paper products, such as post-it notes and note pads. In addition to offering Nordic ecolabelled printed matter, printing companies may also use the Nordic ecolabel in marketing themselves. A minimum of 90% of the total weight of The Nordic Swan Ecolabelled printed matter must consist of inspected or Nordic Swan Ecolabelled paper. In the case of books, folders, ring binders, notepads and forms, the threshold is 80%. The requirements apply mainly to the printing process, including paper consumption, and the paper and	The printing material accounted for Y% of the printing company's turnover may not consist of/contain PVC or halogenated flame retardants. For 25% of the printing company's turnover, there is no requirement set for the printing material.

	chemicals used by the printing company. The Nordic Swan Ecolabel for printed matter may apply for a licence for specific types of printed matter. This may be a newspaper, book, magazine, catalogue, envelope series or pads and booklets with a specific trademark. Wrapping paper, posters, notepads are also eligible.	
Blue Angel		
RAL-UZ14 a ***Recycled paper* (as of 01/01/1019)**	Recycled papers and finished products made from recovered paper according to the Association of German Paper Mills' grading system. The scope includes: carrier bag continuous paper copy paper multipurpose paper paper for processing: drawing paper, nature paper paper for processing: envelope paper and jiffy bag paper paper for processing: kraft- and natron paper paper for processing: lining paper paper for processing: writing paper, nature paper printing paper/publication paper (DE-UZ 14a) waste bag	The paper fibres of the products must be made 100% from recovered post-consumer paper.
DE-UZ 14b ***Finished products made***	The scope of the product group includes following product type. The basic award criteria apply to finished products from recycled paper (that must be certified according to DE-UZ 14a and recycled cardboard	A tolerance limit of 5% of other materials such as plastic, metal, etc. is permitted, based on the total mass of the product.

from recovered paper for office and school demand	(certified according to DE-UZ 56) that are primarily intended for office and school supplies: Coloured drawing papers, contruction papers Colouring books (Desk pads Drawing and painting pads envelopes, unprinted Exercise books Flip chart pads Form books Index cards Labels mailing bags, unprinted Memo pads Notebooks Notepads and college blocks Office calendars Paper indices Presentation cards Ring binder filler paper self-stick notes Textbooks and puzzle books Wrapping paper Show all	
(RAL-UZ 72)	Writing papers for office and home use, computer paper, laser printers, inkjet printers, digital printing and offset printing, publication paper, newsprint magazines or catalogues. Special conditions are made for aging	

Graphic paper	resistance paper. The scope includes: graphic paper and expiring on 31 Dec 2015: finished products made from recovered paper, e.g. for the product lines of exercise books, writing pads, drawing book, calendars, envelopes, mailing bags, manuals, invoice papers, posters, photo envelopes, masking papers (e.g. for painting and varnishing work) as well as print and press products (e.g. telephone books).	
DE-UZ 56 ***Environmentally Recycled Cardboard***	Products made of recycled cardboard, e.g. folders, binders and filing material. . Recycled cardboard with an area-related mass of about 150 g/m2 or more. application folders cardboard finished products, other cardboard for crafts cardboard for processing: gray cardboard for books and calendar backs cardboard for processing: manila-cardboard cardboard for processing: other circulation files and file covers clipboard file flat files index cards magazin files registry, eyelet indexes registry, hanging maps registry, hook-in indexes	Cardboard for one-time packaging (packaging material). A tolerance of 5% shall be allowed for finished products, i.e. binders

	registry, pendulum indexes separator sheets und separator strips signature folder sorters lockable	
Austrian Ecolabel **Version 6.0 (2013)**	Printed paper produced by offset printing, ink jet printing or electrophotographic digital printing. Packaging is excluded from the eco-label award. Publishers, publishers and other print contractors, as well as printers and bookbinders, can use the Ecolabel for their products. Products may include (but are not limited to): Books Periodical publications (e.g. magazines, magazines) Brochures Address books mercantile types of printing (e.g., forms, bills) phone books Newspapers Advertising prints Calendar Envelopes Blocks (spiral blade holder, glued, wire-stitched) Sticky notes (loose, glued, sticky notes)	
Green Seal	Blanks including papers for printed signs, point of purchase displays, windows displays, poster and	Uncoated ground wood papers including newsprint.

	calendar backs. Bond paper including letterhead, stationery, invoices, self-adhesive note paper, statement papers and duplicating papers for gelatine type of ground wood of hectographic reproduction. Bristols including file folders, index cards, ruled forms, mailing cards, tag papers, wedding invitations, and postal Bristol. Business forms including papers sold to be used in business forms and computer printout paper. Copy paper including paper made for use in the high speed electrostatic reproduction process. Cover paper including heavy papers sold for use as covers for books, catalogues, brochures, pamphlets and similar purposes. Drawing paper including paper for architects, artists, and draftsmen for pen or pencil drawings and paper used primarily by school children for sketching, crayon, or watercolour work. Labels including labels for file folders, mailing, shipping, and similar purposes. Ledger paper including paper used in bound and loose-leaf ledger books, accounting record systems, and legal paper. Lightweight printing paper including high quality, high opacity lightweight papers used in bibles, dictionaries, manuals, and professional reference books to reduce bulk. Manifold and onionskin paper including paper used for airmail stationery, catalogs, manuals, envelope enclosures, advertisements and carbon copies of correspondence and legal documents. Tablet paper including loose leaf paper, notebooks, note pads, adding machine rolls, and cash register rolls.	Packaging materials Tissue products Specialty papers such as carbon paper and carbonless paper. Coated ground wood paper and coated ground wood free printing paper.

	Text paper including paper used in annual reports, booklets, menus, announcements, advertising and corporate advertising circulars. Uncoated ground wood free papers including uncoated paper used for personalized computer generated letters and promotional mailings in the business forms industry, book manufacturing, magazine blow cards, and duplicating paper for spirit machines. Gift wrapping paper including plain and decorated wrapping papers, not including packaging or packaging materials. Other recycled printing and writing paper including all other paper sold primarily for use in printing and writing.	

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List of abbreviations and definitions

CEPI	Confederation of European Paper Industries
CoC	Chain of Custody
EPD	Environmental Product Declaration
EU-ETS	The European Union Emission Trading System
FAO	Food and Agriculture Organization of the United Nations
FEPE	Federation of Envelope Producers in Europe
FSC	Forest Stewrship Council
ISO	International Standards Organization
LCA	Life Cycle assessment
PCR	Product Category Rule
PEF	Product Environmental Footprint
PEFC	Programme for the Endorsement of Forest Certification
PEFRC	EU Product Environmental Footprint Category Rule
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SFM	Sustainable forest management
SOFEA	Sustainable Office European Association

List of figures

List of tables

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