Methodology for the free allocation of emission allowances in the EU ETS post 2012

Sector report for the pulp and paper industry

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Disclaimer and acknowledgements

Disclaimer

The views expressed in this study represent only the views of the authors and not those of the European Commission. The focus of this study is on preparing a first blueprint of an allocation methodology for free allocation of emission allowances under the EU Emission Trading Scheme for the period 2013 – 2020 for installations in the pulp and paper industry. The report should be read in conjunction with the report on the project approach and general issues. This sector report has been written by Ecofys.

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Table of content

1 Introduction

The pulp and paper industry produces different types of pulp, both from virgin (wood) and recycled material that is subsequently processed into paper. Virgin pulp production can be integrated with paper production on the same site, however stand alone market virgin pulp mills also exist and stand alone paper mills exist that buy a mix of different market pulps to produce specific paper products. In Europe about 18% of all mills in the pulp and paper industry are integrated mills producing both virgin pulp and paper although different degrees of integration occur (CEPI, 2009c). Except for one deinked market pulp mill, pulp production from recycled fibres is always integrated with paper production, although deinked recycled pulp is also sold to the market by a number of these mills. The production of pulp and paper requires the use of power and steam. The electricity/steam consumption ratio at paper mills enables efficient use of co-generation of heat and power (CHP) and CHP is therefore widely applied in the paper industry.

In order to acquire information and data on the pulp and paper industry, Ecofys has been in contact with the Confederation of European Paper Industries (CEPI). The members of this association together account for about 95% of the total number of paper mills in EU, and an even higher share of EU pulp and paper production (CEPI, 2009a).

Table 1 provides an overview of the classification of the pulp and paper industry in relevant activity classifications.

Table 1 Classification of the pulp and paper industry in the categories of activities of the Annex I to Directive and in the NACE Rev. 1.1 classification of economic activities

Category of activities according to Annex I to the original Directive	**NACE Rev. 1.1 code**	**Description (NACE Rev. 1.1)**
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		
Categories of activities according to Annex I to the amended Directive		
Production of pulp from timber or other fibrous materials[1]	21.11	Manufacture of pulp
Production of paper and card board with a production capacity exceeding 20 tonnes per day	21.12	Manufacture of paper and paperboard

As can be seen in the table above, the pulp and paper industry is associated with one category of activities in the Annex I to the original Greenhouse Gas Emission Allowance Trading Directive[1]. This situation has changed in the Annex I to the amended Directive[2] in which the

[1] Directive 2003/87/EC
[2] Directive 2009/29/EC amending Directive 2003/87/EC

industry is associated with two categories of activities. In the NACE Rev. 1.1 classification of economic activities the sector is associated with two four-digit codes.

In May 2009, the Community Independent Transaction Log (CITL) listed 844 open accounts (825 in EU27 and 19 in Norway) specified in the original Annex I category of activities "Industrial plants for the production of (a) pulp from timber or other fibrous materials (b) paper and board" (CITL, 2009a).

In the first and second round of national allocation plans, permits have been given by the member states to sites, mills, or parts of sites. In most cases, the paper mill is synonymous with the site. However, a site may also incorporate more activities, e.g. there can be more paper mills, with more than one paper machine, but also a chemical plant, woodworking industry, converting activities, waste treatment/incineration, etc. This report does not consider these additional activities on the pulp and paper mill sites. Energy conversion units can be located either on or off site. CHP installations (and also steam generating installations) can be operated by the paper mill under the same ownership and GHG permit. However, the heat generating installations can also be owned by a utility company or via a joint venture between the paper mill and utility company. Combinations with self owned boilers and off site activities also occur (Ecofys and Fraunhofer Institute, 2009).

Because of the ownership structure of installations and the different interpretation of Member States of the Directive, about 82 installations that are part of the pulp and paper industry are classified in the Annex I category of activities 'combustion of fuels in installations with a total rated thermal input exceeding 20 MW (except in installations for the incineration of hazardous or municipal waste)', which from hereon will be denoted as 'combustion of fuels' (CEPI, 2009c).

Table 2 (next page) gives an overview of the distribution of 'paper, pulp and board' installations and 'combustion of fuel' installations over EU27. The figure before the dash denotes the number of installations that are registered in CITL as 'paper, pulp and board' installations and the number after the dash denotes the number of installations that are registered in CITL as 'combustion of fuel' installations. The number of installation includes accounts that were closed in 2008.

Table 2 Number of installations of the pulp and paper industry in the EU ETS (CEPI, 2009c)

Country	No. of installations[1]	Country	No. of installations[1]
Austria	26/4	Latvia	1/0
Belgium	13/0	Lithuania	3/0
Bulgaria	4/0	Luxembourg	1/0
Cyprus	0/0	Netherlands	25/0
Czech Republic	10/8	Malta	0/0
Denmark	3/2	Poland	20/14
Estonia	2/0	Portugal	29/9
Finland	48/8	Romania	11/0
France	119/0	Slovakia	2/8
Germany	130/40	Slovenia	9/0
Greece	15/0	Spain	112/4
Hungary	6/0	Sweden	57/3
Ireland	1/0	United Kingdom	63/15
Italy	170/0		

[1] a/b: a denotes the number of installations that are registered in CITL as 'paper, pulp and board' installations and b denotes the number of installations that are registered in CITL as 'combustion of fuel' installations. The number of installation includes accounts that were closed in 2008.

Table 3 lists the allocated allowances and estimated EU emissions of greenhouse gasses (GHGs) of the pulp and paper industry from 2005 onwards for the pulp and paper industry as defined in CITL (2009a,b) and according to CEPI (2009c). The CEPI overview is based on the full list of installations identified in CITL which has been made available to Ecofys. In the list all data points from CITL are included. A reason for differences between the CEPI and CITL data is the identification of combustion installations belonging to the sector and the fact that the UK installations under the climate change levy agreement were not included in the EU ETS in the first trading period, while being an important and significant paper sector and emitter. About 25 % of the emissions listed in the right column can be attributed to the production of electricity (CEPI, 2009d).

Table 3 Allocated allowances and estimated EU emissions of greenhouse gasses (GHGs) from 2005 onwards for the pulp and paper industry according to the original Annex I category of activities 'paper, pulp and board' (CITL, 2009a,b) and according to CEPI (2009c); allowances and emissions were taken from CITL (2009a,b)

	'paper, pulp and board' (CITL, 2009a,b)		'paper, pulp and board' and 'combustion of fuels' (CEPI, 2009c)	
Year	Allocated allowances (Mt CO_2 eq.)	Verified emissions (Mt CO_2 eq.)	Allocated allowances (Mt CO_2 eq.)	Verified emissions (Mt CO_2 eq.)
2005	37.0	30.2	51.7	41.8
2006	37.3	30.3	52.4	41.6
2007	37.8	29.4	53.3	40.5
2008	37.8	30.9	46.6	37.8

Almost 55 % of all EU ETS permits in CITL, representing 12% of the sector emissions, show emissions of less than 25 kt CO_2 per year. This gives an interpretation of the number of small mills, but does not necessarily show the entire picture. When assessing the small mills one should consider that these emissions can be low because conversion installations have been outsourced, because of the use of biomass in the mill, still producing large quantities of paper, because several permits have been given for one site and the emissions are split over several permits, because installations were in the process to be closed. Small installations are present in all countries and grades, but do more often occur in the specialty papers.

2 Production process and GHG emissions

The production of pulp and paper can be divided into three main operations:

- Virgin pulp making
- Recovered paper processing
- Paper production

As mentioned earlier these processes may be integrated in one installation. The main activities are supported by a number of associated activities such as power and steam generation, wood handling, water treatment, waste handling and storage handling of chemicals and converting paper into paper articles.[3] This report does not consider these additional activities on the pulp and paper mill sites.

Virgin pulp making process

In the pulping process the raw cellulose-bearing material is broken down into its individual fibres. This can be done by roughly three types of processes (descriptions from the reference document on best available technologies (BREF P&P, 2001):

- Kraft (sulphate) pulping: in this process, fibres are liberated from the wood matrix by dissolving in a chemical solution at a high temperature (the cooking process).
- Sulphite pulping: in this process, aqueous sulphur dioxide (SO_2) is used in the cooking process.
- Mechanical pulping: in this process, the wood fibres are separated from each other by mechanical energy applied to the wood matrix. In chemi-mechanical pulping, the wood is pre-softened with chemicals.

Depending on the quality requirements with respect to brightness and brightness stability, bleaching may be applied. The various types of processes result in different grades of virgin pulp (see section 3.1 for a description of grades). Heat consumption for the various virgin pulp production processes are summarized in Table 4.

Table 4 Best practice specific heat consumption for the production of virgin pulp

	BREF P&P (2001) (GJ /adt[2])	**Price et al. (2007)[1] (GJ /adt)**
Bleached kraft pulp	10 – 14	10 - 12.2
Bleached sulphite pulp	16 – 18	16 - 18
Thermo-mechanical pulp		0

[1] Based on BREF P&P (2001), Karlsson et al. (2005), Francis et al. (2002).
[2] Air dried tonne

[3] The combination of converting and papermaking on site can lead to confusion in the dedicated NACE codes.

In the Kraft pulping process about 15.8 GJ/adt (air dried tonne) pulp can be recovered from the black liquor recovery process in which the lignin from the wood is combusted (Price et al., 2007). The amount of generated heat through the black liquor recovery process exceeds the heat demand of the process as indicated in Table 4 and consequently non-integrated Kraft pulp mills can be net heat exporters as is shown in the reference document on best available technologies (BREF P&P, 2001).

In the sulphite pulping process, energy can be recovered from the green liquor, similar to the black liquor process, producing about 15 GJ/adt pulp (Price et al., 2007).

The specific energy consumption in mechanical pulping is dependent on the particular pulping process, the properties of the raw material and, to a large extent, the quality demands on the pulp set by the end product. There are several types of processes that can be used for mechanical pulping, i.e. groundwood (GW), thermo-mechanical pulping (TMP) and chemo-thermo-mechanical pulping (CTMP). Generally TMP consumes more energy than groundwood pulping (BREF P&P, 2001). As only a fraction of the mechanical energy supplied to the process is actually used to separate the fibres in the wood, the process allows the recovery of heat from the process in the form of hot water and steam (see Table 5).

Table 5 Energy consumption and recovery of energy in mechanical pulping (BREF P&P, 2001)

	Energy consumption[1] (kWh/t)	**Recoverable energy in the form of**	
		hot water (%)	**steam(%)**
Groundwood pulp[2]	1100 - 2300	20 - 30	0 - 20
Thermo-mechanical pulp	1800 - 3600	20	40 - 45
Chemi-thermo-mechanical pulp	1000 - 4300	20	40 - 45

Figures are only average numbers, which may deviate ±10%, due to local mill circumstances and also due to measuring inaccuracies
[1] Energy consumption refers to oven dry (100%) pulp
[2] Different types of groundwood pulping processes were grouped together.

A case study in the reference document on best available technologies (BREF P&P, 2001) shows that the TMP process can be a net heat exporting process. Price et al. (2007) states that the TMP process has little heat demand and can export up to 5.5 GJ /AD t of pulp (Price et al., 2007)

In addition to the heat from the black/green liquor in chemical pulping and from the process heat recovery in mechanical pulping, process steam is produced in additional boilers, often using bark, sludges and in some countries peat as a fuel. The use of start up fuels and peat are sources of CO_2 emissions.

Lime kilns

In Kraft pulping, lime recovery is an integral part of the pulping process, resulting in emissions from the use of fossil fuel (see Table 6) in the lime kiln, but also in process emissions which contrary to outside lime production, from biomass origin as shown by Miner and Upton (2002). Lime usage depends on the pulp yield (wood species that is pulped) and

sulfidity (ratio of sulphur to sodium in white liquor). The lime kiln energy requirement is the product of the heat requirement, lime availability and lime requirement, where lime availability is the share of lime available as CaO in the lime kiln product from total lime. The lime kiln is typically fired with oil or natural gas but can also be fired with gasified biomass (Gilbreath et al. 1995). The energy use in the lime kiln is dependent on the fuel used, i.e. different energy values apply for the gas based process and the oil based process.

Table 6 Lime kiln fuel consumption as reported in various literature. CEPI indicated that all values refer to oil based processes

Reference	Energy use (GJ/adt)
Price et al. (2007)[1]	1.2
Theoretical (Brown et al. 2001)	0.77[6]
1982 Canadian survey (Brown et al. 2001))[2]	2.69[6]
Modern design (Brown et al., 2001)	1.55[6]
1988 average Swedish lime kilns (Gilbreath et al. 1995)[3]	1.8
1986 Austrian pulp mill (Gilbreath et al. 1995)[4]	2
Model 2000 mill (Gilbreath et al. 1995)[5]	1.3

[1] Value adopted from Francis et al. (2002) who reported to having it adopted from Nilsson et al. (1995) of which Gilbreath et al. 1995 is the background document
[2] Based on Simonsen and Azarniouch (1987)
[3] Value adopted from ÅF-IPK (1989)
[4] Value adopted from Schweizer et al. (1987)
[5] Value adopted from Warnquist (1989)
[6] Based on 240 kg active CaO/adt

Recovered paper processing

Using recovered paper will involve some cleaning of contaminants prior to use and may involve de-inking depending upon the quality of material recycled and the requirements of the end product (e.g. tissue, carton board and newsprint). For the processing of recycled fiber, fossil fuels are required. Based on 1994 performance of Swedish mills as reported by Francis et al. (2002) who adopted a value from Nygaart (1994), Price et al. (2007) report an average fuel heat demand was, about 0.3 GJ/adt.

Paper production process

Paper is produced with virgin pulps or processed recovered paper. In many cases a combination of different pulps is used to make the paper. Paper (and board) is made on paper and board machines. A machine can make different paper grades throughout the day, month or year, based on different raw material mixes, or be used to make a single paper grade. Most paper mills have more than one paper machine and make multiple paper grades.

The CO_2 emissions from paper mills mainly originate from energy generation (steam and electricity), but also from direct fuel use in Yankee-cylinders or dryers for coating. Energy use in the papermaking process is concentrated in the paper machine and is determined by the specific grade of paper to be produced and the fibre quality. For a description of paper grades the reader is referred to section 3.1. Table 7 provides an overview of the specific heat consumption for the production of paper products.

Table 7 Best practice specific heat consumption for the non-integrated production of paper

	BREF P&P (2001)[1] (GJ /adt)	Price et al. (2007)[2] (GJ /adt)
Uncoated fine paper[3]	6.5 - 9.0	6.7
Coated fine paper[3]	7.0 - 11.0	7.5
Tissue mill	5.5 - 7.5	6.9
Newsprint		5.1
Board		6.7
Containerboard[3]		5.9

[1] Based on Jaakko Pöyry (1998), SEPA report 4712, mill case studies and data from a supplier.
[2] Based on BREF P&P (2001), Karlsson et al. (2005), Francis et al. (2002).
[3] For Price et al. (2007) the value is representative of wood free paper
[4] Although Price et al. (2007) only reports a heat consumption value for the production of kraftliner on a paperboard machine, CEPI has indicated that the reported value is most likely a good starting point as well for a value for the heat consumption of testliner and fluting production, however not for the related CO2 emissions, which will mostly be based on fossil fuels for testliner and fluting and biomass based for integrated kraftliner production. (CEPI, 2009d).

Table 8 gives an overview of the fuel mix in the pulp and paper industry in the EU27. The type of fuel used is strongly related to the local availability of raw material, historic development and government policies. In particular, the availability of biomass significantly decreases the specific emissions of paper production.

The pulp and paper industry also applies technologies that make direct use of combustion process heat rather than using steam (direct heat applications); the Yankee cylinder used in tissue production and dryers in the coating processes.

Table 8 Average fuel mix per country in EU27 for the period 2005-2007 (CEPI, 2009c). n.a. in this table can both mean that no pulp or paper production is present, or that the data were not available.

Country	Coal	Gas	Fuel oil	Other fossil	Biomass	Waste
Austria	7%	45%	2%	0%	46%	0%
Belgium	7%	33%	11%	1%	48%	0%
Bulgaria	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Cyprus	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Czech Republic	16%	19%	5%	0%	59%	0%
Denmark	n.a	n.a.	n.a.	n.a.	n.a.	n.a.
Estonia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Finland	0%	14%	4%	6%	73%	2%
France	5%	40%	5%	0%	51%	0%
Germany	13%	62%	2%	n.a.	21%	2%
Greece	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Hungary	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ireland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Italy	0%	95%	5%	0%	0%	0%
Lithuania	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Luxembourg	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Continuation Table 8

Country	Coal	Gas	Fuel oil	Other fossil	Biomass	Waste
Latvia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Malta	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Netherlands	0%	97%	0%	0%	2%	0%
Poland	25%	3%	4%	0%	69%	0%
Portugal	0%	15%	10%	1%	74%	0%
Romania	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Slovakia	18%	23%	0%	0%	59%	0%
Slovania	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Spain	1%	62%	5%	0%	32%	0%
Sweden	0%	1%	9%	1%	89%	0%
U.K.	6%	88%	1%	0%	5%	0%
Total EU27	**4%**	**38%**	**5%**	**2%**	**51%**	**1%**

Integration of processes

Integration of pulp production and paper production has been realized because of location, processes, history and efficiency. The wording with respect to integration is not used uniformly throughout literature and discussions. In this report, an integrated mill is defined as a mill where virgin pulp making is integrated with paper making on the same site. The words non integrated mills is used for mills using recycled fibre and mills that buy pulp from the market. Market pulp mills only produce pulp for sale to the market. In Europe about 18% of all mills in the pulp and paper industry are integrated mills although different degrees of integration occur (CEPI, 2009c).

Energy use and emissions can be optimized by integration because of the following three reasons (Price et al., 2007):

- It avoids energy consumption for intermediate drying of the pulp which can be of the order of 3 GJ/tonne of pulp or some 25 % of the total heat requirement for a Kraft pulp mill (BREF P&P, 2001).
- While stand-alone pulp mills may have excess steam that cannot be used (due to black/green liquor recovery or from heat recovery), an integrated mill can use this excess heat to serve the additional heat use of the paper machine.
- Process integration of the different processes may result in a further optimization of the steam use on site.

In Chapter 3 and 4, we further discuss how we propose to deal with integrated versus non integrated mills.

3 Benchmark methodology

3.1 Background on products

Virgin pulp

PRODCOM 2007 lists four six-digit and thirteen eight-digit pulp products. CEPI distinguishes seven groups of pulp products (see Table 9). The link between these groups and CN and PRODCOM 2007 codes is given in Appendix A: Link between product classifications. The reference document on best available technologies (BREF P&P, 2001) broadly groups the pulps in three types (see Table 9).

Table 9 Overview of pulp product groupings

CEPI	BREF P&P (2001)
Sulphate (or kraft) pulp	Sulphate (or kraft) pulp
Sulphite pulp	Sulphite pulp
Thermo-mechanical (TMP)	Mechanical and chemi-mechanical pulp
Chemi-thermomechanical (CTMP)	
Other mechanical pulp	
Semi-chemical	
Other pulps	

Pulp is produced both by stand-alone market pulp mills and in integrated pulp and paper mills. Integrated mills may sell part of their pulp production on the market. In 2006, 32% of total pulp production was market pulp (based on CEPI data, 2006). About 65% of total pulp production and 92% of market pulp production is produced by kraft or sulphite pulping, the production of the latter being much smaller. Apart from a negligible quantity (1 %), the remaining pulp is produced mechanically or semi-mechanically (CEPI data 2006). Table 10 (next page) provides an overview of the number of installations producing the CEPI pulp grades. The table is followed by a description of the different grades.

Table 10 Number of installations producing each CEPI pulp grade. The number of installations are the number of open CITL accounts minus the accounts closed in 2008 and accounts that reported zero emissions in 2008 (CEPI, 2009c).

	No. of installations	No. of integrated installations (pulp and paper)	No. of non-integrated installations (pulp only)	Of which single product
Dissolving pulp	4	1	3	1
Kraft pulp[1]	84	56	28	27
Sulphite pulp	20	16	4	2
TMP/CTMP	20	14	6	4
Other Mechanical pulp	64	59	5	3
Semi-chemical pulp	10	9	1	0
Other pulps	7	4	3	3

[1] Unbleached Kraft pulp is always integrated with paper production

Pulp grades:

- Dissolving pulp: The group defined as dissolving pulp encompasses a small number of specialty pulp mills, which make biochemicals or viscose from dissolving wood pulp.
- Sulphate (or Kraft) pulp: Kraft pulp is a wood pulp produced by the sulphate chemical process using cooking liquor. Key fossil emissions in this group are process related emissions coming from the production of lime. The lime in the kraft pulp mills is integrated in the production and does not leave the mill. The product group encompasses the production of both bleached and unbleached (brown) pulp. Bleached pulp is particularly used for graphic papers, tissue and carton boards. Unbleached pulp is commonly used in liner for corrugated board, wrappings, sack and bag papers, envelopes and other unbleached speciality papers. With possibly a single exemption, unbleached Kraft pulp production is always integrated with kraftliner production (CEPI, 2009d).
- Sulphite pulp: the group defined as sulphite pulp in the table above covers a specific pulp making process, e.g. pulp produced by cooking wood chips in a pressure vessel in the presence of bisulphite liquor. Key fossil emissions are from start-up fuels. It must be noted that all new chemical pulp mills are Kraft mills and that the sulphite mills are limited in number. The number of mills in this group is small, sometimes overlapping dissolving pulps. Sulphite pulp can be either bleached or unbleached. Unbleached Kraft pulp has a considerable lower initial brightness than unbleached sulphite pulp (BREF P&P, 2001). End-uses range from newsprint, printing and writing papers, tissue and sanitary papers.
- (C)TMP pulp: the group defined as (C) TMP covers both thermomechanical pulp (TMP) and chemi-thermomechanical pulp (CTMP). TMP is pulp produced in a thermo-mechanical process where wood particles are softened by steam before entering a pressurised refiner. CTMP pulp is produced in a similar way to TMP, but the wood particles are chemically treated before entering the refiner. Both processes are electro-intensive, with a limited direct fossil fuel based heat use. CTMP is classified under semi-chemical pulps in the Harmonised System of the Customs Co-operation Council. In the FAO, as well as in other industry statistics, such chemi-thermomechanical pulps are

grouped with mechanical pulp. Mechanical pulp has favourable printing properties and has a low resistance to ageing (BREF P&P, 2001). CTMP pulp has properties suited to tissue manufacture. Some CTMP is used in printing and writing grades.

- Other mechanical pulp: the group defined as other mechanical pulp covers the groundwood process - pulp produced by grinding wood into relatively short fibres. Groundwood pulp has a higher proportion of fine material and damaged fibres giving the pulp good optical and paper-surface properties (BREF P&P, 2001) The process is electro-intensive, with a limited direct fossil fuel based heat use. In many of the mills, a combination of recycled and virgin fibres is used as raw material. This pulp is used mainly in newsprint and woodcontaining papers.
- Semichemical pulp: The semichemical pulp is produced in a two-stage process which involves partial digestion with chemicals, followed by mechanical treatment in a disc refiner. This pulp is specifically used in the production of semichemical fluting medium for corrugated board. Because of the double character the process is much more fossil fuel based heat intensive than the other mechanical pulps.
- Other pulps: the category other pulp is by definition the collection of pulps that cannot be classified in other places. This pulp can be produced from fibres other than wood, such as sugar cane bagasse, wheat straw, kenaf, cotton rags and hemp.

Processed recovered paper

In PRODCOM 2007, processed recovered paper is classified as the eight-digit product 'Pulp of other fibrous cellulosic material'. A distinction can be made between deinked and non-deinked recycled paper. Deinked recycled pulp is pulp made from recovered paper from which inks and other contaminants have been removed. Key emissions in this group are heat/steam related emissions in the deinking and drying.

In Europe the recovered paper use divided by the total amount of fibres was 49% in 2006 (CEPI, 2009e). It has to be taken into account that the maintenance of the fibre cycle relies on the feed of primary fibres to ensure the strength and other properties of the paper to be produced. About two thirds of recovered paper is used for non-inking purposes and about one third of the recovered paper is used for de-inked paper grades (BREF P&P, 2001). The production of recycled fibres takes place in all EU paper producing countries, but is especially large in countries with a high population density and high per capita consumption, such as Germany, France, Italy, and the Netherlands (BREF P&P, 2001).

Table 11 provides an overview of the number of installations producing processed recovered paper that is sold on the market.

Table 11 Number of installations in CITL producing processed recovered paper sold on the market. The number of installations are the number of open CITL accounts minus the accounts closed in 2008 and accounts that reported zero emissions in 2008 (CEPI, 2009c).

	No. of installations	No. of integrated installations (pulp and paper)	No. of non-integrated installations (pulp only)	Of which single product
Recycled deinked (market)	8	7	1	1
Recycled non-deinked (market)				0

Paper products

PRODCOM 2007 lists 18 six-digit and 66 eight-digit paper products based on NACE Rev. 1.1 code 21.12. An overview of other product grouping is given in the table below. CEPI breaks down the paper sector in 13 product groups. The link between these groups and CN and PRODCOM 2007 codes is given in Appendix A: Link between product classifications. The reference document on best available technologies (BREF P&P, 2001) lists eight different paper products (see pp. 11 of BREF P&P, 2001). Ecofys and Fraunhofer Institut (2009) defined six different product groups based on Price et al. (2007) and Starzer (2004) which was based on the reference document on best available technologies (BREF P&P, 2001).

Table 12 Overview of paper product groupings

CEPI	**BREF P&P (2001, pp.11)**	**Ecofys and Fraunhofer Institut (2009)**
Newsprint	Newsprint	Newsprint
Uncoated mechanical	Uncoated printing and writing papers	Uncoated fine paper
Coated Mechanical	Coated printing and writing papers	Coated fine paper
Uncoated woodfree	Tissue	Tissue
Coated woodfree	Liner and fluting	Kraftliner
Tissue (sanitary and household)	Packaging paper	Board
TAD – Through Air Dried Tissue	Packaging paper boards	
Kraftliner (Kraft Linerboard)	Speciality papers	
Testliner		
Fluting		
Carton board		
Other (other paper and other packaging)		

The differentiation of types of products lies in their use. Specific products or product groups may be manufactured through various different processes. For instance, newsprint may be manufactured from several different pulp sources (BREF P&P, 2001). The substitutability of a product between the main grades is generally unlikely from a practical point of view. For

example, the market for newsprint cannot be substituted with grades such as packaging or household paper because their physical properties would not be appropriate. On the other hand, the other grades (e.g. coated/uncoated graphics) despite being of better quality are not only more energy intensive but also economically not convenient for that market.

Table 13 provides an overview of the number of installations producing each CEPI paper grade. The table is followed by a description of the different grades.

Table 13 Number of installations in CITL producing each CEPI paper grade. The number of installations are the number of open CITL accounts minus the accounts closed in 2008 and accounts that reported zero emissions in 2008 (CEPI, 2009c), based on a detailed installation list and classification.

	No. of installations	**No. of integrated installations (pulp and paper)**	**No. of non-integrated installations (paper only)**	**Of which single product**
Newsprint	39	25	12	8
Uncoated mechanical	43	23	20	2
Coated mechanical	38	28	10	4
Uncoated woodfree	110	28	82	31
Coated woodfree	72	18	54	26
Tissue	152	4	148	129
TAD	7	1	6	2
Kraftliner	22	16	6	1
Testliner	102	5	97	22
Fluting	94	11	83	8
Cartonboard	113	25	88	60
Other packaging grades	121	30	91	31
Other paper grades	171	20	151	80

Paper grades

- Newsprint paper: the group defined as newsprint covers the specific paper grade used for printing newspapers. The group Newsprint covers a mix of mills producing newsprint from groundwood and/or mechanical pulp or recycled fibres or any percentage of combinations of these two. Newly build newsprint mills are mainly recycled fibre based, for which specific qualities (grades) of recovered paper are used. 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. Key emissions in this group are heat/steam related emissions in for deinking and in the paper production.
- Uncoated mechanical papers: the group defined as uncoated mechanical papers cover the specific paper grades made from mechanical pulp (less than 90% of fibre furnace consists of chemical pulp fibres), used for packaging or graphic purposes/magazines. In many mills the production of this grade is combined with the production of other coated mechanical papers, newsprint or (other) packaging grades from both recycled and virgin

fibre. There is no typical combination. Key emissions in this group are heat/steam related emissions in the paper production, which in integrated mills can come from heat recovery from the pulpproduction on the same site.

- Coated mechanical papers: the group defined as coated mechanical papers covers the specific paper grades made from mechanical pulp (at least 90% of fibres produced by a mechanical pulping process), used for packaging or graphic purposes/magazines. The group is also known as coated groundwood. In many mills the production of this grade is combined with the production of other uncoated mechanical papers, newsprint or (other) packaging grades from both recycled and virgin fibre. There is no typical combination. Key emissions in this group are heat/steam related emissions in the paper production and the direct fired heaters in the coating process. Steam/heat in integrated mills can come from heat recovery from the pulp production on the same site.
- Uncoated woodfree paper: the group defined as uncoated woodfree papers covers papers 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 of mainly virgin fibre furnishes, with variable levels of mineral filler and a range of finishing processes. This grade includes most office papers, such as business forms, copier, computer, stationery and book papers. The mills in the group are mainly non integrated, buying market (kraft) pulp. Key emissions in this group are heat/steam related emissions in the paper production.
- Coated woodfree papers: this group covers the papers made of fibres produced mainly (90%) by a chemical pulping process which are coated in process for different applications and are also known as coated freesheet. This group focuses mainly on publication papers. The mills covered by the group are mainly non integrated, buying market virgin (kraft) pulp. Key emissions in this group are heat/steam related emissions in the paper production and the direct fired heaters in the coating process.
- Tissue papers (sanitary and household): this group covers a wide range of tissue and other hygienic papers for use in households or commercial and industrial premises. Examples are toilet paper and facial tissues, kitchen towels, hand towels and industrial wipes. 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. The converting of that paper can take place both on and off site. The vast majority of the mills covered by the group are non-integrated, using mostly natural gas and a deinked recycled and virgin fibre or a mix of the two. Key emissions in this group are heat/steam related emissions in the paper production and the direct fired Yankee-cylinders in the tissue process.
- TAD - Through Air Dried Tissue papers: this group covers the latest developments in the production of tissue, through the so-called through air dried tissue – which produces a high absorbing special tissue grade, but is more energy intensive than any other tissue production processes.
- Kraftliner (Kraft Linerboard): this group covers the paper mills producing kraftliner - a paperboard made up of a high percentage of unbleached Kraft pulp mixed in some cases with recycled paper stock. It is used primarily as the outside layer of multi-ply corrugated container-board. The key fossil emissions are related to the heat consumption in the paper machine.. The group covers about 20 lines in the file, mostly in an integrated set-up,

combined with the production of unbleached brown kraft pulp. Key emissions are related to start-up fuels and lime kiln fuels in the kraft pulping part of the process**.** The group Kraftliner still encompasses both unbleached (brown) pulp based kraftliner production as well as number of mils that also uses recycled fibre on site.

- Testliner: the group testliner covers types of paperboard that meet specific tests adopted by the packaging industry to qualify for use as the outer facing layer for corrugated board, from which shipping containers are made. Testliner is made primarily from fibers obtained from recycled fibres. The key fossil emissions are related to the heat/steam consumption in the paper machine.
- Fluting: the group fluting refers to the centre segment of corrugated shipping containers, being faced with linerboard (testliner/kraftliner) on both sides. Fluting covers mainly papers made from recycled fibre but this group also holds paperboard that is made from chemical and semi-chemical pulp. The key fossil emissions are related to the heat/steam consumption in the paper machine.
- Carton board: this group covers probably the widest range of products still - which may be single or multiply, coated or uncoated. Carton board is made from virgin and/or recovered fibres, and has good folding properties, stiffness and scoring ability. It is mainly used in cartons for consumer products such as frozen food, cosmetics and for liquid containers; also known as solid board, folding box board, boxboard or carrier board. The key fossil emissions in the mills are related to the heat consumption in the paper machine, possible deinking, or in the direct fired heaters in the coating process
- Other packaging grades cover packaging up to 150g/m^2: this category embraces all paper and board mainly for packaging purposes other than those listed above. Most are produced from recovered fibres, e.g. greyboards, and go for conversion, which in some cases may be for end uses other than packaging including book covers and games. Also known as greyboard or unlined chip. Wrappings: papers whose main use is wrapping or packaging made from any combination of virgin or recovered fibres, bleached or unbleached. They may be subject to various finishing and/or marking processes. Included are sack kraft, other wrapping krafts, sulphite and grease-proof packaging papers.
- Other paper and board for industrial and special purposes: this wide ranging category includes cigarette papers and filter papers, as well as gypsum liners and special papers for waxing, insulating, roofing, asphalting, and other specific applications or treatments.

3.2 Proposal for products to be distinguished

As a starting point in distinguishing products we take the products groups as defined by CEPI, since in general it gives a good classification of products based on differences in characteristics due to technical requirements for particular applications. Grouping products within these groups is done based on our guiding principle not to distinguish products for which the benchmark emission intensity does not differ substantially (see section 4.4.3 of the report on the project approach and general issues). Products groups or certain (specialty) products within product groups for which benchmarking is not considered to be feasible are grouped together.

Virgin pulp

Pulp is a traded intermediate product and to make an allocation possible for non-integrated market pulp mills, separate benchmarks for pulp and paper are necessary (see section 4.4. of the report on the project approach and general issues).

Based on the reference document on best available technologies (BREF P&P, 2001) and Price et al. (2007) the specific emissions for sulphite and mechanical pulp ((C)TMP pulp and other mechanical pulp) are expected not to differ greatly. In absence of data suggesting otherwise, we propose one benchmark value for these two pulps benchmarks together.

As mentioned earlier, in kraft pulping, lime making is an integral part of the pulping process resulting in emissions from the lime kiln, which is normally operated using fossil fuels. The emission intensity of kraft pulp making is therefore expected to differ significantly from those of sulphite and mechanical pulp making. For this reason we propose a separate benchmark for Kraft pulp. In view of our proposal for system boundaries for pulp benchmarks (see section 3.3) and the proposed benchmark value (see section 4.2), we propose to let this benchmark comprise both bleached and unbleached Kraft pulp.

For dissolving pulp and semi-chemical pulp no literature data was found. The number of installations on basis of which a benchmark for these grades could be developed (all single product installations) is deemed to small to come to a benchmark value (see Table 10). We therefore propose to group these pulp grades together with the 'Other pulps' in one group.

PRODCOM codes of distinguished products are listed in appendix A.

Processed recovered paper

Like pulp, deinked processed recovered paper is a traded intermediate product and therefore a separate benchmark for processed recovered paper is needed (see section 4.4. of the report on the project approach and general issues). A separate benchmark for processes recovered paper also avoids the need to discuss on what ratio of recycled fibres to virgin pulp benchmarks for paper products should be based. As discussed by Ecofys and Fraunhofer (2009), the assessment of such a ratio is not deemed to be feasible. We therefore propose to distinguish both deinked processed recovered and non-deinked processed recovered paper as separate products.

In the absence of better data, it is not possible to assess emission intensity difference between deinked and non-deinked processed recovered paper and we therefore propose to make no distinction between the two. There are no PRODCOM codes associated with processed recovered paper.

Paper

The grouping of paper products is a result of a trade-off of the desire to account for differences between products and the need to avoid a disproportionately large number of product groups considering the amount of emissions associated with product groups and differences between benchmark specific emissions of product groups. Due to the limited availability of quantitative information on (specific) emissions associated with products, a

differentiation of products groups has large been made using technical insight taking. Taking the CEPI product grouping as a basis, we propose the following grouping of paper products:

- Newsprint
- Uncoated fine paper. This group comprises both uncoated mechanical paper and uncoated woodfree paper. These two products have been grouped because the principle not to distinguish products based on a difference in process technology
- Coated fine paper. This group comprises both coated mechanical paper and coated woodfree paper. These two products have been grouped because the principle not to distinguish products based on a difference in process technology (see section 4.4 of the report on the project approach and general issues).
- Tissue papers (sanitary and household)
- Containerboard (comprising Kraftliner, testliner and fluting): The benchmark emission factor for integrated Kraftliner production may deviate substantially from that of testliner and fluting and there may therefore be a need to distinguish it as separate product. However, at the time of writing this report no quantitative data was available yet to assess the need for further differentiation.
- Carton board; carton board comprises a wide range of products and some specialty products which may have an emission factor that deviates substantially from the benchmark emission factor for carton board. In particular, this may be the case for folding box board. Also, the application of a coating factor or split in coated and uncoated carton board could be considered. However, at the time of writing this report no quantitative data was available yet to assess the need for further differentiation.
- Other papers (comprising TAD, other packaging grades cover packaging up to 150g/m^2, and other paper and board for industrial and special purposes); TAD is grouped with other paper since no literature data is available and the number the number of installations on which a benchmark value could be determined is considered to be too small (see Table 13)

PRODCOM codes of distinguished products are listed in appendix A.

3.3 Pulp benchmark methodology

At EU ETS installations producing pulp, heat is produced that is used for different applications (use in the pulping process, use for paper making at integrated pulp and paper installations, electricity production, delivery to outside costumers such as district heating). We distinguish two types of heat production with a different background:

- Heat production by boilers using fossil fuels or biomass of which the availability only indirectly related to the pulping process (e.g. bark/sludge/peat/residues)
- Heat production that is inherent to the pulping process: heat generated through the black/green liquor recovery process (chemical pulping) and heat recovered from mechanical pulping

With regard to heat production of the second type, in case of kraft pulping and mechanical pulping, best practice data indicate that heat production through the black liquor recovery process and heat recovered from mechanical pulping (i.e. the heat that is inherent to pulp making) exceeds the heat needed for the respective pulping processes (see chapter 2), meaning that the processes can in principle be net heat exporters. Also sulphite pulp making can be self-sufficient with respect to the heat demand. As such, there is no need for an allocation for pulp making with the exception of the lime kiln in kraft pulping[4] (see Chapter 4 for more details). One could even think of going one step further by determining a negative benchmark for pulp making to account for the excess heat that can be exported. We do not recommend this, because negative allocations for non-integrated pulp mills can in practice not be applied and a sound data basis to determine such a negative benchmark is not available.

The heat production of the first type is only indirectly related to the pulping process. As we aim to have pulp benchmarks reflect the performance pulp making and not that of associated activities that may or may not be performed in the pulping mill, this heat production is left outside the system boundary of pulp production if it is used for other activities than pulp making. In case the heat is delivered to other EU ETS installations (district heating, downstream activities), the pulping mill might receive allowances for this heat production in accordance with the rules set up for cross-boundary heat flows (see section 6.1 of the report on the project approach and general issues).

3.4 Paper benchmark methodology

As mentioned earlier, energy use and emissions can be optimized through the integration of paper and virgin pulp production (see last paragraph of Chapter 2). Virgin pulp producers by nature have access to biomass resources that, albeit not directly linked to the pulp making (see above), are available to use and virgin pulp mills also sometimes have a net heat export which is inherent to their production process[5]. Paper benchmarks based on all pulp and paper mills (without taking into account whether they are integrated or not) will therefore most likely be dominated by integrated mills due to the inherent availability of excess biomass related to pulp making. Consequently, allocations based on such benchmarks will result in a structurally too low allocation for those mills using recycled fibre or market pulp. To avoid this situation, we propose, as a starting point, to base the benchmark for paper products on non-integrated paper production (Chapter 4). It would also be very difficult to determine a separate benchmark for paper making in integrated mills, because it would involve splitting the emissions (net of electricity) to a part allocated to pulp making and a part allocated to pulp making. This split is difficult to make given the large degree of integration between the pulp and paper section.

[4] We thereby neglect small quantities of fossil start-up fuels that might be required in boilers converting black or green liquor. Considering onsite boilers that are not directly related to pulp making as separate activities would mean that these onsite boilers are "Units using exclusively biomass" including units which use fossil fuels only during start-up or shut-down of the unit', which could mean that they can be excluded from the EU ETS in accordance with Annex I which states that such units shall not be taken into account when determining whether or not a an installation needs to be included in the EU ETS. However, if they are under the same permit as the pulp making process, it might not be possible to exclude such units because they are part of a pulp producing installation which by definition is included in the EU ETS.

[5] In addition, there is no need for drying the pulp. Since we anyway propose a heat related benchmark of 0 for pulp making (see section 4.2), this is not relevant.

3.5 Integrated pulp and paper mills

The benchmark for pulp (only allocation for the lime kiln in kraft pulping) and for paper (based on non-integrated mills) will not entirely fit the situation in integrated pulp and paper mills and may result in over allocation due to the reasons described above.

Several approaches can be thought of that would make the methodology better fit the situation of integrated pulp and paper mills. One option would be to develop separate benchmarks for integrated pulp and paper mills. However, such an approach should somehow be able to take into account the gliding scale of integration (i.e. the fact that not all integrated mills use the same amount of virgin pulp versus recycled paper and that some mills also import market pulp). We do not regard this as feasible option. Another option is to adopt a negative benchmark for pulp making, but this has been discarded above and does not solve the issue fully, because integrated pulp and paper mills also make use of biomass sources that are only indirectly linked to pulp making (see above). A third option is to use a correction factor for integrated mills. Such a factor could somehow be linked to historical emissions of the mill (net of electricity) or could otherwise be determined, based on a further categorization of integrated sites. Finally it could be decided not to correct for integrated pulp and paper mills. Since currently no information is available on the order of magnitude of this problem, we propose to leave the decision on the best approach for integrated pulp and paper mills to the moment when more detailed bottom-up data is available to base a decision on (see next chapter).

4 Benchmark values

4.1 Background

In order to be able to construct benchmark curves in order to define benchmarks based on the 10% most efficient installations in EU 27 in accordance with Art. 10a(2) of the amended Directive[6], it is needed to assess the specific emissions for that product for each installation that produces this product. Ideally, one would like to accomplish this for the pulp and paper industry via the following method:

a) Splitting for each integrated pulp and paper mill the emissions into a part allocated to pulp, a part allocated to processed recovered paper, other activities on site and a part allocated to paper making (and in addition a part allocated to emissions resulting from electricity)
b) Splitting for each non-integrated paper mill the emissions into a part allocated to processed recovered paper, other activities and paper production (and in addition a part allocated to emissions resulting from electricity)
c) Use the resulting specific emissions to make benchmark curves for each pulp and paper type

However, given the current availability of data it is regarded to be infeasible to associate emissions with individual products in multi-product mills (regardless of whether or not pulp and paper production are integrated). For this reason, it is only feasible to assess the emissions of each product for those installations that solely produce a single product. For pulp and paper products, the tables in section 3.1 indicate the number of installations for pulp and paper making that are single product only. This is also in line with the choice for to base the benchmarks for paper products on non-integrated paper production.

As an alternative approach to come to a benchmark, we therefore propose to use best available technology values as reported in literature and test these values with the CITL data identified from single-product installations[7]. CEPI has identified each paper and pulp installation in CITL and identified the pulp and paper grades made. The emissions of these installations were obtained from CITL and need to be evaluated / corrected for:

- The presence of outsourced installations / split permits – several permits per installation/large changes in the mills in the reference period and use of laminating paper (sourced paper not self produced but present in final tonnage).
- Electricity production and use: for each considered installation, the emissions excluding electricity production and use will need to be estimated. This can be done by first calculating the share of fossil fuel is used to produce the heat on site assuming a 90% boiler efficiency (in line with the CHP Directive). The remaining share of the

[6] See section 4.4.1 of the project report for the interpretation of this Article used for the present study
[7] The comparison with multi-product and integrated sites, although not directly applicable to test benchmark values for single products, can also be useful to test the overall feasibility of the approach.

fossil fuel and associated emissions can be considered to be account for by electricity production.

- Steam import and export

The total number installations the producing certain products are given in section 3.1. Table 14 summarizes the number of installations for which the emissions can be attributed to a listed product. It can be observed that for some products, the number of mills for which it is feasible to assess the specific emissions is rather small compared to the number of mills producing a product making comparison with best literature values.

Table 14 Number of installations for which the emissions can be attributed to a single product

Pulp Products	No. of single-product installations	Paper products	No. of single-product installations
Kraft pulp	27	Newsprint	8
Sulphite pulp	2	Uncoated fine paper	33
(C)TMP	4	Coated fine paper	30
Other mechanical pulp	3	Tissue	129
		Containerboard	31
Processed recovered paper (market)	1	Cartonboard	60

4.2 Final proposed benchmark values

Pending the outcome of data collection exercise by CEPI as described above we propose to base benchmark values on the lowest best available technology heat consumption found in the reference document on best available technologies (BREF P&P, 2001) and Price et al. (2007) in combination with the assumption of an energy conversion efficiency and choices of reference fuels. Since best available technology data are at least partly based on studies from the '90s, they are most likely not representative of the present 10% most efficient installations in EU27. This is particularly true for the heat consumption during processing recovered paper which is based on 1994 Swedish average. Also, the specific fuel consumption of the lime kiln may be too low based on other literature (see Table 6).

In order to test best available technology values, we propose to use the data from the single product mills identified by CEPI and use the progressing work by CEPI in the phase following publication of this report.

Virgin pulp

Due to the inherent sufficient availability of biomass in the production of virgin pulp that is inherent to pulp making (see Section 3.3), we propose to assume a benchmark of 0 t CO_2 / t pulp for heat used for pulp making. Note that this value does not take into account excess heat that according to literature is inherent to best practice Kraft pulping and mechanical pulping (see chapter 2 and section 3.3).

To determine a benchmark emission factor for lime production, the amount of lime required per tonne of air dried pulp (240 kg active CaO/adt (Brown and Williamson, 2001)) could be

multiplied with the part of the benchmark for lime production that is related to the combustion of fuel (0.2 t CO_2/t lime (see report for the lime sector), yielding 0.048 t CO_2/adt.

An alternative approach to come to an emission factor for lime production would be to multiply the lowest reported best practice energy use (1.2 GJ/adt, Price et al. (2007), see chapter 2) times the emission factor of oil[8] (0.073 t CO_2/GJ; IPCC, 1997). The resulting value (0.088 t CO_2/adt) is significantly higher than the one using the one earlier determined. Since the lime to our knowledge is always captively used in Kraft pulp making and is specific to that process, a separate benchmark for the lime in Kraft pulping could be justified. We recommend further exploring this via the bottom-up verification as outlined above.

For the products in the group 'other pulp', we propose to use a fall-back approach in order to come to an allocation (see section 5 of the report on the project approach and general issues).

Table 15 gives an overview of the proposed benchmark values for virgin pulps. For PRODCOM codes of the benchmarked products, the reader is referred to appendix A.

Table 15 Benchmark emission factors for virgin pulp products

	Specific heat consumption[1] (GJ /adt)	**Emission factor (kg CO_2/GJ)**	**Benchmark emission factor (t CO_2/adt)**
Bleached Kraft pulp			0.048
- Bleached Kraft pulp (excl. lime kiln)	10	0	0
- Lime kiln			0.048[2]
Bleached sulphite pulp	16	0	0
(C)TMP and other mechanical pulp	0		0
Other pulp			No product benchmark

[1] Lowest as reported in BREF P&P (2001) and Price et al. (2007); all values are from Price et al. (2007) (see section 2)
[2] Based on 240 kg active CaO/adt (Brown and Williamson, 2001)) and the part of the benchmark for lime production related to the combustion of fuel (0.2 t CO_2/t lime (see report for the lime sector)

Recovered paper processing

For recovered paper processing, Price et al. (2007) reports a specific energy consumption of 0.3 GJ/adt. Assuming a heat conversion efficiency of 90 %[9] and taking the specific emission factor of natural gas (56.1 kg CO_2/GJ (IPCC, 1997)), the benchmark emission factor would be: 18.7 kg CO_2/adt. Note that as explained before, this value needs careful consideration as it may not be representative of the 10% most efficient installations in EU27. There are no PRODCOM codes associated with processed recovered paper.

[8] All best practice values summarized in chapter 2 are believed to refer to oil based processes
[9] Commission Decision 2007/74/EC establishing harmonised efficiency reference values for separate production of electricity and heat in the application of Directive 2004/8/EC on the promotion of cogeneration: for steam and hot water, reference efficiency values are given ranging from 70 % for biogas to 90 % for natural gas.

Paper

As mentioned earlier, in order to define benchmark values for paper product we propose to base benchmark values on the lowest best available technology heat consumption found in the reference document on best available technologies (BREF P&P, 2001) and Price et al. (2007). We underline that in general these values are considered to be on the high side and further investigation is needed to assess the extent to which they are representative of the 10% most efficient installations in EU27

Assuming a heat conversion efficiency of 90 %[4] and taking the specific emission factor of natural gas (56.1 kg CO_2/GJ (IPCC, 1997)), the benchmark emission factor would be as listed in Table 16. For PRODCOM codes of the listed products, the reader is referred to appendix A. Some drying processes use hot air for drying and thus apply fuels for heat other than via steam boilers, e.g. Yankee cylinders and through-air drying used in tissue production. It is unclear to which extent the best practice specific energy consumption values in Table 16 correspond to steam or direct fuel use. Although natural gas seems a reasonable choice of reference fuel for non-integrated mills when looking at the fuel mix in Europe as shown in Table 7, the resulting values should be further checked via the bottom-up verification.

For the products in the group 'other papers', we propose to use a fall-back approach in order to come to an allocation (see section 5 of the report on the project approach and general issues)

Table 16 Benchmark emission factors for paper products

	Specific heat consumption[1] (GJ /adt)	**Emission factor[2] (t CO_2/GJ_{fuel})**	**Benchmark emission factor (t CO_2/adt)**
Newsprint	5.1[4]	0.0561	0.318
Uncoated fine paper	6.5[3]	0.0561	0.405
Coated fine paper	7.0[3]	0.0561	0.463
Tissue	5.5[3]	0.0561	0.343
Containerboard	5.9[4]	0.0561	0.368
Carton board	6.7[4]	0.0561	0.418
Other papers			No product benchmark

[1] Lowest as reported in BREF P&P (2001) and Price et al. (2007) (see section 2)
[2] IPCC (1997)
[3] BREF P&P (2001)
[4] Price et al. (2007)

5 Additional steps required

Several open issues have been mentioned in this report that need further analysis following the publication of this report:

- Data collection exercise by CEPI needs to be finalized. The following data needs to be checked/collected: classification of mills: recycled and virgin pulp classification, integrated /non-integrated/single product and multiple product mills, identification of grades produced, collection of grade based mill production data, identification heat and electricity production/matching with CITL, collection of other potential data needs.
- Correction of CITL emissions (see section 4.1)
- Comparing BAT values with results of data collection exercise if feasible
- Based on comparison define benchmarks that can be regarded as representative for 10 % most efficient.
- Identify most suitable approach for lime in kraft pulping based on data evidence (separate benchmark or fuel use benchmark for the non-captive lime sector).
- Solve other issues raised in the report: assess grouping of containerboard and carton board (see section 3.2)
- Define most appropriate approach for integrated pulp and paper mills based on data analysis by CEPI.

6 Stakeholder comments

These are the CEPI comments made on a first draft report discussed with the sector before summer 2009 (CEPI, 2009f). We (Ecofys) feel many of these comments have been answered. Comments on the present report can only be made after publishing:

The following key issues are important to discussed, when developing an allocation approach to our sector:

- Diversity. You have rightly found the pulp and paper industry to be a very diverse sector, applying different raw materials in different products, using different technologies. This was recognised by you in the earlier 2008 and the current report. For this complexity we need to find solutions to come to fair and comparable allocation rules.
- Fuel mix is everything, also in our sector. The key issue that needs to be solved is the way the fuel mix debate is handled. Fuel mixes differ in the different countries; there are different historic set-ups and different reasons for being on different fuels. The only way to come to any final approach to our sector is to find an approach to fuel mixes that gives a fair and equal result to the companies. Fuels are not only linked to choice, or technology, but also to history, availability and set-up. Even though the final outcome is CO_2 emission, a benchmark approach based on energy efficiency, translated to CO_2 emissions via a fuel mix approach is the only way forward for our sector.
- Recycling. The second element of diversity is the broad range of recycled and virgin raw material mixes and products. Solutions need to be found here as well.
- Integration. Your definitions and references to what is an integrated and non integrated mill are not yet clear enough. A solution has to be found that allows for the methodology to both fit the situations in integrated and non integrated mills.
- Direct fuels and lime kiln process emissions. Direct fuels – e.g. fuels for direct heating in infrared dryers or Yankee cylinders and start-up fuels for biomass boilers are again not mentioned in the report. When developing an approach one will see that pulp and paper mill sites cover more activities than paper making alone, for which solutions need to be found (the “non benchmark part”). Further, the fuels used for direct heating in the process (infrared/Yankees) need to be handled in the approach as well and finally, the lime kiln process emissions, part of kraft pulp making, require attention.
- There can be no penalties or negative allocations. It is clear that any approach will have to find a balance between being very precise and not being able to cover everything. Some methodological choices will lead to the creation of outliers. However any balance struck at that time needs to give a result that is fair and explainable. The negative allocations or penalties that you now proposed are not the right way forward.

With regard to your approach we think the following aspects should be discussed:

- One approach to the sector. To minimise the internal distortions of competition, the aim should be to have one approach for the sector as a whole – either the benchmark or fall back approach.
- 2008 report. The approach you put forward in the 2008 report came quite a long way in solving the characteristical challenges of our sector. We could agree with the main directions of that report, but now see changes made. In several cases we think the text in the original 2008 document on our sector (page 75-ev) is actually more accurate than the new chapter.
- Separate benchmarks for pulp and paper. We agreed with the fact that there should be separate benchmarks for pulp and paper; the fact that the benchmarkable unit is the paper machine; the resulting approach towards a non integrated reference and the fact that the basis for comparison is energy efficiency and not fuel choice.
- Changed approach. We have unfortunately seen that this last starting point seems to have changed. In your 2008 report you clearly concluded that because of the complexity of the sector the best approach is to base the emission benchmark on the most energy efficient processes (page 79). Our sector has not changed, so your conclusions should technically have not changed either.
- Further choices. The CHP rules not allocating to electricity and the fact that all small installations remain in the benchmark, have complicated issues severely. The fact that there are numerous mills producing different pulp types and paper products, electricity and heat and hot water at the same site, make the use of CITL data almost impossible. A split of heat use or CO2 emissions based on comparable methods per product has not been done in the mills.
- 20 % criteria for product classifications. Products that are benchmarked and grouped need to be comparable; need to be sold on the same markets, for similar prices. This is a key principle to be added to the text. Your choice in the allocation rules for a 20 % difference in the emission intensity of products as a boundary for grouping products together is fundamentally wrong and contradicting your very own starting points and key principles. This results in an in-built punishment for the products being on the wrong end of the 20 % without any ground.
- Pulp Number of benchmarks. As said in the report, we are working on a product classification based on logical and statistical references. Based on this the number of benchmarks should be found, not based on the 20% rule. It might be that several benchmarks have the same number as an outcome. However, this is for pulp not a reason to "call all pulp pulp" We object to the grouping of mechanical and sulphite pulps into one benchmark. Recovered paper number of benchmarks - We need to analyse the BREF further to give a foundation to the statement that deinked and non deinked recovered paper pulp are part of the same benchmark.
- Data and curves. CEPI does not have the data to make a specific benchmark curve. We therefore appreciated your earlier proposal to look at literature values. These have now however not come back to your report. When literature values are applied, a debate on fuel mixes will again come forward. We have not solved this issue and the report does not provide answers either.
- The allocation rule proposal. Based on the comments above and attached you will not be surprised we do not agree with the proposed allocation rules to our sector – and have made proposals in the annex. We ask you, for our sector, to return to the 2008 approach.

The pulp and paper industry is a very diverse sector, applying different raw materials in different products, using different technologies. This was recognised already in the earlier 2008 report. For this complexity solutions need to be found to come to fair and comparable benchmarks that allow for a fair allocation.

Benchmarks need to be developed to the extent feasible. This is still a question for the paper industry. The current wording of the directive holds a number of challenges, which have a significant impact on the sector situation and the harmonised rules compared to before.

- For example, as member states may exclude small emitters in Article 27 and do not have to give clarity soon on this, roughly half of the sector consists of small emitters with a large variety of benchmarks and products.
- Further, as the political decision makers unfortunately and in the sector's opinion wrongly have not exempted electricity from CHP that is used on site from the auctioning regime, the sector is now faced with a situation that the CITL numbers on the sector represent a wide variety in situations concerning energy conversion, ownership, etc. and that the sector cannot use CITL in a straightforward manner as all emissions related to electricity production have to be taken out somehow.

Further to this, the mix of integration, raw material and fuel availability, the fact that sites produce several products on one site, from different raw material mixes and the fact that a best practice optimum on a product does not exits, brings challenges.

The sector organisation (CEPI) has studied and extensively discussed the possibilities of establishing benchmark curves within the sector. The literature and BAT based approach working with efficiency and fuel mix instead of an overall CO_2 allocation curve, which was proposed in the 2008 report, seemed feasible. The current line of thinking seems not.

As the requested data, which should be established to objective and established guidelines, and curves derived from these data are not available in the sector now, and can only be made when a number of general choices has been made in, CEPI has doubt to whether these curves can be available on time for the project and the benchmark process.

For CEPI, the discussion on fall back options is therefore as relevant as the main approach.

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Appendix A: Link between product classifications

Table 17 CEPI product groups with associated CN and PRODCOM codes

CEPI product group	CN code	PRODCOM 2007 code		Description (CN)
Virgin pulp				
Dissolving pulp	4702	21.11.11.00	-	Chemical wood pulp, dissolving grades .
Kraft	4703.11	21.11.12.13	-	Chemical wood pulp, dissolving grades, unbleached, coniferous
	4703.12	21.11.12.53	-	Chemical wood pulp, dissolving grades, unbleached, coniferous
	4703.19	21.11.12.55	-	Chemical wood pulp, dissolving grades, unbleached, non-coniferous
	4703.29		-	Chemical wood pulp, dissolving grades, semi-bleached or bleached, non-coniferous
Sulphite	4704.11	21.11.13.13	-	Chemical wood pulp, sulphite, other than dissolving grades, Unbleached, Coniferous
	4704.21	21.11.13.15	-	Chemical wood pulp, sulphite, other than dissolving grades, Semi-bleached or bleached, Coniferous
	4704.19	21.11.13.53	-	Chemical wood pulp, sulphite, other than dissolving grades, Unbleached, Non-Coniferous
	4704.29	21.11.13.55	-	Chemical wood pulp, sulphite, other than dissolving grades, Semi-bleached or bleached, Non-Coniferous
TMP/CTMP	4701.00.10	21.11.14.15	-	Thermo-mechanical wood pulp
Other Mechanical pulp	4701.00.90	21.11.14.19	-	Other mechanical wood pulp
Semi – chemical pulp	4705	21.11.14.30	-	Wood pulp obtained by a combination of mechanical and chemical pulping processes
Other pulps	4706	21.11.14.50	-	Pulps of fibres derived from recovered (waste and scrap) paper or paperboard or of other fibrous cellulosic material:

Continuation Table 17

CEPI product group	CN code	PRODCOM 2007 code		Description (CN)
Processed recovered paper				
Recycled pulp deinked				
Recycled pulp non-deinked				
Paper				
Newsprint	4801	21.12.11.50	-	Newsprint, in rolls or sheets
Uncoated mechanical	4802.6	21.12.14.70	-	Uncoated paper and paperboard, of a kind used for writing, printing or other graphic purposes, and non-perforated punchcards and punch-tape paper, in rolls or rectangular (including square) sheets, of any size, other than paper of heading 4801 or 4803; handmade paper and paperboard:
Uncoated woodfree	4802.20	21.12.13.10	-	Paper and paperboard of a kind used as a base for photosensitive, heat-sensitive or electrosensitive paper or paperboard
	4802.40.10	21.12.13.55	-	Wallpaper base: Not containing fibres obtained by a mechanical process or of which not more than 10 % by weight of the total fibre content consists of such fibres
	4802.40.90	21.12.13.59	-	Wallpaper base: Other
	4802.54	21.12.14.10	-	Other paper and paperboard, not containing fibres obtained by a mechanical or chemi-mechanical process or of which not more than 10 % by weight of the total fibre content consists of such fibres - Weighing less than 40 g/m2
	4802.55	21.12.14.35	-	Weighing 40 g/m2 or more but not more than 150 g/m2, in rolls:
	4802.56	21.12.14.39	-	Weighing 40 g/m2 or more but not more than 150 g/m2, in sheets with one side not exceeding 435 mm and the other side not exceeding 297 mm in the unfolded state:
	4802.57	21.12.14.39	-	Other, weighing 40 g/m2 or more but not more than 150 g/m2
	4802.58	21.12.14.50	-	Weighing more than 150 g/m2:
	4802.10	21.12.12.00	-	Handmade paper and paperboard

Continuation Table 17

CEPI product group	CN code	PRODCOM 2007 code	Description (CN)
Coated mechanical	4810.22	21.12.53.60	- Lightweight coated paper
	4810.29.30	21.12.53.75	- Lightweight coated paper - Other
	4810.29.80	21.12.53.79	- Lightweight coated paper – Other than in rolls
Coated woodfree	4810.13.20	21.12.53.35	- Paper and paperboard, coated on one or both sides with kaolin (China clay) or other inorganic substances, with or without a binder, and with no other coating, whether or not surface-coloured, surface-decorated or printed, in rolls or rectangular (including square) sheets, of any size, in rolls, Paper and paperboard of a kind used as a base for photosensitive, heat-sensitive or electrosensitive paper or paperboard, weighing not more than 150 g/m2
	4810.13.80	21.12.53.37	- Paper and paperboard, coated on one or both sides with kaolin (China clay) or other inorganic substances, with or without a binder, and with no other coating, whether or not surface-coloured, surface-decorated or printed, in rolls or rectangular (including square) sheets, of any size, in rolls, Paper and paperboard of a kind used as a base for photosensitive, heat-sensitive or electrosensitive paper or paperboard, weighing not more than 150 g/m2 - Other
	4810.29.30	21.12.53.75	- Lightweight coated paper
	4810.29.80	21.12.53.79	- Lightweight coated paper - other
	4809.90.10	21.12.55.30	- Carbon or similar copying papers
	4809.20	21.12.55.50	- Self-copy paper
	4809.90.90	21.12.55.90	- Self-copy paper – other

Continuation Table 17

CEPI product group	CN code	PRODCOM 2007 code	Description (CN)
Tissue – excluding converting	4803.00.10	21.12.21.30	- Toilet or facial tissue stock, towel or napkin stock and similar paper of a kind used for household or sanitary purposes, cellulose wadding and webs of cellulose fibres, whether or not creped, crinkled, embossed, perforated, surface-coloured, surface-decorated or printed, in rolls or sheets, Cellulose wadding
	4803.00.31	21.12.21.55	- Not more than 25 g/m2
	4803.00.39	21.12.21.57	- More than 25 g/m2
	4803.00.90	21.12.21.90	- Other
Kraftliner	4804.11	21.12.22.50	- Kraftliner - unbleached
	4804.19	21.12.22.90	- Kraftliner – Other
Testliner	4805.24	21.12.25.20	- Testliner (recycled liner board), Weighing 150 g/m2 or less
	4805.25	21.12.25.40	- Testliner weghing more than 150 g/m2
Fluting	4805.1	21.12.24.00	- Semi-chemical fluting paper
Carton board	4804.4	21.12.23.35	- Other kraft paper and paperboard weighing more than 150 g/m2 but less than 225 g/m2 - Unbleached
	4804.5	21.12.23.37	- Other kraft paper and paperboard weighing 225 g/m2 or more - Unbleached
	4805.92	21.12.30.65	- Weighing more than 150 g/m2 but less than 225 g/m2
	4805.93	21.12.30.69	- Weighing 225 g/m2 or more, made from recovered paper
	4810.92.10	21.12.54.53	- Other paper and paperboard – multy ply
	4810.92.30	21.12.54.55	- Other paper and paperboard – multy ply - With only one outer layer bleached
	4810.92.90	21.12.54.59	- Other paper and paperboard – multy ply - With only one outer layer bleached - other
	4811.51	21.12.56.55	- Paper and paperboard, coated, impregnated or covered with plastics (excluding adhesives), Bleached, weighing more than 150 g/m2
	4811.59	21.12.56.59	- Paper and paperboard, coated, impregnated or covered with plastics (excluding adhesives), other

Continuation Table 17

CEPI product group	CN code	PRODCOM 2007 code	Description (CN)
Other packaging grades – wrappings up to 150g/m2	4804.21	21.12.23.15	- Sack kraft paper, unbleached
	4804.29	21.12.23.19	- Sack kraft paper - Other
	4804.3	21.12.23.33	- Other kraft paper and paperboard weighing 150 g/m2 or less - Unbleached
	4808.20	21.12.23.50	- Sack kraft paper, creped or crinkled, whether or not embossed or perforated
	4805.30	21.12.30.10	- Sulphite wrapping paper
	4805.91	21.12.30.61	- Sulphite wrapping paper - Weighing 150 g/m2 or less
	4806.10	21.12.40.10	- Vegetable parchment, greaseproof papers, tracing papers and glassine and other glazed transparent or translucent papers, in rolls or sheets, Vegetable parchment
	4806.20	21.12.40.30	- Greaseproof papers
	4806.40	21.12.40.70	- Glassine and other glazed transparent or translucent papers
	4808.30	21.12.52.30	- Other kraft paper, creped or crinkled, whether or not embossed or perforated
	4808.90	21.12.52.50	- Other
	4810.3	21.12.54.30	- Kraft paper and paperboard, other than that of a kind used for writing, printing or other graphic purposes
	4810.99	21.12.54.70	- Other paper and paperboard
Other paper grades, specialities	4813.90	21.12.30.20	- Cigarette paper, whether or not cut to size or in the form of booklets or tubes - other
	4805.40	21.12.30.30	- Filter paper and paperboard
	4805.50	21.12.30.40	- Felt paper and paperboard
	4806.30	21.12.40.50	- Tracing papers
	4807	21.12.51.00	- Composite paper and paperboard (made by sticking flat layers of paper or paperboard together with an adhesive), not surface-coated or impregnated, whether or not internally reinforced, in rolls or sheets:
	4811.10		- Tarred, bituminised or asphalted paper and paperboard

Continuous Table 17

CEPI product group	CN code	PRODCOM 2007 code	Description (CN)
	4811.41		- Self-adhesive paper
	4811.49		- Other
	4811.60	21.12.56.70	- Paper and paperboard, coated, impregnated or covered with wax, paraffin wax, stearin, oil or glycerol
	4811.90		- Other paper, paperboard, cellulose wadding and webs of cellulose fibres
	4821.10.10		- Paper or paperboard labels of all kinds, whether or not printed, Printed, Self-adhesive
	4821.10.90		- Paper or paperboard labels of all kinds, whether or not printed, Printed, Self-adhesive, other
	4821.90.10		- Paper or paperboard labels of all kinds, whether or not printed, Printed, other
	4821.90.90		- Paper or paperboard labels of all kinds, whether or not printed, Printed, other. other
	4812	21.25.13.00	- Filter blocks, slabs and plates, of paper pulp
	4813.10	21.25.14.30	- Cigarette paper, whether or not cut to size or in the form of booklets or tubes
	4813.20	21.25.14.15	- In rolls of a width not exceeding 5 cm
	4822.10		- Bobbins, spools, cops and similar supports, of paper pulp, paper or paperboard (whether or not perforated or hardened)
	4822.90		- Bobbins, spools, cops and similar supports, of paper pulp, paper or paperboard (whether or not perforated or hardened), other
	4823.20	21.25.14.51	- Filter paper and paperboard
	4823.40		- Rolls, sheets and dials, printed for self-recording apparatus
	4823.70	21.25.14.57	- Moulded or pressed articles of paper pulp
	4823.90.85	21.23.13.50	- Moulded or pressed articles of paper pulp, other