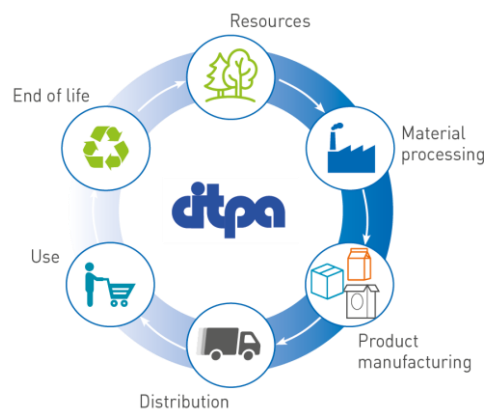




## Guidelines for calculating Carbon footprints for paper-based packaging



March 2018

## CITPA

# Guidelines for calculating Carbon footprints for paper-based packaging

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#### **1. Introduction**

The European paper packaging converting sector faces a pressing demand to calculate and deliver carbon footprints to its customers.

This guideline document provides support for the individual Associations in the paper packaging converting sector and member companies to calculate their carbon footprint.

The guidelines follow the 2017 “Framework for Carbon Footprints for Paper and Board Products”. Which updated the original framework of 2007 for better harmonization with existing internationally accepted protocols and frameworks, namely:

- The "Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification and communication" technical specification from the International Organization for Standardization (ISO/TS 14067:2013 );
- The Product Life Cycle Accounting and Reporting Standard (Product Standard) from the World Resource Institute (WRI) and World Business Council for Sustainable Development (WBCSD) GHG Protocol published in 2011; and
- The European Commission Product Environmental Footprint (PEF) Category Rules (PEFCR) for Intermediate Paper Product (Draft PEFCR for stakeholder consultation, May 2016).

The guidelines cover:

- the common CITPA approach to the open issues identified in the Framework
- Identification of issues for which no common approach is possible and which need to be dealt with by each industry sector or Association

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- An Annex with CO<sub>2</sub> factors for background processes that are to be used in the calculations for the carbon footprints of the industry sectors represented by the Association, and as default factors for mills in case primary data from suppliers for processes do not have to be used

The guidelines are based on the previous guidelines for the paper packaging sector:

- CITPA Guidelines for calculating carbon footprints for paper-based packaging 2007

An overview of the background data used for these guidelines can be found in an Annex (excel file) which is available on request to CITPA members.

**The CO<sub>2</sub> factors from these processes are confidential and may only be used in the context of these guidelines. They may not be copied or published for other purposes.**

The excel spreadsheet contains the CO<sub>2</sub> factors described in this document and calculates the sector's cradle-to-gate and cradle-to-grave carbon footprint after the sector's specific gate-to-gate datasets have been introduced in the appropriate cells. Member companies can insert specific data from their suppliers and use the CO<sub>2</sub> factors described in this document as default factors in case the supplier specific factors are not available to them.

## **2. Basic Principles**

Calculations are based on each tonne of final product produced per industry sector or per company or site (kg/t).

Green House Gas emissions are expressed in CO<sub>2</sub> equivalents.

The footprints consist of four separate figures:

- Fossil origin CO<sub>2</sub>-equivalent (CO<sub>2</sub>-eq) emissions
- Biomass origin CO<sub>2</sub>-equivalent (CO<sub>2</sub>-eq) emissions
- Biogenic CO<sub>2</sub> removals
- Emissions and removals of biogenic CO<sub>2</sub> (CO<sub>2</sub>-eq) due to direct land use change (dLUC)

In each case, these impacts are expressed per ton of product. These can be added up to give a total footprint.

Carbon stored in the product can also be calculated. At an industry level, the calculation is based on the average product composition in the specific industry sector.

For companies and sites, the amount of carbon stored for each product is calculated on the most representative grammage (paper basis weight) for sold product and per site (kg/t). It should be noted that paper packaging is a short-lived product and therefore carbon storage in the product is temporary. Although carbon stored in the product is calculated, this value must not be included in the summation of the total footprint, and therefore storage. In any communications, this value must

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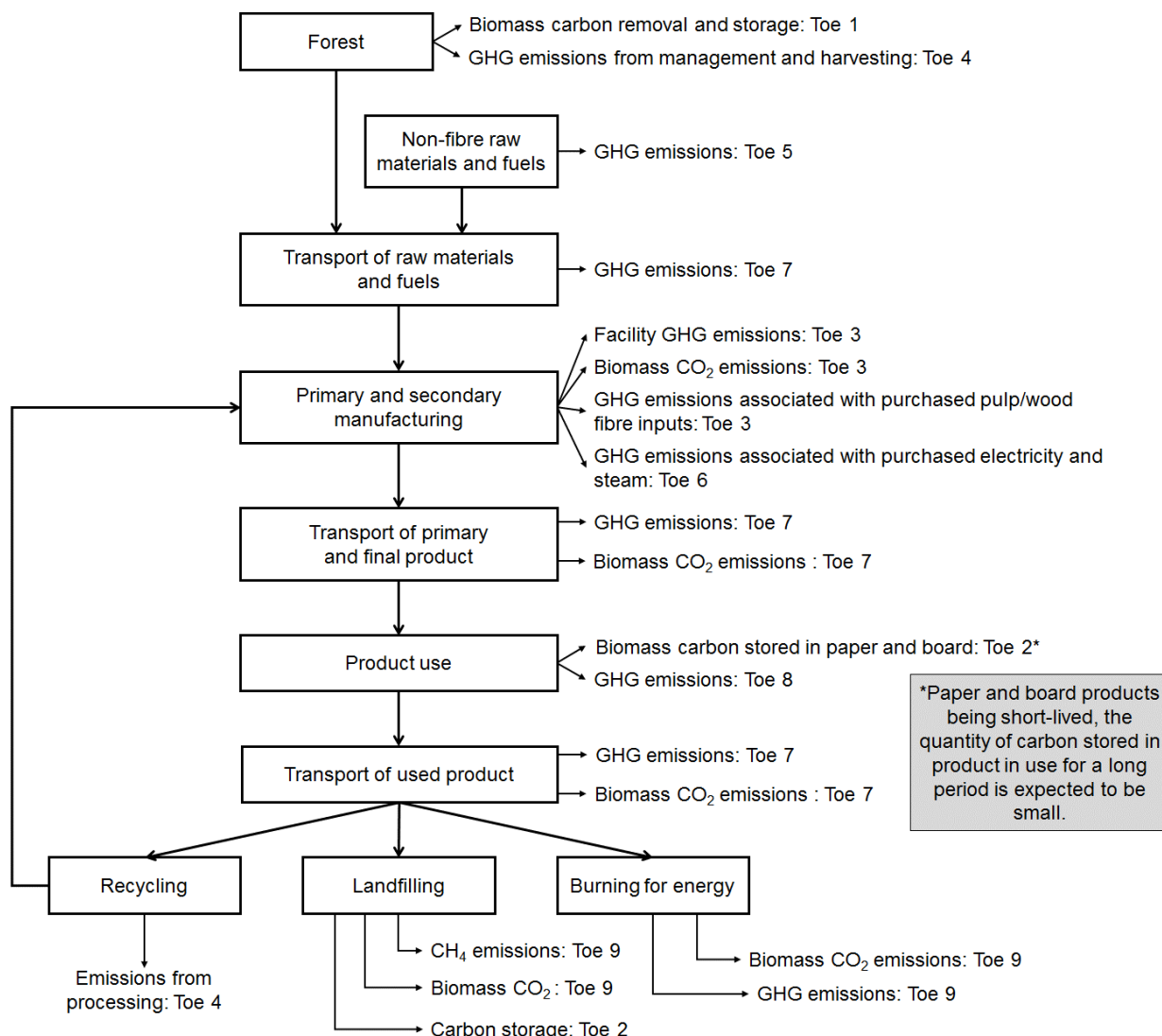
be reported separately from the total footprint and the temporary nature of the carbon stored in the product must be clearly communicated.

The industry sector's carbon footprint is an average carbon footprint, based on the environmental databases maintained by a sector. In general the flows reported in the databases should be multiplied with the background factors determined for these guidelines to calculate the carbon footprint for the industry sector.

Calculations for companies may be made on a regular basis. Each statement must refer to the reference year. In the event of the introduction of new processes or internal improvements, data must be determined on the basis of at least 3 consecutive months. In general, mills should use CO<sub>2</sub> factors from suppliers whenever available and background factors from the guidelines only if these are not available.

The boundaries are cradle-to-gate (product, toes 1-7 in figure 1), and cradle-to-grave, also including transport to the customer, the use phase and end-of-life processes (toes 8-9 in figure 1).

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**Fig .1 Elements of a carbon footprint from the Framework<sup>1</sup>**

*Note how to address “Recycling” in these guidelines: emissions associated with the purchased deinked pulp reported under toe 3, input of recovered paper under toe 4, transport for collection of paper for recycling under toe 7.*

The footprint can be calculated for a mix of virgin fibre and recycled fibre based paper product, reflecting the ratio of activities belonging to virgin and recycled fibre products as reported in the sector’s dataset. No further allocation of activities belonging to virgin fibre products and recycled fibre products is made, nor are any credits (avoided emissions through system expansion) taken into account. However the objective of the carbon footprint may require allocation for recycling. If this is the case, the choice for e.g. a closed-loop approach by an industry sector or another choice of the allocation formula by a company, needs to be justified.

Boundaries for processes included are described for each toe in Section 3 of the guidelines.

<sup>1</sup> (2017) Framework for the development of Carbon Footprints For Paper and Board Products

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The footprint includes a statement on carbon in forests, but by default carbon storage in the forests is set at zero. In the case that evidence supports that the carbon storage is not zero, then it can be included but the justification and approach for calculation of carbon storage should be presented. All packaging materials of the final product and external process waste treatment are excluded from the calculations.

Avoided emissions are not included in the calculation of the carbon footprint, nor are emissions relating to sold co-products, but avoided emissions may be reported separately in toe 10.

Note: sometimes it may not be possible to report avoided emissions separately, as the available data for Toe 9 (end of life) and Toe 10 (avoided emissions) may be a single black box.

Calculations should be as close to the physical reality of the respective supply chains as possible. Companies should use data from their own operations and their own suppliers wherever possible. Only if it is not possible to get the data from these suppliers, companies could use the CO<sub>2</sub> factors from these guidelines.

The CO<sub>2</sub> factors for background processes in the guidelines are calculated, in order of preference, from the ELCD<sup>2</sup>, Ecoinvent<sup>3</sup>, Gabi<sup>4</sup> and KCL<sup>5</sup> databases. Exceptions, if any, can be found under details for a specific toe.

Calculations need to be transparent and reproducible (within the bounds of confidentiality).

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<sup>2</sup> Commission's "European Reference Life Cycle Data System" v. 3.2, <http://lca.jrc.ec.europa.eu>.

<sup>3</sup> The ecoinvent database v.3.3 from the ecoinvent Centre, also known as the Swiss Centre for Life Cycle Inventories, is a joint initiative of institutes and departments of the Swiss Federal Institutes of Technology Zürich (ETH Zurich) and Lausanne (EPFL), of the Paul Scherrer Institute (PSI), of the Swiss Federal Laboratories for Materials Testing and Research (Empa), and of the Swiss Federal Research Station Agroscope Reckenholz-Tänikon (ART), <http://www.ecoinvent.org/>.

<sup>4</sup> GaBi database from PE INTERNATIONAL, [http://www.ikpgabi.uni-stuttgart.de/english/index\\_e.html](http://www.ikpgabi.uni-stuttgart.de/english/index_e.html)

<sup>5</sup> KCL EcoData, calculated for CITPA, <http://www.kcl.fi>

### **3. Default factors for Toes**

#### **TOE 1, Biomass Carbon Removal and Storage In Forests<sup>6</sup>**

##### *Carbon removal:*

The CO<sub>2</sub> content of wood is calculated by multiplying the dry wood weight with 1,833 kg CO<sub>2</sub>/kg dry wood, also in case background processes are used.

All carbon removals are calculated from inputs of biomass in other toes and reported under toe 1:

- toe 3: removals by wood used for the market pulp production
- toe 4: removals from inputs of wood
- toe 5: biomass wood inputs as fuel

Toe 1 can understate the net carbon removal accomplished in the paper and paper board products value chain and should therefore be viewed in combination with the issue of carbon content of paper products, discussed in toe 2.

Note: 10% is added because the wood dataset is reported as “under bark”. The specific wood density factor to calculate from m<sup>3</sup> to weight may be used in case this is known.

##### *Carbon storage*

The following statement should be part of the footprint:

“According to the European GHG inventory, forests of the EU-28 are a net carbon sink, with net CO<sub>2</sub> removals by forests having increased by over 19 % between 1990 and 2014.”

The level for carbon storage used for toe 1 has been set at zero (the net annual variation of carbon), while consensus data and calculations are still developing in this field.

When forests are managed sustainably, carbon stocks are growing or at least equal. Forest-owning paper producers should give details of carbon storage in their forest activities on a corporate level. CEPI’s definition for Sustainable Forest Management can be used to qualify and quantify such sequestration/sink values.

In order to prove that fibres are derived from sustainably managed forests, the user guide assumes the availability of Forest Certification and respective Chain-of-Custody or, in case Forest Certification is not yet available, “3rd party verified traceability” referring to the wood source.

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<sup>6</sup> ISO/TS 14067:2013 requires GHG emissions and removals to be included. It defines greenhouse gas removal [or carbon removal] as “mass of a greenhouse gas [or carbon] removed from the atmosphere”. In this context, this framework uses the term “**carbon removal**” to mean the action of removing the carbon from the atmosphere, for instance by tree growing. Alternative terminologies for “removal”, for instance by IPCC, includes “carbon uptake” or “carbon sequestration”. In contrast, ISO/TS 14067:2013 defines “carbon storage” as “carbon removed from the atmosphere and stored as carbon in a product”. Hence, in this framework, “**carbon storage**” is used to mean carbon that was previously removed from the atmosphere and is now maintained out of the atmosphere.

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## Rationale

According to the “Framework for Carbon Footprints for Paper and Board Products”, all footprints should include two qualitative statements on the two unique positive aspects of paper and board products:

- The fact that our products are based on a renewable raw material, using the starting point of our products – the capacity of forests to bind CO<sub>2</sub>.
- The fact that our products store carbon and, furthermore, that recycling of paper and board products keeps this CO<sub>2</sub> from returning to the atmosphere.

### *Rationale for the calculation of carbon removals<sup>7</sup>:*

Carbon has an atomic weight of 12, oxygen (O<sub>2</sub>) has a molecular weight of 32. CO<sub>2</sub> which has a molecular weight of 44 is reduced through photosynthesis and fixed in the product as biogenic Carbon, while O<sub>2</sub> is released to the atmosphere.

- 1000 kg of dry wood = 50% C or 500 kg C
- 500 kg C \* (44/12) = 1833 kg CO<sub>2</sub>
- 1000kg of dry wood = 1833 kg CO<sub>2</sub>

Discrepancies were found in removals in background data as average densities for the input of wood are used to calculate inputs from m<sup>3</sup> to tonnes. Therefore it was decided to base all removals, including those from background processes on this calculation to achieve consistency between removals, carbon content of the product and emissions from incineration at the end of life.

### *Rationale for carbon storage*

The link with forests is an important asset for the paper packaging industry and this should be taken into account in the footprint. However, claiming credits should only be done when these can withstand scrutiny, otherwise they may discredit the footprint as a whole.

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<sup>7</sup> (Formula source: Intergovernmental Panel on Climate Change (IPCC).

IPCC Report on Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003

[http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf\\_files/Chp3/Chp3\\_2\\_Forest\\_Land.pdf](http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Chp3_2_Forest_Land.pdf)  
(page 3.24) (August 2017)



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**TOE 2, Biomass Carbon In Paper And Board Products**

The CO<sub>2</sub> relating to the biomass carbon content of paper products together with starch should be included.

The amount should be calculated by the following method:

Determine the fibre content of paper: weight minus non biomass laminates, coating, fillers, binders. Then use 50% biomass carbon by weight (dry) and calculate the CO<sub>2</sub> by multiplying the C content by a factor of 44/12.

Example for one tonne of uncoated woodfree paper with the following composition: 70% fibre, 25% fillers and other additives, 5% moisture:

700 kg of fibres/t paper \* 0,5 \* (44/12) = 1283 kg CO<sub>2</sub>

**Rationale (see also toe 1)**

This method follows the IPCC default calculation<sup>8</sup>. This reflects the amount of biomass carbon in the product as long as it is in use (and is a simple way to deliver the message according to the “Framework for Carbon Footprints for Paper and Board Products”).

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<sup>8</sup> (Formula source: Intergovernmental Panel on Climate Change (IPCC).

IPCC Report on Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003

[http://www.ipcc-nggip.iges.or.jp/public/gpplulucf/gpplulucf\\_files/Chp3/Chp3\\_2\\_Forest\\_Land.pdf](http://www.ipcc-nggip.iges.or.jp/public/gpplulucf/gpplulucf_files/Chp3/Chp3_2_Forest_Land.pdf)

(page 3.24) (August 2017)

**TOE 3, Greenhouse gas emissions from forest product manufacturing facilities.**

This toe should include:

1. For industry sectors: all site (direct) emissions and market pulp inputs as reported in the industry sector database.
2. For an integrated pulp and paper mill, all site (direct) emissions
3. For non-integrated paper mills, site emissions, as well as the carbon footprint data of the pulp manufacturers weighted by the amount of pulp in the final product provided that the data reflect what is included within the manual boundaries. If there is insufficient data available from the pulp supplier, the background CO<sub>2</sub>-factors for market pulp from the guidelines database may be used.
4. For paper mills, CO<sub>2</sub> emissions from combustion to generate energy and from the production process, based on the physical reality of the consumption of fuels related to production. Calculations include all combined heat and power (CHP) plants associated with pulp and paper sites.
5. When a mill produces energy from combined heat power (CHP), only fuels and emissions to air allocated to paper production should be included in the carbon footprint. However, depending on the objective of the footprint, a different approach can be taken and should be justified.
6. Energy-related emissions from chips production at external sawmills are allocated according to the flow of material and should be allocated to toe 4.
7. Process waste treatment processes should not be included. Only process waste that is used on site e.g. incinerated with energy recovery is included, as it is not leaving the site and emissions should be included in the direct emissions from the production site.

The CO<sub>2</sub> content of wood should be calculated by multiplying the dry wood weight for pulp production with 1,833 kg CO<sub>2</sub>/kg dry wood, also in case background processes are used.

*CO<sub>2</sub> Factors for background processes*

There are no pulp data available in ELCD and those in ecoinvent are considered too old and not representative.

The European Pulp Industry Sector Association (EPIS) collected gate-to-gate data for several kraft pulps which are representative for 2015. The CO<sub>2</sub> factors for these pulps were calculated by multiplying the input flows with the corresponding background factors from the guidelines. The factors include economic allocation to pulp production only.

For other pulp grades the CO<sub>2</sub>-eq. factors calculated by KCL in 2007 for typical market pulp are used. It is recommended to initiate data collection for those grades.

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**Rationale**

Direct CO<sub>2</sub> emissions from the industry sector database, companies and production sites are of high quality; directly collected from production sites and checked within the industry sector.

An exception for the pulp factors for CO<sub>2</sub> removal calculated by KCL to the general principle for calculating the CO<sub>2</sub>-removals had to be made because the calculations did not include the amount of wood used for the pulp production.

Contrary to waste treated on site, data for external process waste treatment are not always available and need to be seen together with which emissions would be avoided by the treatment. This means that assumptions would need to be made. Further uncertainty is added by matching the Industry data to waste processes in existing background databases, possible differences between countries and the question of the quality of these data.

It is thus decided not to include the external treatment of process waste.  
Including treatment of process waste should be reconsidered when more reliable information becomes available in future.

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**TOE 4, Greenhouse gas emissions associated with producing fibre**

In the case of virgin fibre, toe 4 starts at the point of site preparation and includes thinning and wood harvesting to the point where the wood is loaded onto trucks ready to leave the forest.

In the case of recycled fibre, all emissions starting from the point of collection (household or business) and the weighted emissions of processing and/or sorting centres must be included. Transport calculations should be included in toe 7.

If there is no data available, database values are accepted provided that they include emissions from the relevant value chain.

Industry sectors should use the CO2 factors for background processes for forestry, chips and deinked pulp.

The CO2 content of wood should be calculated by multiplying the dry wood weight with 1,833 kg CO2/kg dry wood, also in case background processes are used.

*CO2 Factors for background processes*

Use CO2 factors for forestry and chips from ecoinvent, recalculated to tonnes dry wood assuming 45% dry mass and the following average density factors:

*Reference: Praktisk skogshandbok  
1994*

Wood type	Hard or Soft Wood	Tonne / m3 solid wet wood under bark	
		Min-Max	Average
<b>Pine</b>	Soft Wood	0,900 - 1,000	0,900
<b>Spruce</b>	Soft Wood	0,800 - 1,000	0,825
<b>Birch</b>	Hard Wood	0,825 - 0,950	0,875
<b>Aspen</b>	Hard Wood	0,650 - 0,800	0,675
<b>Beech</b>	Hard Wood	1,000 - 1,075	1,050
<b>Oak</b>	Hard Wood	0,975 - 1,050	1,025

For an average soft wood dataset a dry-fresh density of 400 kg/m3 should be used and for an average hard wood dataset a density factor of 525 kg/m3, for eucalyptus 525 kg /m3 should be used.

For purchased deinked pulp use the factors as calculated by KCL in 2007.

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**Rationale:**

Ecoinvent data is used for wood and wood chips as the ELCD wood data are for use in building and construction sector and are therefore not applicable for paper packaging.

Deinking is often an on-site process and would be included in the mill data.

Carbon factors were calculated by KCL for CITPA in 2007 and should be used in case deinked pulp is purchased as no other data source is available for such pulp.

### **TOE 5, Greenhouse gas emissions associated with producing raw materials/fuels**

This toe includes:

1. Carbon footprint data related to the production of non-wood raw materials that represent on mass basis criteria a value higher or equal to 1% of pulp and paper production respectively.
2. Carbon footprint data related to the production of fuels used in the process.
3. For practical reasons and the difficulty that companies are facing in obtaining suppliers' values, the use of the CO<sub>2</sub> factors for background processes is accepted provided that they reflect the CO<sub>2</sub> fossil emissions related to the manufacture of the different raw materials.

In principle, when a mill produces energy from combined heat power (CHP), only fuels and emissions to air allocated to paper production should be included in the carbon footprint. However, depending on the objective of the footprint, a different approach can be taken and should be justified.

#### *CO<sub>2</sub> Factors for background processes*

ELCD CO<sub>2</sub> factors should be used for fossil fuels, calcium carbonate, kaolin, sodium hydroxide, titanium dioxide, and sulphur. Ecoinvent CO<sub>2</sub> factors should be used for all other additives and chemicals, except Gabi CO<sub>2</sub> factors made in 2007 for sodium hydrogen carbonate and the proxy for coagulant.

Factors for specific type(s) of starch should be used, and if unknown a factor for a mix of 50% maize and 50% potato starch should be used as a default.

Use Ecoinvent CO<sub>2</sub> factors for wood chips fuel production. For heating value of wood chips, the effective calorific value (for DRY solids) of 19 MJ/kg should be used.

#### **Rationale**

ELCD data are available for fuels (except wood chips) but only for a few for additives and chemicals.

Ecoinvent contains data for wood chips and most additives and chemicals used in the process

The processes for which Gabi calculations are used are limited to 2 processes for which the inputs are relatively small.

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**TOE 6, Greenhouse gas emissions associated with purchased energy**

Under toe 6, companies should include the site's (pulp and paper site for the specific paper product) net balance of imports minus the exports of energy (electricity, heat, etc). If the net balance gives a negative value (net exporter), associated emissions should be reported as avoided emissions under toe 10.

The approach must be based on physical reality of the consumption of fossil fuels related to production.

Purchased power should always be calculated based on supplier's information. If this information is not available, national grid figures can be used. Purchased steam should be based on the respective primary fuel mix. If this information is not available, use the CO<sub>2</sub> factor for heat produced from natural gas. Sold energy should always be based on the real fuel mix used.

For industry sectors, the CO<sub>2</sub> factors for electricity production should be taken from country specific production mixes, based on bought electricity.

Net energy inputs from the Industry Databases should be used for the calculations (bought minus sold electricity, bought minus sold steam/thermal energy).

In case this is a negative (the amount of sold electricity and/or steam/thermal energy is higher than the purchased amount), this should be reported under toe 10 as avoided emissions.

For bought heat the factor for heat produced from natural gas should be used.

*CO<sub>2</sub> Factors for background processes*

For electricity country specific production should be used, based on bought electricity. The ELCD CO<sub>2</sub> factors should be used.

For bought and sold steam/thermal energy use the CO<sub>2</sub> factor for heat produced from natural gas.

Note: also in this case, a company may use specific information from the supplier if this is available.

**Rationale**

ELCD contains data for electricity grids for European countries.

Natural gas is the most used fuel for energy production.

**TOE 7, Transport-related greenhouse gas emissions**

Referring to CEPI's carbon footprint framework, page 33, the following items are included in toe 7:

1. Harvested wood to the mill or chipping facility
2. Chips to the mill
3. Purchased pulp and other major raw materials (on a weight or volume basis) to the mill
4. Transport of recycled fibre to the mill
5. Primary product (e.g. rolls of paper or paperboard) from the mill to facilities that produce final products
6. Transport of waste generated by the mill to treatment facilities
7. Final products transport to distribution centres, retailers and final consumers
8. Transport of used products to waste-to-energy facilities, landfill sites or processing centres where waste is sorted to produce recycled fibre

Cradle-to-gate carbon footprints should include items 1-5. Item 6 does not have to be included as process waste treatment is excluded from the calculation.

Cradle-to-grave footprints should include also include items 7 and 8. However this will probably have to be based on assumptions as it is outside the control of the paper and paper packaging industry.

For transport, companies should use their own available data, otherwise the CO<sub>2</sub> factors for background data should be used.

*CO<sub>2</sub> Factors for background processes*

CO<sub>2</sub> factors from ELCD should be used.

**Rationale**

ELCD contains all transport processes.



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**TOE 8, Emissions associated with product uses**

The use phase is not included in the footprint as it is outside the control of the paper packaging industry.

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**TOE 9, Emissions associated with product end-of-life**

The cradle-to-grave footprint includes emissions associated with product end-of-life treatment.

A statement should be included that landfill should be avoided whenever possible. The preferred end of life treatment is material recovery and if it is not an option, then energy recovery.

The following average default percentages for material and energy recovery and landfill should be used both by industry sectors and companies if no more accurate information is available.

Product	Material recovery <sup>9</sup>	Energy recovery <sup>10</sup>	Landfill <sup>11</sup>
Case Materials	0,85	0,08	0,07
Carton Board and Other Packaging	0,91	0,05	0,04

Country specific incineration and landfill percentages can be found in a spreadsheet prepared in the context of the Product Environmental Footprint project by JRC in 2015, based a.o. on Eurostat statistics.

Eventual avoided emissions from these processes, e.g. because energy is recovered from incineration, should be reported under toe 10. Note that may not always be possible when a dataset, e.g. for waste treatment incineration with energy recovery, includes credits for sold energy

*CO2 Factors for background processes*

CO2 factors from ELCD should be used. The partly terminated ELCD process for incineration does not include credits the sold energy. The credits, calculated as the difference between the full LCI ELCD dataset and the partly terminated one, may be reported under toe 10. Biogenic CO2-emissions from the proportion of the paper products that are incinerated should not use the biogenic CO2 factors from the ELCD incineration process, but be calculated from the CO2 content of the paper product reported in toe 2.

Note: The dataset process for landfill does not separate out fossil and biotic CO2 emissions, although the emissions are probably mainly from biogenic source. The breakdown of the paper in the landfill generates methane. If this is flared, the final emission is biogenic CO2. According to the process

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<sup>9</sup> Source Cepi June 2017

<sup>10</sup> Source JRC/Eurostat 54% incineration

<sup>11</sup> Source JRC/Eurostat 46% landfill

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description, 22% of the methane is flared, 29% is used, and 50% is emissions. Similar Ecoinvent datasets report about 1% fossil CO<sub>2</sub>-eq, therefore the fossil CO<sub>2</sub> in the ELCD dataset has been changed to biogenic CO<sub>2</sub>.

The dataset includes a credit for the energy generated from the landfill gas that is captured, so the dataset covers Toe 9 and 10 combined. As it is an aggregated dataset it is not possible to break it down to the same detail as other datasets.

**Rationale**

Product end-of-life treatment is outside the control of the paper industry.

ELCD contains the data for incineration and landfill of paper.

However, as these are average data, the CO<sub>2</sub> content needs to be corrected by matching it to the CO<sub>2</sub> content of the specific paper product.

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**TOE 10, Avoided emissions**

The carbon footprint does not include offsets.

Avoided emissions can include credits for sold surplus energy from the mills. The surplus energy should match e.g. the same grid electricity mix in case electricity and/or the fuel mix used for the production at the mill.

Double counting should be avoided.

**Rationale**

**Considerations for calculation**

- Although there are a large number of avoided emissions of potential interest to the paper and board products industry, several are mentioned here because they represent especially important connections between the paper and board products value chain and the global carbon cycle. The specific calculations, and whether the information is used in a balance sheet, need to be determined on a case-by-case basis. The attribution of avoided emissions to specific products is an additional problem that will need to be addressed if these are used in a footprint.
- When a mill exports electricity to the grid, it may displace electricity from the grid that would have been produced by more greenhouse gas-intensive methods. Thus, these emissions are avoided by the mill's activities. In producing this electricity, the mill's emissions may have increased even though, by displacing electricity on the grid, the mill may have caused lower emissions overall. Allowing avoided emissions to be netted against the mill's emissions may be the only way for the company to get "carbon footprint credit" for its generation of "cleaner" electricity. Calculation methods are generally related to those for estimating emissions associated with purchases of electricity. Avoided emissions for a mill exports of electricity to the grid should not be accounted for if 1) allocation has been applied and emissions from generating the exported electricity are not included in the footprint, 2) the mill considered emissions from the net purchases of electricity in its footprint.
- Several national authorities have developed information to assist in calculating the greenhouse gas emissions avoided by recycling paper. The avoided emissions are extremely dependent on local conditions and are especially significant in situations where the paper would have been incinerated with energy recovery and/or landfilled if it was not recycled. There is no harmonized method for calculating these avoided emissions. In case of "open-loop recycling", the calculation requires allocation between primary fibres/paper and recycled fibres/paper. The guidelines and standards use different formulas for the allocation.

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Applying different recycling allocation formulas generally requires detailed information for instance: the carbon footprint of the virgin and recycled fibre production process, the recovery rate on the output side and the utilization rate on the input side. Such information will normally be based on national/regional statistics and assumptions.

- One of the most important contributions of the paper and board products industry, but one of the most difficult to quantify, is the role of the industry in providing economic incentives for keeping land in forest. Conversion of forest to other uses almost always results in large losses of carbon. Avoided emissions are sometimes estimated for avoided deforestation in the tropics, but seldom for land in the developed world, even though it is threatened by development, agriculture and other uses. Methods that have been used to examine avoided deforestation in the tropics may be useful in situations where companies want to examine the importance of the company's demand for wood on keeping land in forest, although these methods can be very complex. A simple approach may be to calculate the amount of carbon that must be maintained in sustainably managed forests to produce the functional unit of product on a sustainable basis.
- In some cases, it is possible to address avoided emissions via expanding system boundaries. ISO14044 may be relevant here. The methodology used here depends on the purpose; if used for external declarations, it is proposed to not in the first place include system expansions. If used for decision making, system expansion is recommended.

**Sources of data and emission factors**

Protocols developed for project-level carbon accounting may be useful in calculating avoided emissions.

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**4. Issues to be dealt with by each Industry Sector**

Each Association has (and maintains) its own industry dataset.

Some characteristics are different for each sector and have to be addressed in addition to the overall guidelines, by the individual industry sector:

- Determining the country specific electricity mix
- As not all transport steps are covered by the Industry Databases, assumptions will have to be made for a “typical” transport distance and mode. It is left to the sector to make expert assumptions, although this may be a difficult task.

## 5. Glossary

The following material is taken from Annex III of the report of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel in Climate Change, unless otherwise specified.

### Biomass

Material of biological origin excluding material embedded in geological formations and material transformed to fossilized material, and excluding peat (ISO/TS 14067:2013).

### Carbon dioxide (CO<sub>2</sub>)

A naturally occurring gas, also a by-product of burning fossil fuels from fossil carbon deposits, such as oil, gas and coal, of burning biomass and of land use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured and therefore has a Global Warming Potential of 1.

### Carbon removal

ISO/TS 14067:2013 defines greenhouse gas removal [or carbon removal] as "mass of a greenhouse gas [or carbon] removed from the atmosphere".

This framework uses the term "**carbon removal**" to mean the action of removing the carbon from the atmosphere, for instance by tree growing. Alternative terminologies for "removal", for instance by IPCC, includes "carbon uptake" or "carbon sequestration".

### Carbon storage

ISO/TS 14067:2013 defines "carbon storage" as "carbon removed from the atmosphere and stored as carbon in a product".

This framework, "**carbon storage**" is used to mean carbon that was previously removed from the atmosphere and is now maintained out of the atmosphere.

CO<sub>2</sub>-equivalent: See Equivalent carbon dioxide emission.

Deforestation: Conversion of forest to non-forest (Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (Annex III)).

### Direct land use change (dLUC)

Change in human use or management of land within the product system being assessed (ISO/TS 14067:2013).

### Dry-fresh density

The dry-fresh density of wood is the absolute dry mass of wood per the corresponding fresh volume.

### Equivalent carbon dioxide (CO<sub>2</sub>-eq) emission

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The concentration of carbon dioxide that would cause the same radiative forcing as a given mixture of carbon dioxide and other forcing components. Its value may consider only greenhouse gases, or a combination of greenhouse gases and aerosols. Equivalent carbon dioxide concentration is a metric for comparing radiative forcing of a mix of different greenhouse gases at a particular time but does not imply equivalence of the corresponding climate change responses nor future forcing. There is generally no connection between equivalent carbon dioxide emissions and resulting equivalent carbon dioxide concentration

Functional unit: Quantified performance of a product system for use as a unit of analysis (modified from ISO/TS 14067:2013).

Global Warming Potential (GWP): An index, based upon radiative properties of well-mixed greenhouse gases, measuring the radiative forcing of a unit mass of a given well-mixed greenhouse gas in the present-day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide. The GWP represents the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in absorbing outgoing thermal infrared radiation. The Kyoto Protocol is based on GWPs from pulse emissions over a 100-year time frame.

Greenhouse effect: The infrared radiative effect of all infrared-absorbing constituents in the atmosphere. Greenhouse gases, clouds, and (to a small extent) aerosols absorb terrestrial radiation emitted by the Earth's surface and elsewhere in the atmosphere. These substances emit infrared radiation in all directions, but, everything else being equal, the net amount emitted to space is normally less than would have been emitted in the absence of these absorbers because of the decline of temperature with altitude in the troposphere and the consequent weakening of emission. An increase in the concentration of greenhouse gases increases the magnitude of this effect; the difference is sometimes called the enhanced greenhouse effect. The change in a greenhouse gas concentration because of anthropogenic emissions contributes to an instantaneous radiative forcing. Surface temperature and troposphere warm in response to this forcing, gradually restoring the radiative balance at the top of the atmosphere.

Greenhouse gas (GHG): Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>) and ozone (O<sub>3</sub>) are the primary greenhouse gases in the Earth's atmosphere.

Indirect land use change (iLUC): Change in the use or management of land which is a consequence of direct land use change, but which occurs outside the product system being assessed (ISO/TS 14067:2013). It is not included in the calculations for the guidelines

Intermediate/Final products: Intermediate products are goods that are used as inputs in the production of other goods and services. Final products are goods and services that are ultimately consumed by the end user rather than used in the production of another good or service. (WRI/WBCSD GHG Protocol Product Standard).



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Reforestation: Planting of forests on lands that have previously contained forests but that have been converted to some other use.

Sink: Any process, activity or mechanism that removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas or aerosol from the atmosphere.