Pro Carton Information

Cartons and Carbon Footprint

Cartonboard packaging's approach to fossil and biogenic carbon

PRO CARTON

Association of European Cartonboard and Carton Manufacturers

Cartons and Carbon Footprint

Cartonboard packaging's approach to fossil and biogenic carbon

Contents

Introduction and Summary

Stéphane Thiollier, President of Pro Carton

The cartonboard and carton industry has a great environmental story to tell. Cartons are made from a naturally renewable resource, compostable and easily recyclable, with low and decreasing production emissions. This brochure describes the carbon footprint part of the cartonboard and carton industry's environmental story:

- The European industry's environmental performance is continuously improving, so that the average carbon footprint for cartons is 964 kg/tonne fossil CO_2 equivalent: down 7% in the last three years
- Cartonboard is sourced from sustainably managed forests, where more trees are planted than are harvested. In Europe, forests are expanding by 510 000 ha per year
- Growing trees absorb CO_2. Wood fibres from sustainably managed forests which are made into cartonboard, store carbon in the product and keep the carbon locked up during the recycling process – better for the environment than packaging made from fossil-based materials
- Biogenic carbon sequestration in the forest plays an important role in climate mitigation. A new report suggests that demand for cartons improves carbon sequestration. Recycling cartons stores carbon and helps to prevent emissions

We believe cartons are the best choice for the environment and I am pleased to introduce this brochure which highlights the carbon benefits of choosing cartonboard packaging.

Per Lundeen, President of ECMA (European Carton Makers Association)

Despite the obvious carbon benefits of the carton's raw material, there is currently no agreed way to include forest carbon in the carbon footprint of forest-derived products. In order to advance the debate, ECMA with the help of Pro Carton, commissioned IVL Swedish Environmental Research Institute to produce a report: "Carbon Footprint of Cartons in Europe" which is summarised in this brochure.

The report focuses on carbon sequestration in the forest and suggests a link between carton consumption and net carbon sequestration in sustainably managed forests. IVL suggests that due to demand for cartons from the market, 730 kg of biogenic carbon per average tonne of cartons in Europe, is removed from the atmosphere: -730 kg biogenic CO_2/tonne cartons.

The IVL study complements the Pro Carton report which measured the amount of carbon dioxide equivalents emitted from fossil fuels used by the industry (cradle-to-gate): a figure of 964 kg/tonne fossil CO_2 equivalents emissions from an average tonne of cartonboard produced and converted.

In addition, the study presents a methodology for an EU27 scenario based assessment of end of life treatment and avoided emissions. Accordingly, an average cradle-to-grave Carbon Footprint of converted cartons sold in Europe has been calculated by IVL. The greenhouse gas emissions are 1127 kg CO_2 equivalent/tonne cartons.

The approach taken by IVL to include forest net growth as part of the carton's carbon footprint is open to debate. However, we feel that it is valid to examine and publicise this life cycle approach in order to advance the thinking in this area. And this is consistent with the cartonboard and carton industry's continuing interest in exploring systems to help improve its environmental performance.

Improving Environmental Performance


Pro Carton's Life Cycle Inventory

Every product which is manufactured and used has an effect on the environment. The extent of its effect can be measured by analysing the product's life cycle in terms of:

- the amount of resources used to manufacture the product
- the residual materials generated during processing
- the way in which it is used
- the waste left at the end of the product's life

Pro Carton, on behalf of the cartonboard and carton industries, has collected environmental data on cartonboard packaging produced in Europe, and compiled a Life Cycle Inventory (LCI) of European industry average figures. These do not include the use and waste phases.

By gathering this data on a regular basis, Pro Carton can measure the effect that cartonboard packaging has on the environment over time. And the results show that there is continuous improvement in the European industry's production processes, and that the industry's effect on the environment is reducing.

Pro Carton's data shows that the cartonboard packaging industry's environmental performance is improving

It continues to be among the best in environmental performance of all packaging materials.

In 2005, environmental data was collected for the first time. It included primary and recycled fibres and printed cartons, and represented 56% of the European production capacity of paperboard. In 2008, the same environmental data was collected again and this time it represented 64%. Following recommendations from IFEU (Institute for Energy and Environmental Research), the updated dataset had greater coverage of cartonboard production and more information from converting processes. But meaningful comparisons are possible, as cartonboard mills which returned data both times, cover about 75% of the production.

When comparing the two LCI datasets, improvements are found in all environmental impact categories. Many of the improvements achieved are due to less chemicals and less fossil fuels being used and greater use of biomass to generate energy. The decrease in use of fossil resources has led to a decrease in carbon dioxide, sulphur dioxide and nitrogen oxide emissions from the industry's production processes.

It should also be noted that when data was collected in 2008, the industry was hampered by the unfavourable economic climate and that greater improvements in environmental performance were held back by the necessity to shut down and start up mills over the course of the year.

Table of improvement

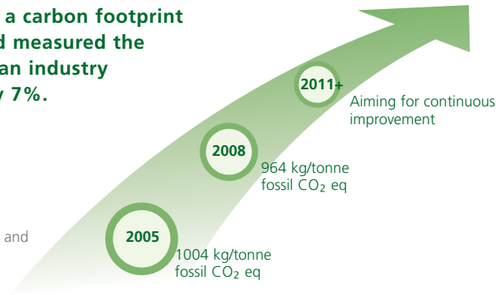
The relative changes in the major environmental impact categories were:	
Consumption of non-renewable resources (Abiotic depeletion)	-10%
Emissions that can cause acid rain (Acidification)	-6%
Emissions to water that can lead to loss of oxygen (Eutrophication)	-8%
Emissions that can harm the ozone layer (Ozone layer depletion)	-9%
Emissions that can cause smog (Photochemical oxidation)	-12%
Carbon Footprint reduction	-7%

Pro Carton's Carbon Footprint for Cartons is 964 kg/tonne fossil CO_2 equivalents emissions from cartonboard produced and converted[1].

Carbon Footprints and how to measure them remain a key topic in the Sustainability debate, as there is currently no standard approach to measuring a Carbon Footprint. The paper industry in Europe under the leadership of CEPI (Confederation of European Paper Industries) has established a framework for measuring carbon dioxide equivalents emitted from fossil fuels in the production of paper based products[2]. This approach has been adopted by all sectors of the paper industry, including cartonboard packaging.

Pro Carton's Carbon Footprint calculation therefore follows CEPI's framework and derives its data from its Life Cycle Inventory of European industry average figures, (which includes primary and recycled fibres and printed cartons). The boundaries are cradle-to-gate, which means that the calculations start at the forest (cradle) and end at the exit door of the carton converter (gate). Thus the carbon emissions of the goods manufacturer and retailer, or the final disposal of the carton at the end of its life, are excluded.

Using the LCI data, Pro Carton calculated a carbon footprint for cartons in 2005 and again in 2008 and measured the improvement. It showed that the European industry average carbon footprint was reduced by 7%.



Average Greenhouse Gas balances for cartonboard and cartons produced and converted (cradle-to-gate)

[1] Calculations for this Carbon Footprint figure have been reviewed by an independent third party: NCASI (The National Council for Air and Stream Improvement), USA.
[2] For detailed information, visit the Sustainability section of the Pro Carton website www.procarton.com and click on Carbon Footprint Methodology.

Sustainable Forest Management





Sustainable Forest Management

Sustainable forestry is, in the words of the European Agreement signed in Helsinki in 1993, "the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their bio-diversity, productivity and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystems".

European forests used by the paper and board industry are sustainable. Not only are they a renewable resource, but every year new growth exceeds the wood harvested by an area equivalent to 1.5 million football pitches

Forests offer a natural habitat to vast numbers and different species of plants and animals. The use of forest land has a low impact on the environment: after 10 – 15 years, there is little difference between managed and natural forests in terms of low ground cover. Also, management of the forest for timber production and leisure activities provides economic benefit to the owners and local communities.

Practising sustainable forest management, involves following a combination of national and European regulations and also international agreements such as the Convention on Biodiversity. Forest owners and operators also take voluntary actions which can exceed legal requirements. They can prove that their forests are sustainably managed through Forest Certification schemes.

Forest Certification

A number of assessment or "forest certification" schemes are in current use, with two leading schemes: the PEFC (Programme for the Endorsement of Forest Certification Systems) scheme (**www.pefc.org**) and the FSC (Forest Stewardship Council) scheme (**www.fsc.org**).

Whilst there is overlap in the types of forest certified by these two schemes, the FSC scheme is more generally applied to large forest areas typical of state and forest industry ownership, while the PEFC is generally used for the certification of smaller private and family owned forests.

In 2009, 86% of the forest areas in Europe leased or owned by companies in the paper and board industry, were forest management certified by independent forest certification schemes. 55% of the round wood, chips and sawdust delivered to mills in Europe were from forest management certified sources.

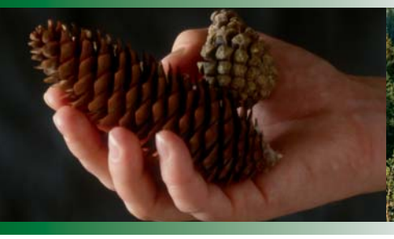
Chain of custody

In order to demonstrate that the wood used in their product originates from a certified forest, manufacturers and retailers of goods produced from the forest need a "chain of custody" certificate. This tracks the origin of the raw material at each stage of the production process. Chain of custody certification is third party verified and only when the whole supply chain has been certified, can the final products be sold with a label and a corresponding claim on accompanying documentation.

For forest products such as cartons, certifying the chain of custody means verifying that the wood used in the production process came from a forest certified as being sustainably managed.

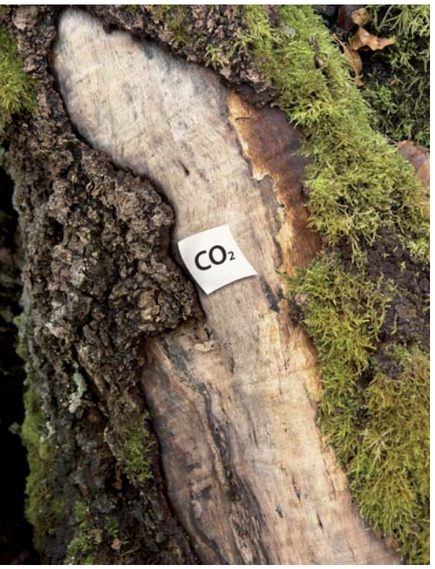
For goods manufacturers and retailers, there is value in being able to label that the cartonboard packaging comes from a sustainably managed forest, as consumers are made aware of the environmental benefits of cartons when they make their shopping choices.

Carbon in Forests




Uptake and Storage

Trees grow by absorbing carbon dioxide and releasing oxygen, through photosynthesis. By removing carbon from the atmosphere, which is known as "fixing" carbon, they help to reverse the "greenhouse effect". This filtering process also delivers a renewable, bio-based raw material which is used for paper and board products.



In order to maximise the amount of carbon removed from the atmosphere, forest management and sustainable forest practices are essential.

Pro Carton has calculated that 1474 kg of carbon dioxide is stored in one tonne of cartonboard. How is this possible?

It does seem strange that the wood fibre used to produce one tonne of cartonboard can store over one tonne of CO_2. But this is due to the chemistry of photosynthesis.

Cartonboard is essentially made from wood and cellulose. (It also contains some fillers) Cellulose is made through photosynthesis by the conversion of carbon dioxide and H_2O into simple sugars and oxygen. The sugars are polymerised to make cellulose and oxygen is released.

So one tonne of cartonboard manufactured from wood fibre contains cellulose which has stored 1474 kg of carbon dioxide which has been converted into carbon (402 kg of carbon).

Photosynthesis:

$$6[CO_2 + H_2O] \rightarrow \underbrace{C_6H_{12}O_6}_{\text{biomass}} + 6O_2$$

$1m^3$ growth

On average, a typical tree absorbs one tonne of CO_2 for every cubic metre's growth and emits 727 kg of oxygen

One tonne of cartonboard stores 1474 kg of CO_2

Fossil emissions to produce one tonne of converted cartonboard are 964 kg of CO_2e

ECCM (Edinburgh Centre for Carbon Management)

Biogenic Carbon in Cartons



Biogenic Carbon in Cartons

As the debate continues about how to measure a Carbon Footprint, the forest products industries, including the cartonboard industry, have a unique attribute to bring to the Carbon Footprinting discussion.

The raw material for cartonboard is wood fibre, which is derived from sustainably managed forests whose trees absorb and store carbon – this process is measured in terms of biogenic carbon. The scientific institute IVL, Swedish Environmental Research Institute has developed a methodology for measuring biogenic carbon in cartons by relating the carbon benefits of the natural raw material to cartonboard packaging.[1]

The study by IVL shows the positive contribution that using cartons can make in the debate about climate change and the environment

It illustrates the link between sustainably managed forests and cartons as follows: consumer demand for cartons stimulates demand for timber (wood fibre to make cartonboard) which in turn encourages the sustainable management of forests. Therefore choosing cartons encourages the capturing of CO_2 to make a renewable material.

Forests that are actively managed, in general, sequester carbon at much higher rates than non-managed forests. The study looked at forests that are the main suppliers of wood fibre for cartonboard. These forests are in Sweden, Finland, France, Germany and Poland. It concluded that the carbon sequestration in their ecosystems can be regarded as sustainable.

[1] Details of the methodology are explained in the following Chapter and Annex and a copy of the IVL, Swedish Environmental Research Institute's Report "Carbon Footprint of Cartons in Europe – Carbon Footprint methodology and biogenic carbon sequestration" can be found at www.procarton.com and www.ecma.org

Carbon Footprint for Cartons in Europe

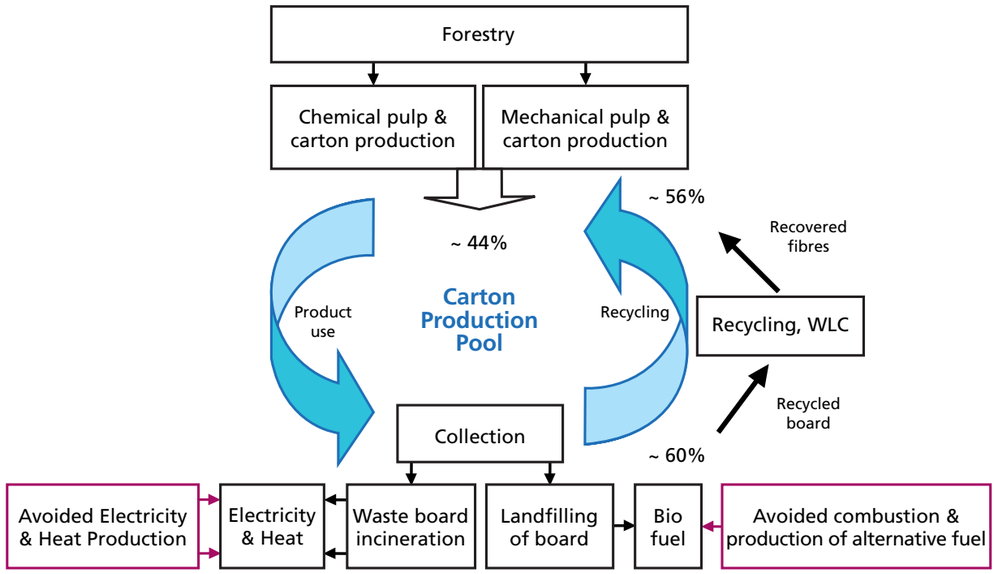


Carbon Footprint for Cartons in Europe

A carbon footprint is a tool to measure and communicate the climate change performance of an activity or product. IVL Swedish Environmental Research Institute has developed a new methodology for carbon footprinting cartons. It includes biogenic sequestration, shows the positive link between carbon sequestration and carton consumption and encompasses end-of-life and avoided emissions[1]. The carbon footprint proposed by IVL, is a measure of the total Greenhouse Gas Emissions of one average tonne of cartons put on the market in the European Union.

This diagram shows, in a simplified way, the carton's life cycle, cradle-to-grave: from the forest, through manufacture to product use and collection and recycling, and then to end of life.

Carton Product Life Cycle



Note: Originating from wood fibres from the forest, the carton production pool is made up of about 44% of virgin cartonboard and 56% of recycled cartonboard.
From an average 60% utilisation of recycled cartonboard, 4% of fibre is lost in the recycling process.

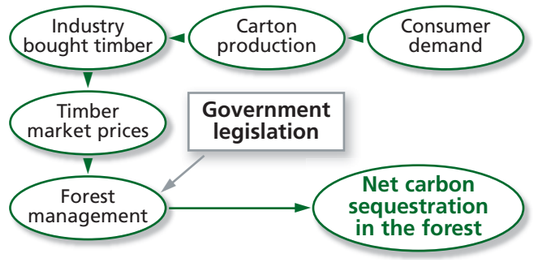
[1] "Carbon Footprint of Cartons in Europe – Carbon Footprint methodology and biogenic carbon sequestration" by Elin Eriksson, Per-Erik Karlsson, Lisa Hallberg, IVL Swedish Environmental Research Institute 2009.

Key Conclusions

Demand for cartons improves carbon sequestration

IVL studied carbon dioxide sequestration and emissions in the production of cartons and the pool of cartons that are made and in use. It focused first of all, on the managed forest, the growing, renewable raw material resource for cartonboard. IVL argues that there is a beneficial link between forest carbon sequestration and consumer demand for cartons.

The link between consumer demand and forest sequestration



IVL suggests that the net biogenic sequestration in the forest (i.e. removals from the atmosphere) is 730 kg of biogenic carbon per tonne cartons: -730 kg biogenic CO_2/tonne cartons

Trees as they grow absorb CO_2 that becomes stored in fibre-based products such as cartons. Pro Carton's information on the carbon stored in cartonboard products follows the CEPI Framework Element 2[1].

Carbon stored in a tonne of cartonboard packaging is 1474 kg.

[1] Visit www.procarton.com, Sustainability / Environment for description of the CEPI (Confederation of European Paper Industries) Framework guidelines and downloadable pdf

Summary of the IVL Report





Choosing cartons promotes the use of renewable energy

Over 50% (55.5% in 2008) of all primary energy used in the manufacture of European pulp, paper and board is biomass based, with the wood by-products providing renewable energy in the form of electricity and steam for the manufacturing process.

The industry is the largest producer and consumer of biomass based energy – 25% of the EU total – thus avoiding the use of non-renewable energy sources such as fossil-based oil, coal or gas. This also means the industry is more carbon efficient. Fossil CO_2 emissions per tonne have been reduced by 42% compared to 1990.

At the end of their life, cartons can easily be used for energy recovery. Electricity and heat produced from the incineration of cartons can be assumed to replace fossil-based energy sources. IVL suggests that on average, 0.7 MWh of electricity is produced per tonne of carton product at incineration and 1.2 MWh of heat is produced per tonne of carton product. Thus 105 kg CO_2 equivalents/tonne of carton product placed on the market is avoided.

Recycling cartons stores carbon and helps to avoid emissions

When paper is recycled, the carbon stored in the paper product is prevented from going back to the atmosphere, keeping the wood fibres that originated from sustainable forestry in the value chain. Thus, carbon storage in paper products is substantially prolonged by recycling. Fibres can be recycled 5 to 7 times and recycling cartons diverts cartons from landfill, thus reducing the methane released from landfills.

If adequate systems do not exist for recovery and recycling or incineration with energy recovery, EU statistics show that at the end of their life cycle, around 24% of cartons currently go to landfill. IVL suggests that methane emissions from landfilled cartons are 308 kg CO_2 equivalents/tonne of carton product placed on the market. However, set against this is the possibility of landfill gas substituting the use of fossil gas if the correct infrastructure is in place. IVL has calculated that 40 kg CO_2 equivalents/tonne of cartons placed on the market are avoided by capturing and using landfill gas as an energy carrier.

The key conclusions of the IVL Report clearly show the excellent environmental credentials of cartonboard packaging.

IVL's study develops a methodology for assessment of the Carbon Footprint of cartons

The Report is based on the CEPI Carbon Footprint Framework[1]. It focuses on carbon sequestration in the forest and suggests a link between carton consumption and net carbon sequestration in sustainably managed forests. IVL suggests that due to demand for cartons from the market, 730 kg of biogenic carbon per average tonne of cartons in Europe, is removed from the atmosphere: -730 kg biogenic CO_2/tonne cartons. IVL's work complements the Pro Carton report which measured the amount of carbon dioxide equivalents emitted from fossil fuels used by the industry (cradle-to-gate): a figure of 964 kg/tonne fossil CO_2 equivalents emissions from an average tonne of cartonboard produced and converted in 2008. In addition to estimating the carbon sequestration in forests associated with carton production in Europe, the study also presents a methodology for an EU27 scenario based assessment of end of life treatment and avoided emissions.

Accordingly, an average cradle-to-grave Carbon Footprint of converted cartons sold in Europe has been calculated by IVL. It represents the total Greenhouse Gas Emissions from one average tonne of cartons produced, converted and printed in Europe, taking into account the current virgin and recycled fibre utilisation mix. The Greenhouse Gas Emissions are 1127 kg fossil CO_2e/tonne cartons.

In a cradle-to-gate approach, the emissions of 964 kg/tonne fossil CO_2e per tonne of cartons is significantly compensated by the figure of -730 kg biogenic CO_2 sequestration

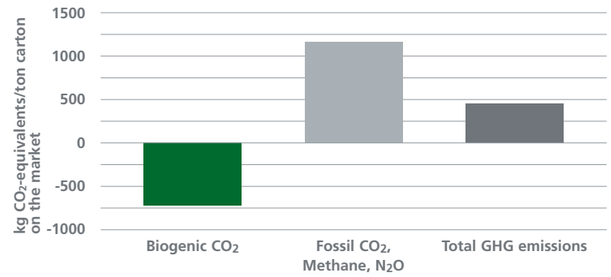
Summary Chart

The Carbon Footprint proposed by IVL presents the net flows as CO_2e. (The delay in emissions according to PAS 2050 at use and in landfills are not included)

Description of carbon footprint of 1 tonne of converted Carton. Given as GWP 100	GHG emission (kg CO_2/tonne Carton)	Biogenic CO_2 (kg CO_2/tonne Carton)
Biogenic CO_2 net sequestration in managed forests		-730
GHG emissions from production and transport of converted cartons	964	
Summary Cradle to Gate	**964**	**-730**
Emissions associated with end of life	308	
Avoided emissions at end of life	-145	
Summary Cradle to Grave including avoided emissions	**1127**	**-730**

Source: IVL Report

The results proposed by IVL for the cradle-to-grave approach can be illustrated:



[1] Visit www.procarton.com, Sustainability/Environment section (Carbon Footprint Methodology) for description of the CEPI (Confederation of European Paper Industries) Framework and downloadable pdf

Annex

Contributing to the debate on biogenic carbon footprints

Despite the obvious carbon benefits of the carton's raw material, there is currently no agreed way to include forest carbon in the carbon footprint of forest-derived products. The Swedish Environmental Research Institute Report[1] contributes to the debate by proposing a methodology to include forest carbon in the carbon footprints of cartons. It sets out a possible approach which is of interest to the carton industry, as it describes a system to improve environmental performance, focusing on the carbon benefits of cartons' raw material. The Report looks in detail at the part of the Greenhouse Gas balance dealing with biogenic carbon flows: carbon dioxide sequestration in the forests, the balance of dead biomass material, flows to and from the ground and biogenic flows during production of forest products. It considers the flows in the product pool in society and after use in recycling and in waste treatment; also considering electricity and heat produced in waste incineration.

Key Points concerning the Scope of the IVL Report

- The Report aims to reflect conditions in the European market, since most of the cartons converted in Europe are sold in Europe. As the import to Europe of timber used for carton production was small during the studied time period, and since there was a lack of data, IVL has elected not to include imported timber in the study and to assume a net sequestration of zero from this timber.
- Attributional LCA methodology is used in this study. This has a bearing on the electricity production mix assumed, which is average national or European. Average data have also been used for avoided emissions at energy recovery.

Summary of Major Assumptions underpinning the IVL Report

(For a full explanation, see Chapter 6 of the Report)

Carbon sequestration associated with the purchased timber is not also claimed by another stakeholder (double counting)
It is important that the benefits of sequestration of a molecule of CO_2 is claimed only by the carton industry, when calculating its Carbon Footprint. At the time of writing of the Report, IVL found no evidence that land or forest owners supplying timber for the cartonboard industry, are claiming credit for carbon sequestration in their forests.

There is one single, homogeneous timber market within the geographical area
IVL identified the main countries supplying timber for European cartonboard production as Finland, Germany, Poland, France and Sweden. IVL used nation-wide data for carbon sequestration as reported to the Climate Convention by these countries. UNECE forest statistics were used to identify national forest fellings. Within the scope of the study it was not possible to identify more precisely where the timber for cartonboard is sourced.

Forestry practices in the countries producing timber for cartonboard, should be sustainable for the next 20 years, and the difference between forest growth and harvest rates remain sustainable.
IVL assessed the main countries producing timber for European cartonboard production. It concluded that when judging the differences between annual increment growth and annual fellings, as well as the annual carbon sequestration to the forest ecosystems, in these countries, the carbon sequestration to forest eco-systems can be regarded as sustainable. Sequestration data should be updated on a regular basis, e.g. every 5 years, to maintain this status.

Frequently Asked Questions arising from the IVL Approach

Should cartons be given credit for the carbon stock increases on European forest land?
The crucial issue is whether or not the market for wood provides an incentive for increasing carbon stocks in the forest. The central point is to establish the links between: consumer demand for forest based products – market demand for wood – forest management operations – forest carbon storage change. IVL argues that a share of the increased forest carbon stocks can be attributed to forest products.

Aren't the stock increases occurring on reserve land rather than land used for wood production?
IVL argues that it is reasonable that the forest carbon stock change in volontary and even formal reserves are included in the carbon footprint calculations. Forestry in Sweden and Finland can, from several aspects, be regarded as a single entity, including production forests, forestry reserves and formal reserves. For example, an official aim of the Swedish Government is that forests should fulfil multiple purposes, including wood supply for the industry, biodiversity and recreation. Hence, there is a connection between the production capacity and forest management of the production forests and the area and management of forests that can be set aside as volontary reserves.

IVL's Conclusions and Recommendations

- Forest management is a prerequisite for high net removals of CO_2 from the atmosphere.
- Net removals of CO_2 which can be associated with the roundwood supply for cartonboard production, are significant

IVL recommends that companies:
- Continue to reduce the use of fossil fuels in processes and at transport and purchase low carbon electricity from their electricity suppliers
- Consider using the Environmental Product Declaration for Cartons (PCR for CPC32153)
- Support systems where landfill of packaging with energy content is avoided
- Support systems where after recycling, energy from waste incineration is utilised

This Report aims to advance the debate about including forest carbon in the carbon footprints of forest products such as cartons. To continue this approach, further studies need to be undertaken to determine:
- The net removals of CO_2 over longer time periods, covering several decades
- More data about the National Inventory Reports submitted by countries to the Climate Convention

Peer Review

A critical review of the Report was undertaken by NCASI (National Council for Air and Stream Improvement) and the Critical Review Statement is included in IVL's Report.

[1] The IVL Swedish Environmental Research Institute report "Carbon Footprint of Cartons in Europe – Carbon Footprint methodology and biogenic carbon sequestration" by Elin Eriksson, Per-Erik Karlsson, Lisa Hallberg & Kristian Jelse can be downloaded as a pdf from: www.procarton.com Sustainability / Environment / Carbon Footprint

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"Carbon Footprint of Cartons in Europe – Carbon Footprint methodology and biogenic carbon sequestration" by Elin Eriksson, Per-Erik Karlsson, Lisa Hallberg, IVL Swedish Environmental Research Institute 2009.

Pro Carton is the Association of Cartonboard and Carton Manufacturers. Its main purpose is to promote the use of cartons and cartonboard to brand owners and retailers as well as designers, the media and regulatory decision-makers as an economically and ecologically balanced packaging medium which plays an important role in society

For further information, please contact:

Jennifer Buhaenko
Head of Public Affairs, Pro Carton
buhaenko@procarton.com

Jan Cardon
Executive Director, ECMA
jan.cardon@ecmabel.be

IVL Swedish Environmental Research Institute
Elin Eriksson
Head of Department: Sustainable Organisations, Products and Processes
IVL Swedish Environmental Research Institute
elin.eriksson@ivl.se

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