

This brochure examines the carbon footprint of a typical Finnish hardback book and discusses key questions related to the calculation of carbon footprints. Carbon footprints are calculated on the basis of life cycle assessments.

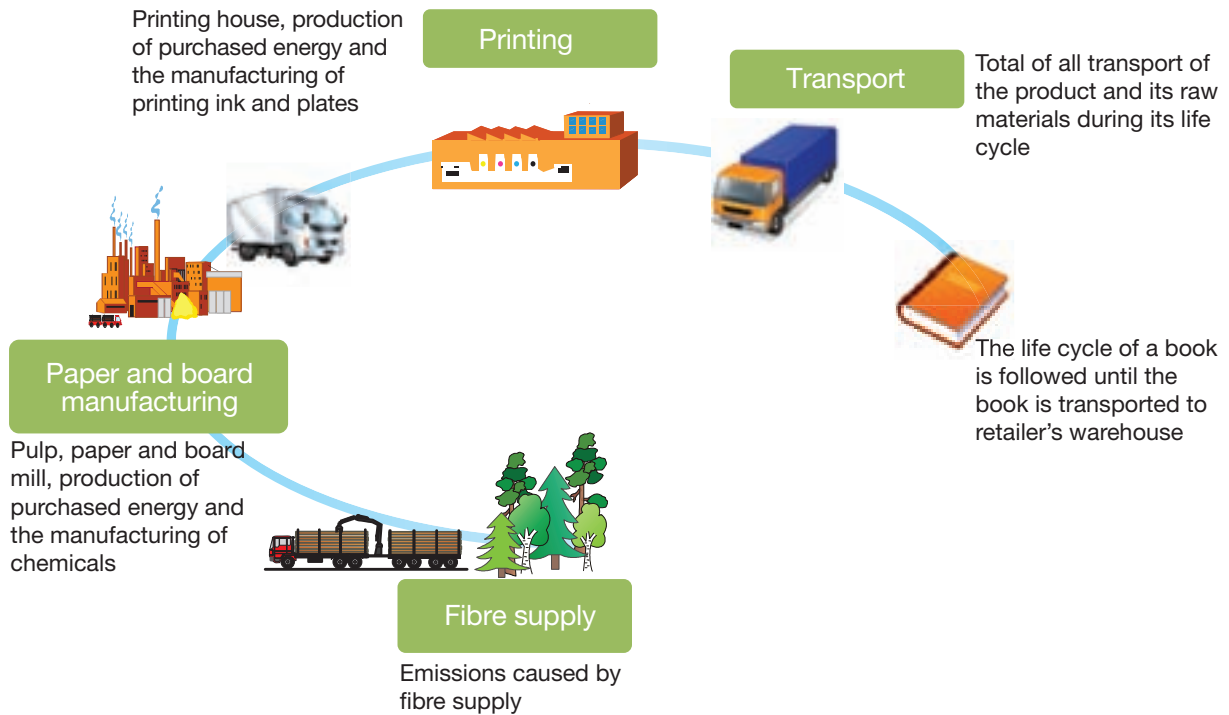
The carbon footprint of books comprises emissions caused by the electricity and heat production required for making the product as well as greenhouse gas emissions resulting from transport. The greenhouse gas emissions produced by a single book during its life cycle (from cradle to retailer's warehouse) correspond to a car journey of approximately 7.3 kilometres.

The results given in the brochure are for a specific type of Finnish book. The results are based on information collected from the Finnish printing and paper manufacturing industry and raw material suppliers as well as transport companies between 2007 and 2010.



Carbon footprint of a hardback book

Carbon footprint calculations take into account the life cycle of books from cradle to the retailer



Phases of a book's life cycle excluded from the calculation. The following life cycle phases were not included in the examination: book content creation, business travel, manufacturing and maintenance of machines and buildings. Additionally, chemicals and raw materials used forming under 1% of the whole were excluded.

CARBON FOOTPRINT CALCULATIONS

| Carbon footprint of a Finnish book (kg CO ₂ e/1,000 kg of books) | | | | | |
|---|----------------|---------------------------------------|-------------------|----------------|---------|
| Carbon footprint [kg CO ₂ e/1,000 kg of books] | 70 kg 3.0 % | 1093 kg 47.1 % | 1084 kg 46.7 % | 75 kg 3.2 % | 2322 kg |
| | | | | | |
| LIFE CYCLE | FIBRE SUPPLY | PAPER AND PAPERBOARD PRODUCTION | PRINTING | TRANSPORT | TOTAL |

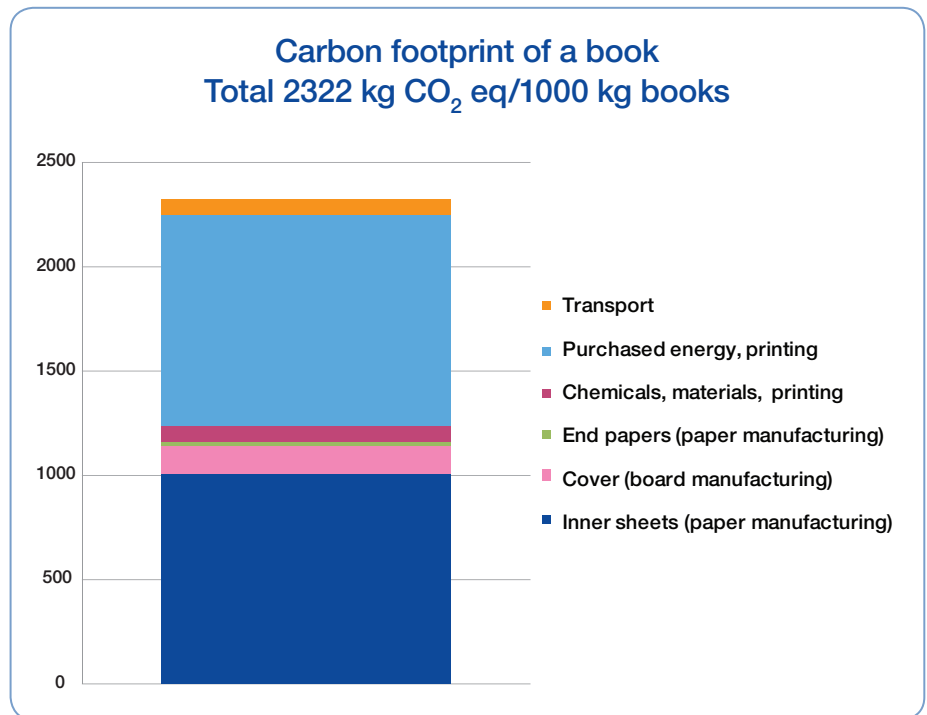
BASIC FACTS ABOUT CARBON FOOTPRINTS

- Carbon footprint is a measurement of the greenhouse gases produced during a product's life cycle.
- Greenhouse gas emissions produced during the life cycle of a typical Finnish book include among others carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O).
- Carbon footprints are expressed as a carbon dioxide equivalent (CO₂e), which is a measure used to describe how much global warming a given type of greenhouse gas may cause, using the functionally equivalent amount of concentration of carbon dioxide as the reference.
- Greenhouse gases in the atmosphere increase the temperature of the Earth similarly to the glass walls of a greenhouse. They allow short-wave solar radiation to pass through the atmosphere but trap long-wave energy reflected back from the Earth. The thicker the blanket of greenhouse gases, the more of the outgoing energy gets trapped and the greater the warming effect.
- Climate change is the result of a rapid rise in the concentration of greenhouse gases in the Earth's atmosphere. According to the UN's Intergovernmental Panel on Climate Change (IPCC), the most rapidly growing sources of greenhouse gases are energy production, transport, industry, housing, deforestation, agriculture, and buildings.

ENERGY PRODUCTION AND CONSUMPTION IN A KEY ROLE

Emissions resulting from the use of purchased electricity in paper and paperboard production and printing are responsible for more than 50% of the carbon footprint of a typical Finnish book. The size of the carbon footprint therefore depends especially on the sources of energy used to produce electricity. The carbon footprint of individual products also varies according to the size and type of the product (number of pages and weight, as well as the method of binding) and the packaging materials used.

Emissions resulting from energy production have been calculated on the basis of a five-year average of Finland's energy production. The production of electricity can be broken down to different sources



of energy as follows: renewable sources of energy 29%, fossil fuels 42%, and nuclear power 29%. In addition to greenhouse gas emissions, different forms of energy production also have many other environmental impacts.

REDUCING THE CARBON FOOTPRINT

As the producer is not always able to influence the production of purchased electricity and heating energy, the best way to reduce the carbon footprint is to lower energy consumption and increase energy efficiency. Other important ways to reduce the carbon footprint include reducing the amount of raw materials and using materials more efficiently. This can be achieved by designing products so as to waste as little material as possible during the production process, for example. Readers can reduce the carbon footprint by recycling the product after use.

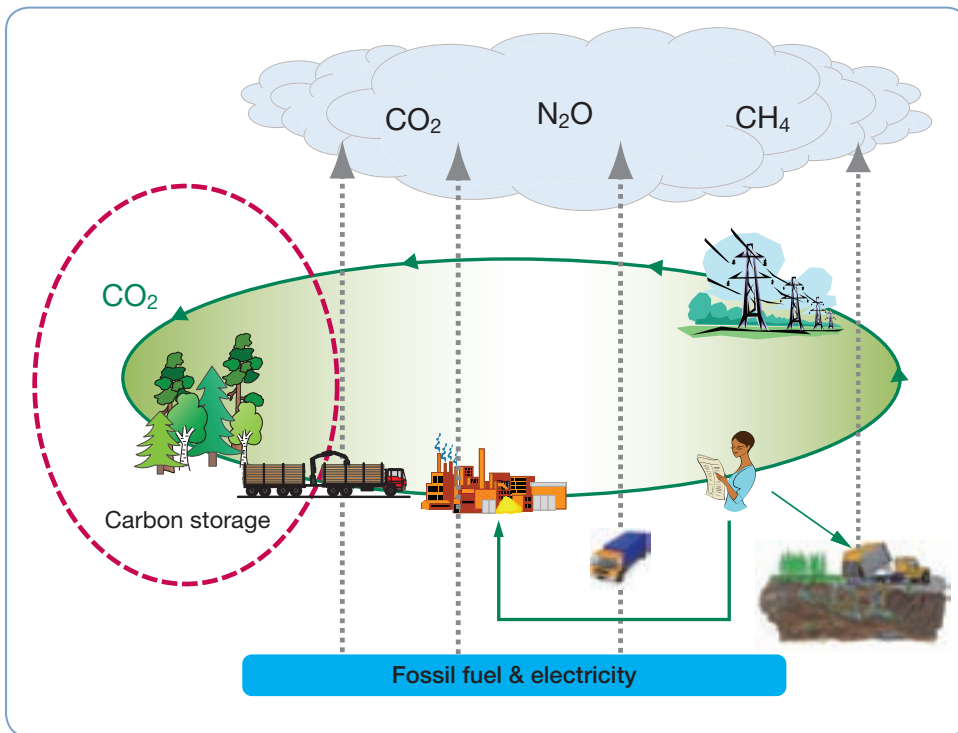
COMPLEX COMPARISONS

The results of carbon footprint calculations depend on the assumptions and data used. Calculations produced for different kinds of products or using different methods cannot be compared with each other. Due to differences in energy

production, variations between different countries can also be considerable. Moreover, other environmental impacts should also be considered when calculating the carbon footprints of different products or product groups.

SO HOW DOES THE CARBON FOOTPRINT OF A TYPICAL FINNISH BOOK COMPARE?

- The carbon footprint of a single book of the type examined in the brochure (weighing 500 g) is approximately 1.2 kg CO₂e. The total greenhouse gas emissions caused by the production and use of one tonne of books amount to approximately 2,322 kg (CO₂e).
- The carbon footprint of an individual book is equivalent to the greenhouse gas emissions of a journey of approximately 7.3 kilometres in a new car (CO₂e = 164 g/km).
- The contribution of newspapers, books, and other paper products to the climate impacts of consumption by Finnish households in 2005 was relatively small (approximately 1%), while the biggest climate impacts were attributable to housing (28%), food products (16%), and transport (13%). (Seppälä et al. 2009)



CARBON STOCKS IN WOOD RAW MATERIAL

The primary raw materials of books are paper and paperboard made of wood fibre. Wood is a renewable natural resource that binds carbon dioxide from the atmosphere. In addition to trees, forests also bind carbon dioxide through other vegetation and soil. Forests and soil also release carbon dioxide in connection with decomposition.

Some of the carbon contained in wood is released to the atmosphere during the paper and paperboard production process, and the rest remains bound to the finished book. The carbon that remains bound to the product is released when books are incinerated or deposited in landfill sites. As paper and paperboard decompose in landfill sites, carbon dioxide and methane are formed, some of which are released to the atmosphere and some of which are recovered.

However, when the product is not discarded for a long time (more than a year), the car-

bon that remains bound to the product can be deemed to be reducing the carbon footprint. According to calculations produced using the PAS 2050 specification, after 5 years, the carbon that remains bound to the product reduces the carbon footprint caused by the production stage by approximately 5%, and after 100 years, by approximately 75%.

OTHER ENVIRONMENTAL IMPACTS

In addition to the carbon footprint, it is also important to factor in any other potential environmental impacts of the production and use of books. The carbon footprint of books is mostly the result of the use of energy and fuels, but the use of energy also produces other emissions in addition to greenhouse gases, and these also contribute to the prevalence of acidification and particulates. Energy consumption also leads to depletion of the Earth's fossil and mineral resources. Discharges into water cause eutrophication.

ASSUMPTIONS

The results given in the brochure are for a typical Finnish hardback book. The calculations are based on typical Finnish conditions, and no general conclusions can be drawn on the basis of the results as regards other countries or other types of books.

- The emissions described in the brochure have been calculated on the basis of 1,000 kg of books. An individual book comprises 300 pages (135 x 205 mm) and weighs 500 g. Based on these assumptions, one tonne corresponds to approximately 2,000 individual books.
- Paper production, printing, and distribution take place in Finland.
- Books are printed using sheet-fed offset printing technology, which is one of the typical methods of producing books.
- The inner pages are printed on uncoated fine paper made of virgin fibre and having a 29% concentration of fillers (mineral materials).
- The covers of books are grey pasteboard made of recycled fibre.
- The life cycle of books is followed from the sourcing of raw materials to the retailer's warehouse. The last stage of the life cycle (recycling and waste management) has been excluded from the examination, as no precise information exists on the end use of the product.

Further information

The data and calculations presented in the brochure are based on the LEADER research project of VTT Technical Research Centre of Finland (2007–2010), which was carried out in collaboration with the Finnish Environment Institute (SYKE) and Metropolia University of Applied Sciences. The objective of the project was to examine the life cycle environmental impacts of different types of printed products by means of life cycle assessment. A further goal was to find ways to reduce environmental impacts and to increase awareness of these impacts. The project was sponsored by the Finnish Funding Agency for Technology and Innovation (TEKES), the Graphic Industry Research Foundation of Finland (GTTS), Metsäliitto Group, Myllykoski Corporation, UPM-Kymmene Corporation, and Stora Enso Group.

Pihkola, Hanna et al. (2010) Carbon footprint and environmental impacts of print products from cradle to grave, VTT Research Notes 2560, 2010. Available at <http://www.vtt.fi/publications/>

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