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Life Cycle Assessment of Paper Products: Part One — The Basics

This brief is provided to offer guidance to our customers and other stakeholders looking for information regarding Life Cycle Analysis (LCA) as it applies to the paper and printing industries. The information can be used to help make informed decisions when buying paper and in developing environmentally responsible procurement policies for paper.

This type of assessment can be used to evaluate different products across a wide variety of environmental impacts (e.g., emissions to atmosphere, water quality, or waste to landfill).

For printing and writing paper grades, many LCA studies have concluded that the two biggest contributors to greenhouse gas emissions (GHG) for a publication are the manufacturing of the paper (the paper mill) and methane emissions from landfills. In other words, it is important for paper buyers to select the mill with the lowest carbon footprint and to promote the recovery and re-use of paper products to keep paper out of landfills.

The information presented herein is based on Sappi's knowledge and expertise and is supported by the studies and documents included in the reference section.

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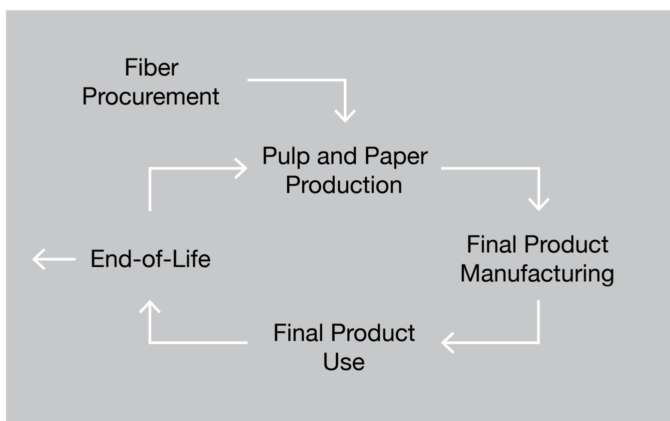
What is LCA?

Life Cycle Analysis (or Assesment) is an approach that covers the whole life cycle of a product or a service, usually “from cradle-to-grave”, i.e., from raw material extraction to manufacturing, packaging, distribution, use and end of life. Process steps are identified for each stage in the life cycle. The inputs (materials and energy) and outputs (products, emissions and pollutants) are determined for each step. The inputs and outputs are then grouped into impact categories, which are categories of environmental problems (e.g., global warming, respiratory effects).



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By examining a product or service over its entire life cycle, informed decisions can be made to avoid transferring pollution from one life stage to another or from one media (air/water/soil) to another.

The basis for analysis in an assessment is typically centered on a unit weight of material (e.g., one ton of paper) or by defining what the product does (e.g., a paper towel cleans up a spill). A proper analysis is set up to avoid “false savings”; e.g., a smaller paper towel may not have a lighter environmental impact if two smaller paper towels are needed for the job compared to one larger one. LCAs have also been conducted to compare different types of products for a given application, such as comparing the use of paper, plastic and reusable bags for transporting groceries. (3)

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Accepted methodologies

The International Organization for Standardization (ISO) has developed guidelines for LCA under the ISO 14040 family of international standards, notably ISO 14040:2006: Principles and framework of LCA and ISO 14044:2006: Requirements and guidelines for LCA standards (4). These define the methods for developing and verifying LCAs. There are specific requirements for data quality and transparency, and requirements to ensure that the assessment is robust. The ISO guidelines also require third-party review by an independent expert panel prior to any public communication of results. These ISO requirements and guidelines ensure a level of rigor and provide the ability to track and repeat an LCA. However, they don’t ensure that analyses of two different paper products can be compared on an “apples-to-apples” basis. This can only be done if the study boundary conditions and method assumptions are identical. Sappi is currently driving an effort with the American Forest and Paper Association (AF&PA) to develop an industry-specific, standardized guidance specifically for paper products.

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Why conduct an LCA?

LCAs provide a detailed breakdown of the main contributors to key environmental impacts (materials, energy sources, step of the life cycle, etc.). This can enable companies to improve performance by prioritizing environmental improvements and investments, e.g., achieving cost savings through more efficient use of resources or energy, or identifying alternative processes that lower overall production costs and environmental impacts. LCAs can also be a major catalyst of innovation because they regroup people with different backgrounds and expertise, and from different points in the supply chain, to find new ways of managing the life cycle of products.

LCAs can provide credible information on which to base marketing communications, such as developing Environmental Product Declarations (EPDs), which are used to communicate product environmental performance information.

Increasingly, companies, policy-makers and NGOs are promoting life cycle thinking since it provides a holistic view of the environmental performance of products. For example, Walmart is making carbon footprinting and emissions reduction actions a requirement for its suppliers for certain product categories. LCA can also help companies comply with laws and regulations designed to reduce the environmental impact of products and services.

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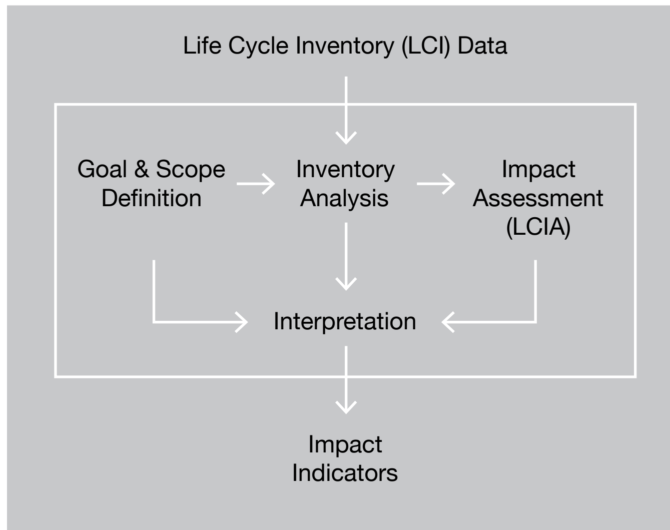
Data needs and results

An LCA study involves four phases:



1. Goal and Scope — defining the purpose and system boundaries of the study

2. Inventory — compiling the inputs and outputs of the product throughout its life cycle

3. Impact assessment — evaluating the significance of potential environmental impacts of the inventory results

4. Interpretation — summarizing results as the basis for drawing conclusions

LCAs require a large amount of data and data analysis and can take up to several months per project. Once all the data is collected for each process step, the data is entered into either dedicated LCA software packages (e.g., GaBi and SimaPro) or a simplified Excel sheet. The National Council of Air and Stream Improvement developed a carbon footprint model specifically for paper products called FEFPro™. Each computer model is set up to allow for the calculation of environmental flows of inputs and outputs and categorize them into impact categories (see Box 1). Once the impacts have been calculated, results can be interpreted in order to fulfill the study objectives. Overall assessment may include reviewing which life cycle stages contribute the most towards each impact category.

Some typical environmental impacts measured by LCA

Air emissions

- Acidification. Decrease in the acidity of rain and deposition of acidic particulates due to the release of gases, such as sulfur dioxide (SO_2) and nitrogen oxides (NOx).
- Global warming. Potential change in the earth's climate caused by the buildup of greenhouse gases (GHGs) in the upper atmosphere that trap heat from the reflected sunlight that would have otherwise passed out of the earth's atmosphere.
- Respiratory effects of inhaled particulates and gases such as SO_2 and NOx .
- Stratospheric ozone depletion due to pollutants that cause the destruction of the protective ozone layer in the upper atmosphere.

Water releases

- Eutrophication. The increase of nutrients, such as phosphorus and nitrogen, discharged to water bodies, which negatively impacts water quality and disrupts ecosystems.
- Oxygen depletion and organic loading in receiving waters due to biochemical oxygen demand (BOD) and chemical oxygen demand (COD) in treated effluents.
- Toxicity of effluents to organisms in the aquatic receiving environment.

Primary energy consumption

- Distinguishing renewable and nonrenewable energy sources. This is increasingly important as a large number of forest product companies have converted to using renewable biomass for much of their energy needs, rather than fossil fuels.

Resources depletion

- Fossil fuel depletion.
- Tracing of wood flows, depletion of nonrenewable energy sources and, depending on the product studied, depletion of certain rare materials.

Source: (2)

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LCA examples for paper and print

In recent years, due to increasing concerns about climate change, a number of life cycle studies have focused on the carbon footprint of paper products (5,6). Although carbon emissions and carbon foot printing are very important aspects of life cycle studies, carbon is just one of many elements evaluated within an LCA. Recent reviews of LCA studies applied to print products have been published by the Rochester Institute of Technology (7) and by the National Council of Air and Stream Improvement (8).

The paper industry as a whole represents a broad range of applications (from tissue and towel to corrugated containers to premium printing and writing grades) and a wide range of performance amongst manufacturing facilities. It is very difficult to draw general conclusions across various paper segments and one must use extreme caution when making comparisons across different studies.

In 2010, Forest Products Association of Canada (FPAC) and AF&PA published the results of an LCA study to evaluate the environmental impact of four North American grades of printing and writing papers. The study concluded that the most significant life cycle impacts for printing and writing papers results from the production of the paper and disposal of used paper at the end-of-life. More specifically:

- The environmental impacts of paper production are largely driven by the use of fossil fuels in the pulp and paper manufacturing process.
- Increasing the use of bio-based energy sources at paper mills reduces climate change impacts.
- Increasing the recovery rate of all papers would have a significant positive effect on global warming impacts.
- Avoiding landfilling of non-recoverable paper fiber by burning with energy recovery would have a significant impact on results.
- Transportation of finished goods is not significant in overall life cycle impacts.

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Key points on recycled content paper

Some customers and consumers focus on papers with high recycled content. This is based on the assumption that more recycled content is always better for the environment for every product. However, recycled content is only one attribute in the life cycle of paper. A life cycle approach can help determine which product application of recycled content, and at what level, can yield the most benefit. For any particular paper product, LCA can be used to account for impacts related to:

- Transportation, including waste collection and transport to recycling facilities
- Sorting and recycling processes
- Recycled fiber processing (e.g., de-inking, bleaching, etc.) and fiber recovery rates from processing
- Alternative end-of-life options (e.g., energy production)
- Type of end product and product attributes

Paper recovery avoids landfilling, which saves landfill space and reduces emissions from decomposition. Paper recovery is particularly important for the reduction of the decomposition product methane, which is over 20 times more effective in trapping heat in the atmosphere than carbon dioxide. It also allows valuable fiber to be reused for new products or energy production. However, the paper fiber cycle depends both on fresh fiber from well-managed forests and recycled fiber from a strong paper recovery network. Recycled fiber alone cannot meet all the fiber supply needs since recycled fiber breaks down with each use and about 15 percent of paper products, such as tissues and documents stored for extended periods of time, cannot be recycled. Both recycled fiber and fresh fiber from sustainably managed forests provide environmental benefits as well as potential impacts.

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Conclusions

LCA is a useful tool to help understand the overall environmental impacts of products and services. In the case of printing and writing grades, recent LCAs have concluded that most of the environmental impacts are related to the paper manufacturing footprint and end-of-life treatment (i.e., landfilling, recycling, and incineration). As a result, buyers of paper and print should adopt life cycle thinking when evaluating the environmental performance of their supply chain, and we all should encourage people to recycle. All of Sappi's coated fine papers are recyclable and we strongly endorse the use of "please recycle" logos on all printed projects (9). Recovered paper should then be re-used in products where it is the most economical and has the lowest environmental impact by considering impacts of the product life cycle.

Because of the scientific rigor required, conducting an LCA is technically challenging and time consuming, but if it is well planned, its benefits can outweigh the costs. LCAs also have a number of limitations that have been well described by AF&PA and FPAC (1). Knowing these limitations is key to determining whether it is the most appropriate tool for a given situation.

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All Web links validated as of January 3, 2012.

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