LCA in the labelling industry

Understand the LCA landscape of the production of self-adhesive labels

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Table of Contents

List of Acronyms

BSI	British Standards Institute
CEPI	Confederation of European Paper Industries
CML-IA	The Institute of Environmental Sciences- Impact assessment
FINAT	Féderation INternationale des fabricants et transformateurs d'Adhésifs et Thermocollants sur papiers et autres supports
FSC	Forest Stewardship Council
GREET model	Greenhouse gases, Regulated Emissions, and Energy use in Transportation model
EMAS	Eco-Management and Audit Scheme.
EPD	Environmental Product declaration
GHG Protocol	Greenhouse Gas Protocol
ILCD	International Reference Life Cycle Data System
IPPC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
L.I.F.E	Label Initiative for the Environment
PAS2050	Publicly Available Specification 2050
PCR	Product Category Rules
PEF	Product Environmental Footprint
PEFC	Programme for the Endorsement of Forest Certification
PEFCR	Product Environmental Footprint Category Rules
TLMI	The premier association for the label and package printing industry
TRACI	Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts
TS	Technical Specification
USLCI	United States Life Cycle Inventory
WBCSD	World Business Council for Sustainable Development
WRI	World Resource Institute

Executive summary

In the past years a growing number of customers have requested insight in the environmental performance of the products of the labelling industry. The industry has met this demand by developing in-house tools and methodologies. It is expected that this number of requests will keep on growing and will need to be met with a harmonized sector approach.

To develop a harmonized sector approach it is vital to understand the LCA landscape of the production of self-adhesive labels. To better understand the LCA landscape of the production of self-adhesive labels, two activities have been carried out:

- Overview of the state of the art of LCA methodologies and norms;
- State of the practice with regards to LCA practice and use in the industry via questionnaires and interviews.

State of the art

The present report provides an overview of the state of the art of LCA methodologies and norms, thereby facilitating a better understanding of the LCA landscape of the production of self-adhesive labels. ISO 14044, CEPI Framework, GHG Protocol, PEF guide, ISO14067, and the PCR 2015:01 are discussed in more detail, as these standards are considered to be most relevant and informative for the labelling industry. It was found that important criteria with possibly conflicts between standards are: the functional unit, cut-off rules, modelling approach, fossil and biogenic carbon emissions and removals, land use change, soil carbon, carbon storage and delayed emissions, data quality, electricity, multi-product processes, end-of-life allocation, and impact assessment.

State of the practice

For the state of the practice, a survey was sent out to all TLMI and FINAT members and two progressive companies within the labelling sector were interviewed. A total of 98 respondents filled in the survey of which 45% of the respondents are label manufacturers, 36% are material suppliers for the labelling industry, and 24% are printers/converters. As expected most respondents have their main markets predominantly in Europe (47%) and Northern America (84%). The most valuable insights from the state of the practice are:

<u>Sustainability in the companies</u>

- 86 % of the companies have sustainability policy goals
- Sustainable forest management is an important driver for environmental labelling of paper labels
- 54% of companies send suppliers requests for sustainability information

<u>Use of LCA</u>

- 86 % of the respondents do not yet use LCA
- 58% of the respondents is not familiar with LCA
- 65% of the respondents have plans to use LCA in the future
- Lack of customer demand is the most important argument for having no plans to use LCA in the future

<u>Main applications of LCA</u>

- Main uses of LCA are: 1) In Marketing, 2) For transparency on environmental performance 3) for product development and 4) To improve operational performance
- The departments using the LCA results are Marketing (80%), Sustainability department (60%), General management (50%), and R&D (30%)

1 Introduction

In the past years a growing number of customers have requested insight in the environmental performance of products of the labelling industry. The industry has met this demand by developing in-house tools and methodologies. It is expected that this number of requests will keep on growing and will need to be met with a harmonized sector approach. Without a common sector approach there is a risk of conflicting messages to customers and suppliers who are 'overloaded' by requests to calculate their environmental impact using various methods.

In order to ensure one harmonised approach for conducting LCA studies on self-adhesive label products, the world-wide association for manufacturers of self-adhesive labels and related products and services (FINAT) and the premier association for the label and package printing industry (TLMI) both want to provide their members with an harmonized sector approach for the industry while working in concert with the developed PCR and tools.

To develop a harmonized sector approach it is vital to understand the LCA landscape of the production of self-adhesive label products, therefore two activities have been carried out:

- Overview of state of the art of LCA methodologies and standards;
- Inventory of state of the practice with regards to LCA practice and use in the industry via questionnaires of interviews.

The insights from the state of the art and practice will be used as input for the harmonized sector approach. Important terms used in this document are explained in the Glossary (see Annex B). For abbreviations, we refer to the list of Acronyms.

2 State of the art of LCA in the labelling industry

The aims of this state of the art are twofold:

1. Give an overview of the standards currently available that can be applied to labelling products, and
2. Show the commonalities and differences between them.

2.1 Leading (inter)national product level standards

There is worldwide agreement that product environmental impact information must be assessed using life cycle assessment (LCA). This way, not only the production impacts are taken into account but the entire life cycle of the product is considered. There are a number of standards for **comprehensive product LCA**, meaning that multiple impact categories are covered. Regarding the ISO standards, which have international applicability, there is the ISO 14040:2006 for general principles and a framework. For a deeper dive into requirements and guidelines, ISO 14044:2006 is available for use. Recent developments for product LCA include the Product Environmental Footprint (PEF) Guide of the European Commission (European Commission 2013) and the underlying ILCD Handbook (EC-JRC-IES 2010). The PEF guide is very generic, and currently a PEFCR specifically for intermediate paper products is still under development. The PEFCR for intermediate paper products will be included if it becomes available in the duration of the project.

These general product LCA standards are often not specific enough to prevent multiple interpretations and they do not address issues that are specific to **carbon footprint**. Therefore, the British Standards Institute (BSI) published the PAS2050 (BSI 2011). Additionally, the World Business

Council for Sustainable Development (WBCSD) and the World Resource Institute developed the Greenhouse Gas Protocol (GHG Protocol) Product Standard (WRI, 2011), which is an international protocol for product carbon footprinting and is largely based on the PAS2050. Recently, the technical specification ISO/TS 14067:2013 (2013) on carbon footprint of products was released. Because it is a technical specification it has no legal binding. There are several other standards, including national carbon footprint standards such as the French BPX30-323 (ADEME 2011) and the Japanese TS Q 0010 (2009). Additionally, there is a carbon footprint guidance developed by a task force established at the FINAT TC meeting of January 2010. **Water footprint** is also a specific environmental theme, so a specific standard for water footprint (i.e. ISO 14046:2014) was recently published.

Furthermore, ISO standards exist for **LCA labels and declarations** (ISO 14020, 14021, 14024 and 14025). International standards refer to PCRs (Product Category Rules) and sector guidelines as relevant documents to consider when performing an LCA of a specific products, such as labelling products. However, using a PCR is only mandatory when labelling and environmental product declarations are required. With regards to labelling products, there is, to our knowledge, only one PCR available: the PCR 2015:01 published in the EPD system (The International EPD System, 2015).

Table 1 gives an overview of the most important available standards on LCA, carbon and water footprint.

Table 1 - Relevant documents and standards at product level for carbon footprint, LCA communication and LCA in general.

Short name	Published	Topic	Geography
ISO 14021	1999	Type II environmental labelling (self declared)	International
ISO 14024	1999	Type I environmental labelling (verified)	International
ISO 14020	2000	LCA labels and declarations	International
ISO 14040-44	2006	Product LCA	International
ISO 14025	2006	Type III environmental declarations	International
CEPI Framework	2007	Carbon footprint guidelines for labels	European
TS Q 0010	2009	Carbon footprint	Japanese
ILCD Handbook	2010	Product LCA	European
PAS2050	2011	Carbon footprint	British
GHG Protocol Product	2011	Carbon footprint	International
BPX30-323	2011	Carbon footprint	French
PEF Guide	2012	Product LCA	European
ISO/TS 14067	2013	Carbon footprint	International
ISO 14046	2014	Water footprint	International
PCR 2015:01	2015	Product category rule for labels	International
PEFCR paper products	soon	Product category rules for intermediate paper products	International

2.2 Comparison of standards

Although similar widely accepted product environmental assessment methods and guidance documents closely align on much of the methodological guidance they provide, there are some discrepancies and/or lack of clarity on a number of important decision points, which reduces the consistency and comparability of analytical outcomes (see Glossary for explanation of terms). Table 2 summarizes the approach for a number of existing methods. Light grey background has been used to signal where important conflicts between the various standards occur or when it is an important element to consider in establishing the harmonised LCA sector approach. Table 2 is adapted from Annex I in the PEF guide (European Commission,2013) Included in table 2 are the ISO 14044, CEPI Framework, GHG Protocol, PEF guide, ISO14067, and the PCR 2015:01, as these standards are considered to be most relevant and informative for the labelling industry. If it becomes clear from the case-studies that water is a relevant impact category, then we will also include the ISO standard on water footprint.

Table 2 - Summary of the approach for the ISO 14044, CEPI Framework, GHG Protocol, PEF guide, ISO14067, and the PCR 2015:01.

Criteria	ISO 14044	CEPI Framework	GHG protocol	PEF guide	ISO 14067	PCR 2015:01
Goal	Intended application and audience, reasons and communication shall be unambiguously stated.	Not specified.	Contact info, studied product, functional unit, reference flow, cradle to grave/gate, additional GHG's, product rules or sector specific guidance, inventory date and version, link to previous reports and description of methodological changes, limitations of potential uses.	Goal definition for a PEF study shall include: • Intended application(s); • Reasons for carrying out the study and decision context; • Target audience; • Whether comparisons and/or comparative assertions are to be disclosed to the public; • Commissioner of the study; • Review procedure (if applicable).	Intent, reasons and communication shall be unambiguously stated.	As the PCR is aligned with ISO 14044, the intended application and audience, reasons and communication shall be unambiguously stated.
Functional unit	Clearly defined and measurable and consistent with the goal and scope of the study.	Not specified.	For all final products. Intermediate products are defined as a reference flow.	• The function(s)/service(s) provided: "what"; • The extent of the function or service: "how much"; • The expected level of quality: "how well"; • The duration/life time of the product: "how long"; • The NACE code(s).	A Carbon Footprint (CFP) study shall clearly specify the functions of the product system being studied.	The EPD must specify (mandatory): • the kind of label, • material used, • production method, • shape, • weight, • thickness, • and more relevant information that the producer considers important. The declared unit in the study is 1000 units of product with the raw material, shape, size etc. as specified above.

	ISO 14044	CEPI Framework	GHG protocol	PEF guide	ISO 14067	PCR 2015:01
System boundaries	Iterative process: • Initial system boundaries are defined based on goal and scope of the study, • Final system boundaries are determined after initial calculations and sensitivity analysis.	Define carbon footprints for basic paper and board products from the forest/the collection of the recycled fiber to the delivery to the customer of the product. Decide at the level of industry sectors or converters of these basic paper and board products whether more aspects of a life cycle approach, the use phase of the product, end of life emissions and avoided emission concepts are included in the footprint. Include in the footprint all relevant and significant emissions for the product, both the emissions under the companies' control and the emissions not under companies' control (e.g. of purchased electricity).	Cradle to grave. Disclose and justify when cradle-to-gate is done.	Cradle-to-grave as default approach. The following elements shall be considered for inclusion in the Resource Use and Emissions Profile: • Raw material acquisition and pre-processing; • Capital goods: linear depreciation shall be used; • Production; • Product distribution and storage; • Use stage; • Logistics; • End-of-life. The processes included shall be divided into foreground and background processes.	The deletion of life cycle stages, processes, inputs or outputs is only permitted if they do not significantly change the overall conclusions of the CFP study. Any decisions to omit life cycle stages, processes, inputs or outputs shall be clearly stated and the reasons and implications for their omission shall be explained. Decisions shall be based on sensitivity analysis. Cradle to gate only for B2B communication.	Cradle-to-grave. The LCA calculations shall be separated into three life cycle stages: • Upstream, • Core • Downstream. In any case, a system diagram with the main processes shall be included, showing the division of the three stages.
Cut-off rules	Allowed – based on mass, energy, or environmental significance.	Aim to include 90% of all emissions within the system boundaries in the carbon footprint of the product. For footprints that are available to the public the cut-off criteria or other approaches that were used to decide which inputs and outputs to include in the footprint should be clear. As used here, cut-off criteria or materiality thresholds are suggested to be expressed as a fraction of the total footprint greenhouse gas emissions.	All attributable processes need to be included. Disclose and justify any exclusions.	No cut-off rules allowed.	The threshold for significance shall be stated and justified. Consistent cut-off criteria that allow the omission of certain processes of minor importance shall be defined within the goal and scope definition phase. The effect of the selected cut-off criteria on the outcome of the study shall also be assessed and described in the CFP study report.	LCI data for a minimum of 99 % of total inflows (in terms of mass and energy) to the core module shall be included.

	ISO 14044	CEPI Framework	GHG protocol	PEF guide	ISO 14067	PCR 2015:01
Modelling approach	Avoid allocation is preferred.	Avoid allocation is preferred, following ISO 14044.	Attributional approach, plus direct system expansion for multi-product processes and closed-loop approximation for recycling.	In principle attributional but includes elements of consequential too, e.g. system boundary expansion for multi-product processes.	Avoid allocation is preferred.	Avoid allocation is preferred.
Fossil and biogenic carbon emissions and removals	No information.	Where used products are burned, the biogenic CO2 emissions from burning the biomass are carbon neutral and not included in greenhouse gas totals (but should be included under "additional information" and may be used to examine carbon sequestration along the value chain as explained in Appendix F). Other greenhouse gas emissions from burning used forest products (CH4 and N2O or CO2 liberated from calcium carbonate) are small compared to emissions associated with Toe 3 (manufacturing), Toe 6 (purchased electricity) and Toe 7 (transport), and can usually be ignored consistent with the default cut-off criteria of 90%.	Both carbon emissions and removals from fossil and biogenic sources are included in the inventory results and reported separately for transparency.	Removals and emissions shall be reported separately for both fossil and biogenic sources.	Removals and emissions shall be reported separately for both fossil and biogenic sources.	Both carbon emissions and removals from fossil and biogenic sources shall be included, with the exception of human food and animal feed products.
Land use change	No information.	No information.	Include when attributable, use physical allocation. 20 years (or one harvest period if this is longer) cut-off, distribute impact over this timeframe. Use sector, country or generic average if unknown. Report method used for calculation. Indirect land-use not required. If it is calculated and relevant it should be reported separately from the inventory results.	GHG emissions from direct land use changes: 20 year depreciation; use country average if not known with IPCC default values table. GHG emissions from indirect land use changes shall not be considered in the default impact categories but can be included as additional environmental information.	Include direct land use change (20 years depreciation), but report separately; indirect land use change not included until internationally agreed method has been established.	No information.

	ISO 14044	CEPI Framework	GHG protocol	PEF guide	ISO 14067	PCR 2015:01
Soil carbon	No information.	No information.	Soil carbon change due to soil management change may be included in the inventory results if a reasonable estimation can be made. Report whether it is included or not.	Included in direct land use change.	Soil carbon change due to soil management change may be included and reported separately.	No information.
Carbon storage and delayed emissions	No specific provision/ information provided.	Some companies may be able to estimate changes in forest carbon stocks and attribute a portion of those changes to individual products. In these cases, the footprint may include quantitative information in the form of a number indicating the net additions to forest carbon stocks per unit of product, averaged over appropriate areas and times. Companies that do not have the possibility to make quantitative statements about forest carbon sequestration in a footprint should still address this issue in the footprint by describing how a company's sustainable forest management practices and fibre procurement practices are helping to ensure that forest carbon stocks are not being depleted.	Carbon that is not released as a result of end-of-life treatment over the time period of the study is treated as stored carbon. The time period should be based on science insofar as possible, or be a minimum of 100 years. Delayed emissions or weighting factors (e.g. temporary carbon) shall not be included in the inventory results, but can be reported separately.	Credits associated with temporary (carbon) storage or delayed emissions shall not be considered in the calculation of the PEF for the default impact categories, unless otherwise specified in a supporting PEFCR.	Carbon storage shall be reported separately.	Where some or all removed carbon will not be emitted to the atmosphere within the 100-year assessment period, the portion of carbon not emitted to the atmosphere during that period shall be treated as stored carbon.
Carbon offsetting		Include the option of carbon offsetting (e.g. planting trees to offset fuel use), but be very transparent about it and add additional information when using it in the carbon footprint.				

	ISO 14044	CEPI Framework	GHG protocol	PEF guide	ISO 14067	PCR 2015:01
Data quality	No minimum data quality requirements are specified. Data quality requirements should be specified for the following criteria: • Time-related coverage • Geographical coverage • Technology coverage • Precision • Completeness • Consistency • Sources of the data • Uncertainty of the information	Initiate the development of generic data on, for example, transport emissions and harvesting emissions in the forest.	Primary data shall be collected for all processes under the ownership or control of the company. Use data quality indicators (Pedigree). For significant processes a description of the data source, quality and improvement efforts shall be reported.	Data quality is evaluated on the basis of: • Technological representativeness • Geographical representativeness • Time-related representativeness • Completeness • Parameter uncertainty • Methodological Appropriateness • and Consistency	Data quality shall be characterized by both quantitative and qualitative aspects. 10 different quality requirements (time, geography, technology, etc.)	Primary data shall be used for the Core Module, and gathered from the actual manufacturing plant(s) where specific processes are carried out and data from other parts of the life cycle traced to the specific product system under study. For the upstream module, generic data may – under certain criteria – be used if specific (real) data are not available.
Assurance	If the study is intended to be used for a comparative assertion to be disclosed to the public, interested parties shall conduct this evaluation as a critical review, and provide general information as to the type of review.	Verification of the footprint is an option that may further enhance its credibility.	Review by an independent first or third party is required. Use ISO 14040/44 for additional guidelines on reviewing.	Critically reviewed by at least one independent and qualified external reviewer (or review team). A PEF study to support a comparative assertion intended to be disclosed to the public shall be based on relevant PEFCRs and critically reviewed by an independent panel of three qualified external reviewers	3rd party verification when B2C (ISO14025)	Independent verification of the declaration and data, according to ISO 14025:2006.
Electricity	No information.	In some cases, purchase contracts may specify emission factors or generation methods. Where specific information is not available, emission factors for the regional or national grid may be best. In other cases, it may be appropriate to use the European average emission factor for electricity produced. There are three methods for adjusting carbon footprints to account for sales of electricity, steam or heat	Not specified.	For electricity from the grid consumed upstream or within the defined PEF boundary, **supplier-specific data** shall be used if available. If supplier-specific data is not available, country-specific **consumption-mix** data shall be used of the country in which the life cycle stages occur	GHG emissions arising from the life cycle of the electricity **supply system**; no green electricity allowed	For the electricity used in the process, electricity production should be accounted for in this priority: • Renewable Energy Certificates (RECs) or Guarantee of Origin from electricity supplier • Electricity supplier's residual energy mix • National electricity production mix/electricity mix on the market (preferably residual mix, otherwise national electricity production mix).

	ISO 14044	CEPI Framework	GHG protocol	PEF guide	ISO 14067	PCR 2015:01
Multi-product processes	1. Avoid allocation by split up of processes 2. Avoid allocation by system expansion 3. Apply allocation based on physical causality 4. Apply allocation based on other parameters (such as revenue)	Allocation of GHG emissions to co-products should be done if these co-products are produced in large quantities. ISO 14044: 2006 gives guidance.	Avoid allocation if possible. When allocation is needed physical allocation is preferred over economic or other allocation. Always justify the used methods.	The following decision hierarchy shall be applied: (1) subdivision or system expansion; (2) allocation based on a relevant underlying physical relationship (substitution may apply here); (3) allocation based on some other relationship.	As ISO 14044.	1. Subdivision 2. Apply allocation based on physical causality 3. Apply allocation based on other parameters (such as revenue)
End-of-life allocation	General principle of avoiding allocation but no specific rule provided – no formula. Examples in ISO/TR 14049.	Allocation rules should be used consistently throughout the carbon footprint calculations to avoid double counting. Handling allocation for recycling is especially important when the intention of the footprint is to compare products based on primary fibres and products based on (partly) recovered fibres. ISO 14044:2006 provides guidance in a stepwise procedure, starting with options to avoid allocation, wherever possible. Allocation needs for recycling may be different for different sectors.	Use closed loop approximation if the material properties are similar. Otherwise use the recycled content method. Other methods are allowed, but need to be clearly reported. Unpublished methods need to be verified externally. When in doubt sensitivity analysis should be done.	Complex equation given in Annex V	Substitution of primary production of avoided product. It follows ISO 14044 allocation hierarchy.	Average scenario or fixed scenarios (e.g. 100% recycling). The different End-of-life options (recycling, incineration, and landfill) should be quantified and modelled as follows: • In all options potential impacts of treatment processes must be quantified; • The benefits from recycling/ incineration of waste must be quantified as avoided product. This approach actually should be considered in all the different stages where waste management is included. No credits associated with upstream burdens of scrap or recycled material used could be included.
Data uncertainty	Listed as a requirement, but no detailed guidance provided.	No information.	Report a qualitative statement on inventory uncertainty.	Qualitative, Monte Carlo is optional.	The CFP study shall include a quantitative or qualitative assessment of uncertainty.	No information.
Sensitivity	Consider sensitivity analysis.	No information.	Report a qualitative statement on methodological choices (use, end of life, allocation, recycling, calculation model).	Sensitivity analysis is optional.	Perform sensitivity analysis on allocation.	Perform sensitivity analysis when economic allocation has been used.

	ISO 14044	CEPI Framework	GHG protocol	PEF guide	ISO 14067	PCR 2015:01
Impact assessment	Numerous environmental impacts.	No information.	100-year GWP factors. IPCC 2007 is preferred, but others (older, etc.) are allowed if this is disclosed and justified. Report the source and date of the used factors.	The following impact categories shall be included, unless exclusion can be justified: Climate change (GWP100), Ozone Depletion, Ecotoxicity for aquatic fresh water, Human Toxicity - cancer effects, Human Toxicity – non-cancer effects, Particulate Matter/Respiratory Inorganics, Photochemical Ozone Formation, Acidification, Eutrophication – terrestrial, Eutrophication – aquatic, Resource Depletion – water, Resource Depletion – mineral, fossil, Land Transformation Soil Organic Matter	Climate change GWP100 factors	• Global warming potential, in CO2 equivalents • Acidification potential, in SO2 equivalents • Creation of ground level ozone, in C2H4 equivalents • Eutrophication, in PO43- equivalents • Ozone-depleting potential, in kg CFC – 11 equivalents • Water footprint, m3 of water
Claims		Include in all carbon footprints 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 CO2. • The fact that our products store carbon and, furthermore, that recycling of paper and board products keeps this CO2 from returning to the atmosphere. Use the statement that Sustainable Forest Management (SFM) ensures that carbon stocks in forests stay stable or even improve over time and build on this statement.	Include disclaimer (single issue) For type I labels: ISO 14024 For type II labels (self declared): ISO14021 For EPDs: ISO 14025 (PCRs) For comparative assertions: ISO 14044	For type I labels: ISO 14024 For type II labels (self declared): ISO 14021 For EPDs: ISO 14025 (PCRs) For comparative assertions: ISO 14044	Annex B: limitations of single issue and methodology assumptions For type I labels: ISO14024 For type II labels (self declared): ISO14021 For EPDs: ISO 14025 (PCRs) For comparative assertions: ISO14044	Any claims made about the product must be verifiable.

	ISO 14044	CEPI Framework	GHG protocol	PEF guide	ISO 14067	PCR 2015:01
Reporting	Provides general requirements for reporting and additional requirements for third party reporting.	In the communication with customers, it will usually be necessary to reduce the results of the carbon footprint to one or two pages of easy-to-communicate information.	Outline given in standard. Any non-standard decisions need to be disclosed and justified.	Outline given in standard. Optional confidential report	Outline given in standard. Optional confidential report	In the EPD shall be included the following materials and substances: • Material composition of the product, in kg per declared unit and % of the total product weight; • All materials of ≥ 1.0 % by weight (except for the case of inks and coatings, they should be included although they are in a lower percentage); • All materials and substances that are regulated by compulsory standards and clients demands; All materials and substances that are hazardous to health and the environment, being allergenic, carcinogenic, mutagenic or toxic if present in such a concentration in the product that it meets requirements for being subjects to labelling according to the legislation (e.g. the European Directives on substances and preparations).

	ISO 14044	CEPI Framework	GHG protocol	PEF guide	ISO 14067	PCR 2015:01
Communication	B2B and B2C.	Where consensus is not possible, transparency needs to be provided. As long as all involved in developing the carbon footprints are clear and transparent on their choices, the approaches taken in different cases can be understood.	The results should not be used to communicate the overall environmental performance of a product.	Any PEF study intended for external communication (e.g. B2B or B2C) shall be critically reviewed in order to ensure that: • The methods used to carry out the PEF study are consistent with this PEF Guide; • The methods used to carry out the PEF study are scientifically and technically valid; • The data used are appropriate, reasonable and meet the defined data quality requirements; • The interpretation of results reflects the limitations identified; • The study report is transparent, accurate and consistent.	• Third party verification/declaration: ISO 14025 • Critical review: ISO 14044 • Disclosure report: report used for allowing publicly available communication without 3rd party verification • External communication report: report based on the CFP study report intended to be communicated externally • CFP performance tracking report: report comparing the CFP of the same product of the same organisation over time	This PCR complies with ISO 14067.

2.3 Main findings

Certain topics remain points of discussion in LCA and carbon footprinting, and it may very well be that the standards differ on their requirements for these topics. In Table 2 light grey background has been used to signal where important conflicts between the various standards occur or when it is an important element to consider in establishing the harmonised LCA sector approach.

The functional unit, cut-off rules, modelling approach, fossil and biogenic carbon emissions and removals, land use change, soil carbon, carbon storage and delayed emissions, data quality, electricity, multi-product processes, end-of-life allocation, and impact assessment are criteria with conflicts between standards.

The goal, system boundaries, assurance, data uncertainty, sensitivity, claims, reporting, and criteria for communication are not likely to result in conflicts.

Some of the most relevant topics are:

- **Cut-off rules.** There is a discussion on the use of cut-off rules. The principle of LCA is to include all attributable processes. Leaving out some of these processes because of insignificant contribution is not always recommended as you need to know how large the contribution is before you can conclude that it is insignificant. If the contribution is very small, primary data is not required and approximation data (often defined as proxies) can be used. This can be done, for example, in the case of capital goods where its contribution is expected to be small. Whether the inclusion of these small contributors is required depends on the standard that is followed.

- **Electricity.** There has been some discussion on what inventory data to use for electricity. The national supply mix can be used, but in some cases this is not realistic due to, for example, strong regional differences. If possible, supplier specific data can also be used. The use of the production mix is not advisable, since this can give a distorted picture due to export.

- **Multi-functional processes.** The discussion on co-products allocation continues as ever, but there are now good guidelines available in the standards. Organisations have started to realise that justification for choices on the allocation method and sensitivity analysis is required.

End-of-life allocation. Allocation of material recovery is also a continuous issue. Most guidelines therefore give clear guidelines on advised methods and how to chose between them.

3 State of the practice of LCA in the labelling industry

The aims of this state of the practice are to gain insight in:

- The current LCA practices in the labelling industry
- Whether there is already a common ground for a sector LCA approach
- The needs for support within the labelling industry for (further) development of LCA practices

3.1 Our approach

3.1.1 The survey

The survey was sent out to all TLMI and FINAT members, who were asked about their companies current sustainability policy, their experiences with LCA and their recommendations for support and development. The full survey is included in Appendix A – Survey state of the practice

A total of 98 respondents filled in the survey of which:

- 45% of the respondents are label manufacturers,
- 36% are material suppliers for the labelling industry, and
- 24% are printers/converters.

As expected most respondents have their markets predominantly in Europe (47%) and Northern America (84%).

3.1.2 The interviews

We identified the progressive companies within the labelling sector, which have integrated LCA in their decision-making processes and have an in-house tool to support these processes. These companies were interviewed on a one-to-one basis. They were asked about their sustainability policy and how they use LCA to support this. Furthermore, they were asked about the LCA approach implemented in their in-house tool.

3.2 Main findings and insights

In the following paragraph the main insights from the interviews and the survey are described.

3.2.1 Organisation's sustainability programs

Sustainability is an important topic in the labelling industry. Only 13 companies out of 98 (14%) indicated that their organisation has not formulated sustainability policy goals. All other companies have sustainability policy goals in place, mainly focussing on waste reduction (74 companies), energy use reduction (62 companies), and recycling (52 companies). This is also illustrated in Figure 1 in percentages.

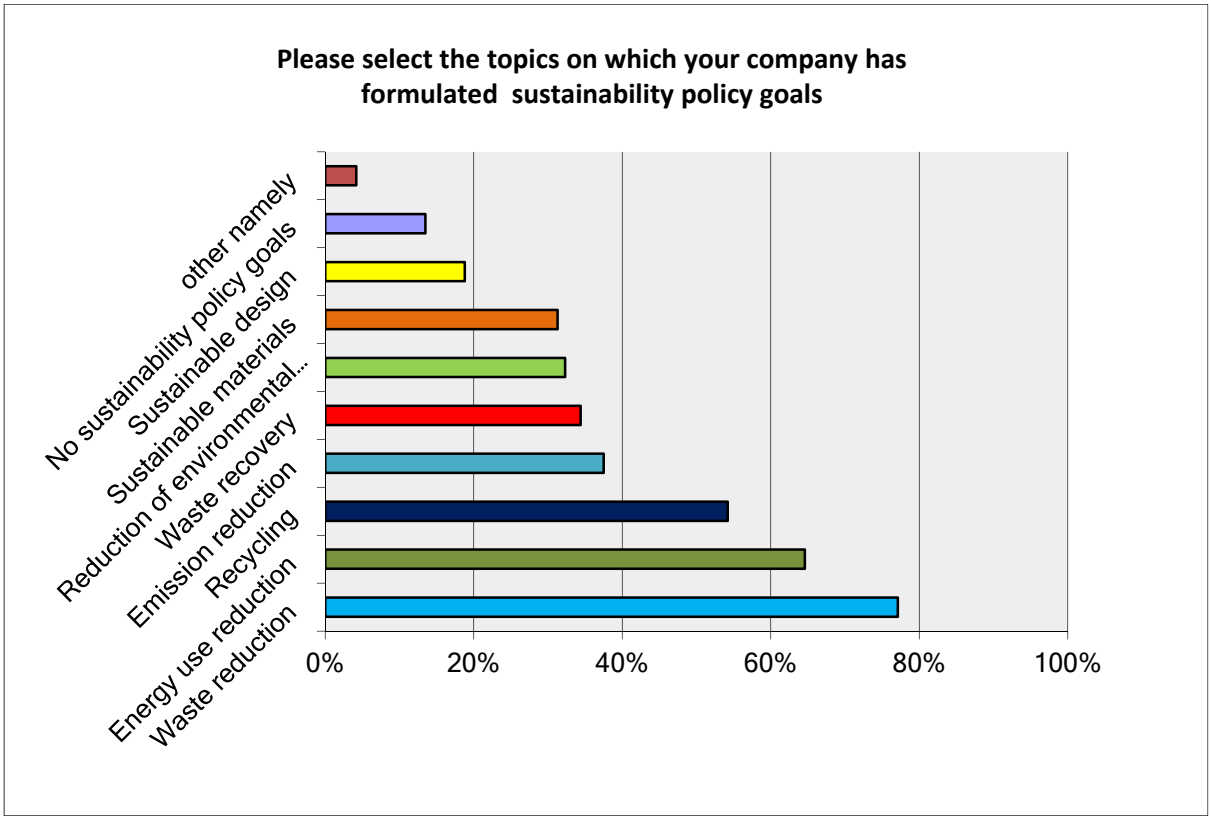

Figure 1: Policy sustainability goal, 96 respondents

Additionally, 66 companies (69%) indicated that they felt their senior management team supported sustainability initiatives such as LCA. During the interviews the importance of the support from the senior management team became clear. The fact that the interviewed were able to come this far with sustainability was attributed to the support from their CEO and it being part of their companies DNA.

3.2.2 Environmental labelling

Regarding environmental labelling, especially sustainable forest management for the paper labels is an important sustainability indicator. The interviewed companies indicated they have extensive programs on sustainable forest management. In the survey, 16 companies indicated that they used the FSC label and 10 companies indicated they used PEFC certification, both certifications are for sustainable forest management. Other important environmental certification programs used by the labelling sector are ISO 14001:2010 (mentioned by 31 companies) and L.I.F.E (mentioned by 21 companies). This is also illustrated in percentages in Figure 2.

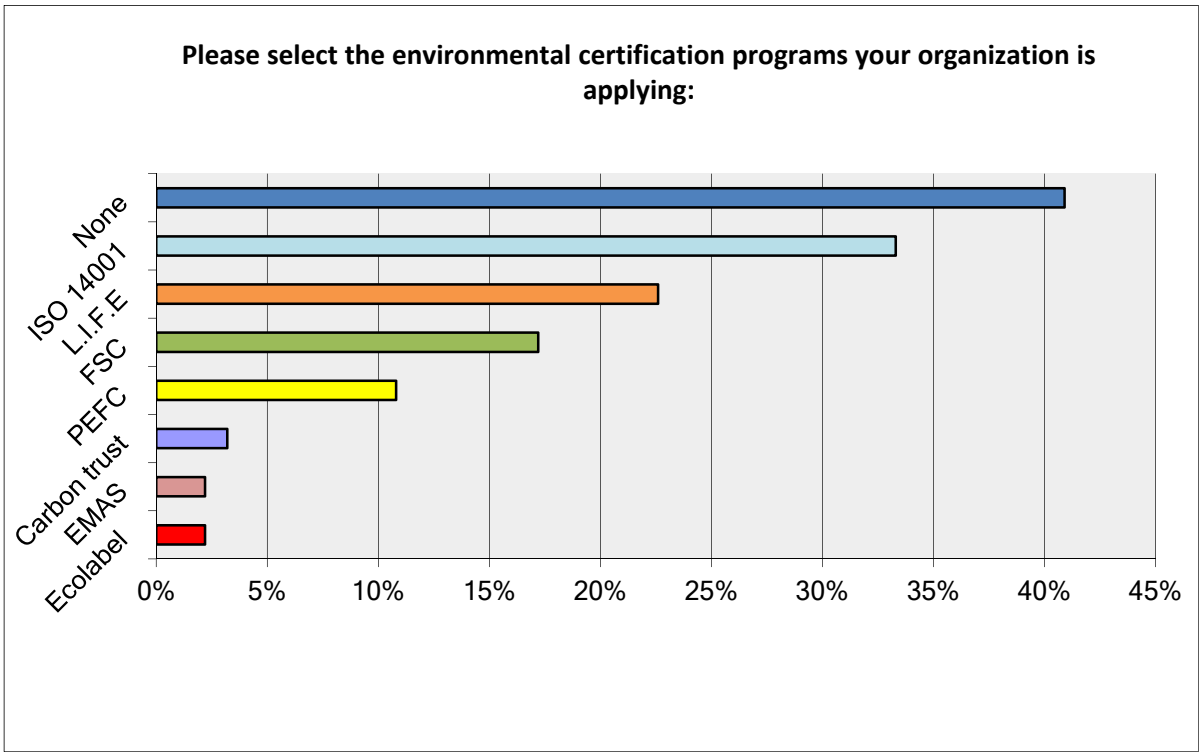

Figure 2 : Environmental certification programs, 93 respondents

3.2.3 Supplier Information requests

From the survey and the interviews it became clear that a growing number of companies have started with information requests to suppliers to gain insight in the sustainability performance of the supplied materials. In the survey 54% of the respondents indicated they requested supplier information on sustainability performance. The main topics on which information is requested are: sustainable material selection (31 companies), waste (29 companies), and energy use (19 companies). Thirteen respondents requested information on the overall environmental impact (entire life cycle).This also illustrated in Figure 3 in percentages.

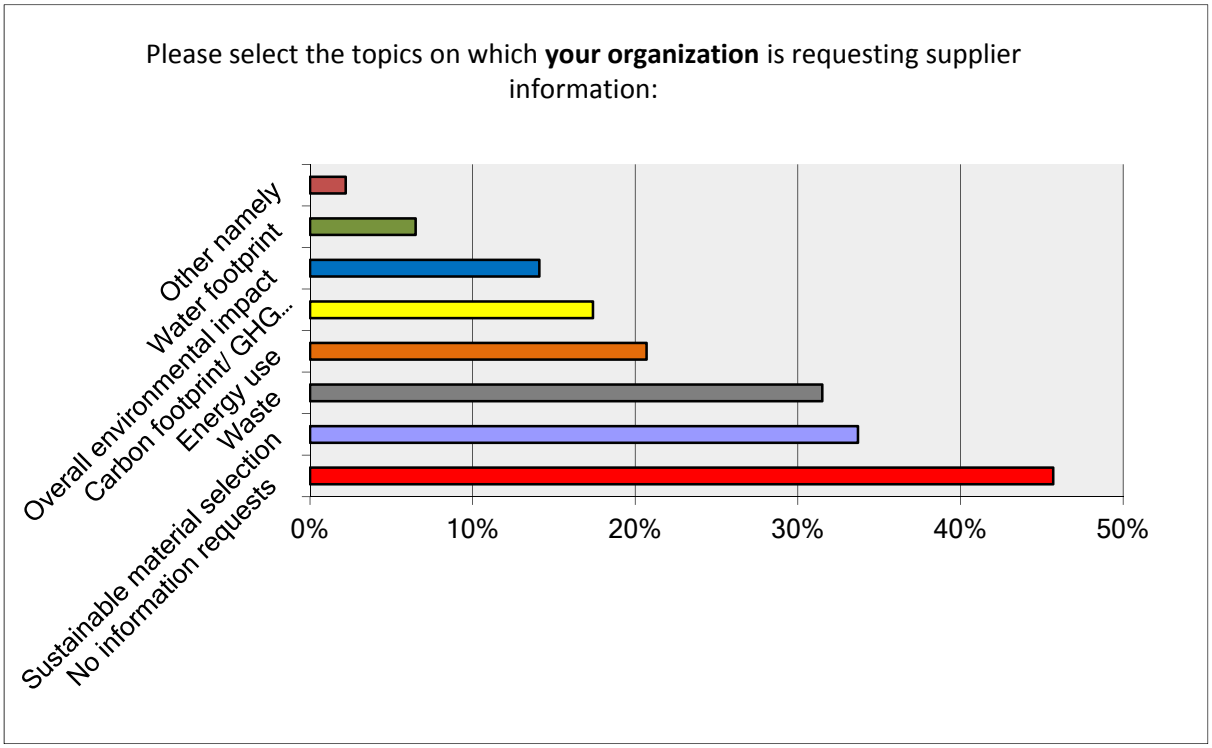

Figure 3: Requests for supplier information, 92 respondents

3.2.4 Customer Information requests

It is interesting to see that significantly more customers (69%) are requesting information on the sustainability performance of the products they buy (see Figure 4). This underlines the growing market demand for more sustainable products. The requests for information focus mainly on sustainable material selection (44 companies) waste (28 companies). Additionally customers are interested in the carbon footprint (20 companies) and the overall environmental impact-full LCA (20 companies).

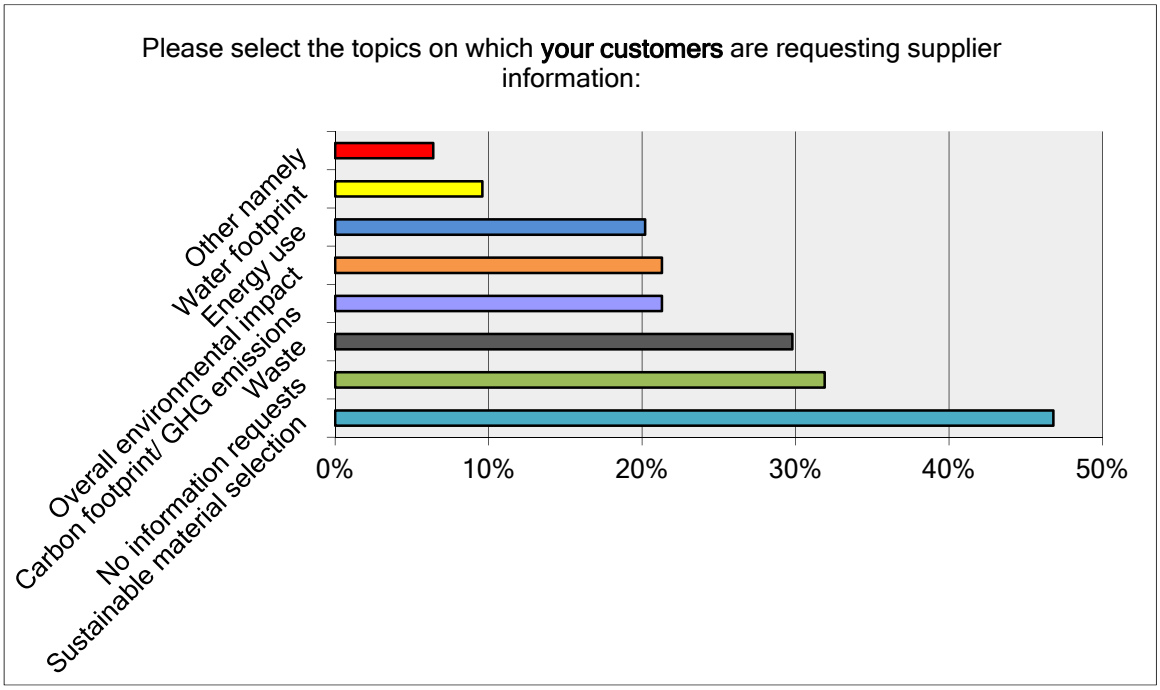

Figure 4: Customer information requests, 94 respondents

3.2.5 Use of LCA

From the survey it became clear that the majority of the companies, 82 of the 95 respondents, are not using LCA to measure environmental impacts of their products (Figure 5). Additional analyses also showed that of the 22 converters/printers who filled in the survey, none are using LCA at the moment.

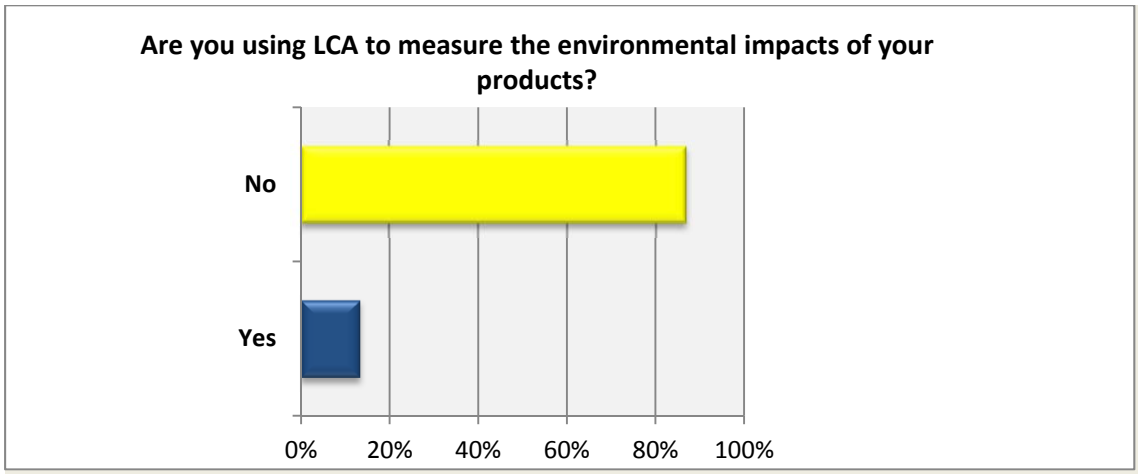

Figure 5: Use of LCA, 95 respondents

From the companies not using LCA, 48 indicated that they are not familiar with LCA and its applications (Figure 6). Especially under printers/converters there is a lot of unfamiliarity, 15 out of the 22 converters/printers indicated that they were not familiar with LCA.

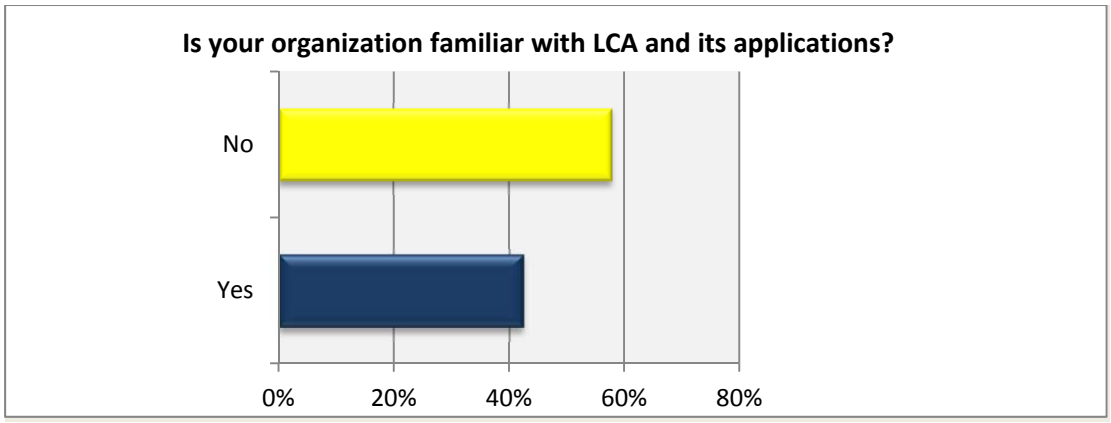

Figure 6: Familiarity with LCA, 83 respondents

3.3 Companies not using LCA

The companies not using LCA got a different set of questions than those who are using LCA. We will now discuss the responses of the 82 respondents not using LCA in their organisation.

3.3.1 Use of other sustainability metrics

Most of the respondents not using LCA indicated that they did have sustainability metrics in place for energy use (50 companies) and waste disposal (45 companies). Only 25 respondents indicated that they have no other sustainability metrics in place (illustrated in percentages in Figure 7).

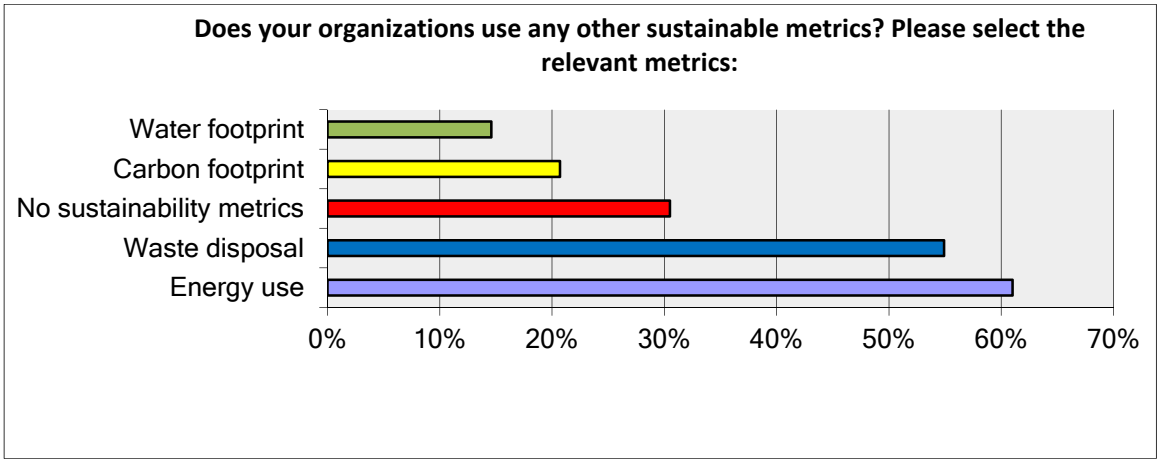

Figure 7: Sustainability metrics, 82 respondents

3.3.2 Ambition to use LCA in the future

The majority of the respondents (43 companies) have ambitions to use LCA in the future (Figure 8). The same applies for the printers/converters, 16 of the 22 want to start using LCA in the future. Twenty one companies indicated that it would depend on customer requests and manpower needed. Twenty-three companies indicated that they don't have any plans to start using LCA. The most important reasons is that there is no customers demand for LCAs. Other reasons for having no plans to use LCA in the future are:

- The methods vary widely, making comparison misleading;
- It has no priority at the moment.

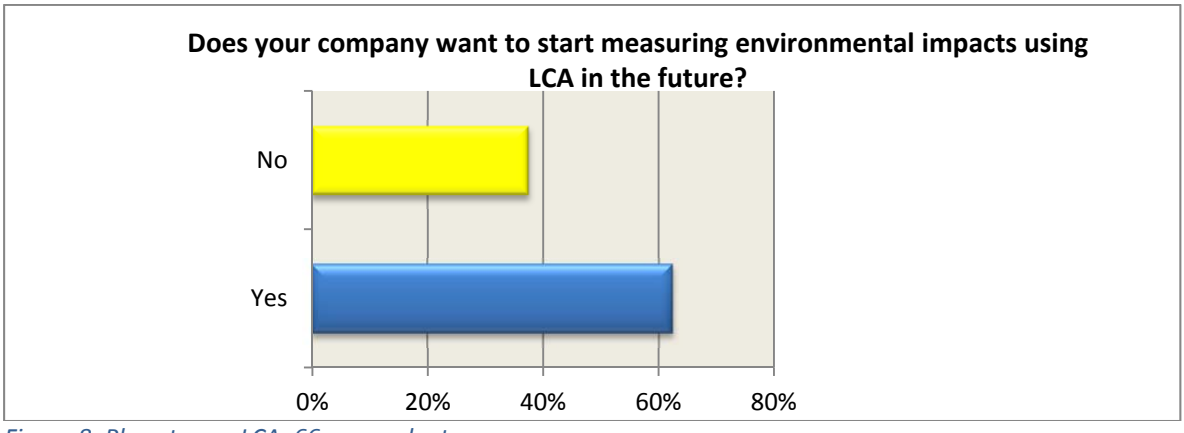

Figure 8: Plans to use LCA, 66 respondents

For the companies with no plans to use LCA in the future this was their last question.

3.3.3 Desired use of LCA

The companies with ambitions to use LCA in the future would like to use LCA to:

- Improve operational performance (40 respondents - 70%)
- Marketing and product branding (37 respondents - 65%)
- Corporate social responsibility program (30 respondents - 53%)
- Development and design of sustainable products (21 respondents - 37%)

3.3.4 Main hurdles and desired support

The main hurdle experienced by the respondents for conducting LCAs is the lack of dedicated personnel (39 respondents - 68%). Additionally, the respondents indicated a lack of internal awareness/knowledge (31 respondents - 54%) and constraints in time and budget (29 respondents - 51%).

The respondents would value the following types of support:

- Training on how to conduct LCAs (19 respondents - 35%)
- Practical examples how LCA can be used (16 respondents - 30%)
- A harmonized and by the sector endorsed methodology (9 respondents - 17%)
- Tools to make LCA application more efficient (7 respondents-13%)

3.4 Companies using LCA

Thirteen respondents of the survey and the interviewed companies use LCA at the moment. We will now discuss their responses.

3.4.1 Use of LCA by whom and how

The respondents from the interview and the survey both indicated that an important application of LCA is marketing. Eight respondents use LCA as a tool for their business-to-business marketing. From the interviews it became clear that development and design of sustainable products is also an important driver for the use of LCA. Some of the interviewed companies had already integrated sustainability in their stage-gate design process. Also 5 respondents of the survey used LCA for the development and design of sustainable products. Other applications for which LCA is used are:

- Transparency on environmental performance (6 companies)
- Improve operational performance (5 companies)

Also illustrated in Figure 9percentages.

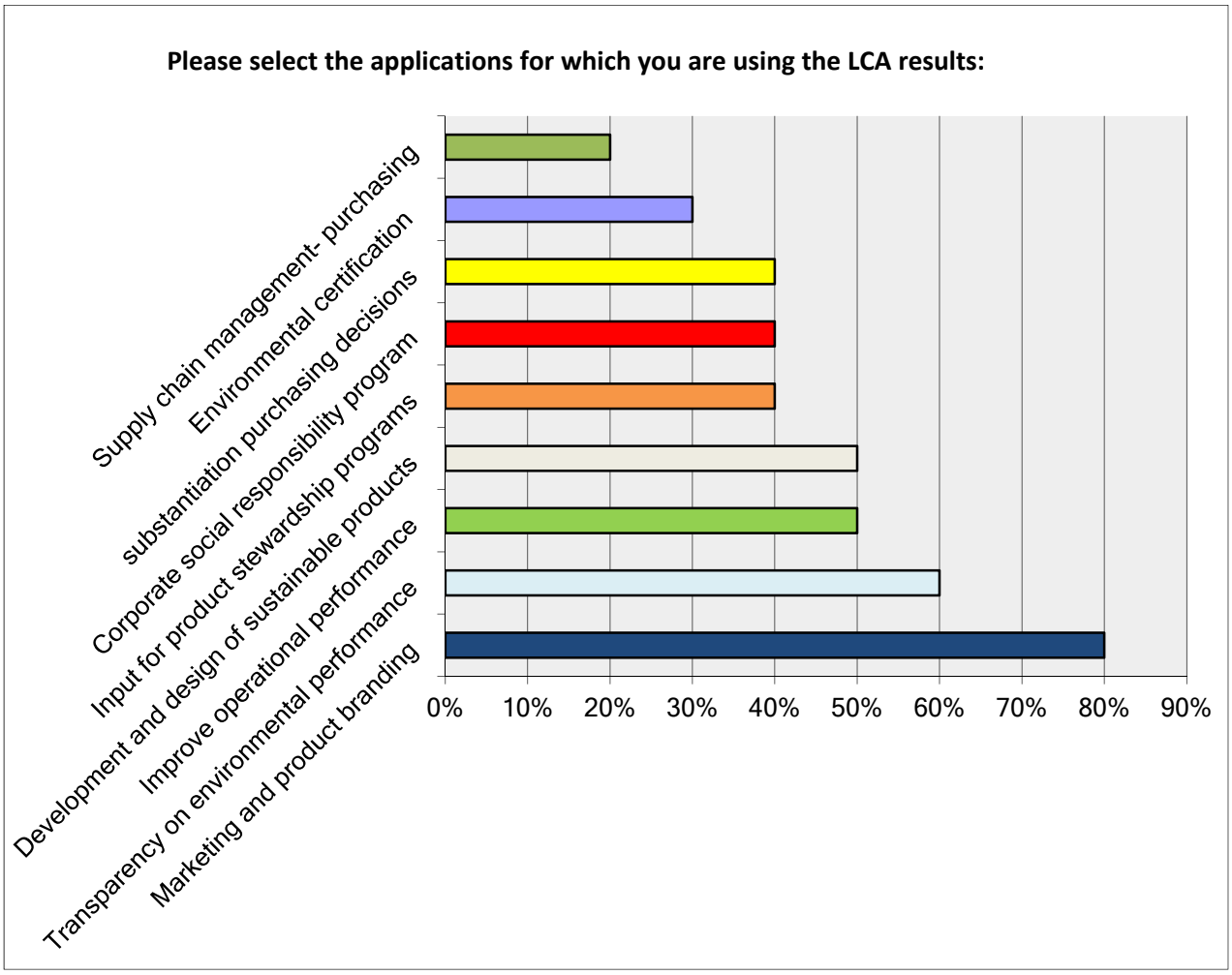

Figure 9: Use of LCA, 10 respondents

The departments using the LCA results are in line with for which applications the companies are using the LCA results namely:

- Marketing (8 companies - 80%)
- Sustainability department (6 companies - 60 %)
- General management (5 companies - 50%)
- Product development (3 companies - 30%)

The interviewed companies had an in-house tool to conduct their LCA as well as 4 respondents of the survey. Due to confidentiality companies did not fill in their company name, so it is a possibility that the interviewed companies also filled in the survey. The other respondents indicated that they used an in-house LCA expert (3 companies) or an external consultant (3 companies) to conduct their LCAs.

3.4.2 Used Impact assessment method, categories and databases

The following impact assessment methods are being used by the respondents: TRACI (2012), IMPACT 2002+, GHG protocol(2009), ILCD 2011, IPPC(2007) and CML-IA (2001).

In the LCA a variety of impact categories are being used to express the environmental impact of the label. The most commonly used are water resources (8), non-renewable resources (7), resource depletion (7), climate change (6) and ozone layer depletion (6). Table 3 shows the impact categories used by the respondents and the number of respondents using these impact categories.

Table 3: Impact categories, 9 respondents

Impact category	Number of respondents that uses this impact category
Water resources	8
Non-renewable resources	7
Resource depletion	7
Climate change	6
Ozone layer depletion	6
Aquatic eutrophication	5
Acidification	4
Land use	4
Photochemical oxidation	4
Human Health	4
Ecotoxicity	4
Total impact (single score)	3
Human toxicity	3
Ecosystem quality	2

Seven respondents indicated that they used the following commercial databases: Ecoinvent. (2 respondents),GaBi (2 respondents), USLCI (1 respondent), LCA food (1 respondent) and the GREET model (1 respondent).

3.4.3 Scope, functional unit and multi-functionality

From the interviews and the survey it became clear that the most common assessment scope is from cradle-to-factory gate, encompassing all supply chain activities up to the production of the label. Three respondents indicated that they conducted cradle-to-grave assessments, this including the entire life cycle from raw materials to end-of life.

We asked the respondents from the interview and survey which quantitative reference was being commonly used, the so-called functional unit. Most companies used a functional unit of x m^2 of ready-made label. Where the x varied between 1000 m^2 and 1.000.000 m^2.

Most respondents did not have multi-functional process in their models. Three respondents did, two used mass allocation to allocate the environmental impacts between the products and one respondent used system boundary expansion.

3.4.4 Hurdles and support

The main hurdles experienced by the respondents in conducting LCAs are:

- Constraints in time/budget (4 respondents - 40%)
- Data confidentiality (3 respondents- 30%).
- No dedicated personnel (2 respondents - 20%)
- Lack of internal awareness/priority/knowledge (1 respondent - 10%)

One respondent indicated that they did not experience any hurdles in conducting LCAs.

The respondents who are already using LCA would value development of a harmonized and by the sector endorsed methodology the most (8 respondents - 80%). Additionally, they would value support in training on how to conduct LCAs (4 respondents - 40%) and practical examples of how LCA can be used (3 respondents - 30%)

3.5 Conclusion and Recommendations

Generally, the results show that sustainability is an important topic in the labelling industry. Almost all companies have a sustainability program in place and are working with sustainability policy goals on waste, energy use and emission reduction. Most companies also feel that their sustainability initiatives are supported by the senior management team.

The majority of the respondents (86%) is not yet using LCA as tool to measure the environmental impact of their products and is also not familiar with LCA (58%). Despite their unfamiliarity with LCA 65% of respondents want to start measuring their environmental impact using LCA in the future. The main reason for the companies with no ambitions to use LCA is that their customers are not requiring it.

The main hurdles in starting to use LCA are lack of dedicated personnel and internal awareness/priority. The respondents would value training on how to conduct LCAs and practical examples how LCA can be used.

For the companies already using LCA, LCA is an important tool in marketing and product development. The companies use similar impact categories to express the LCA results namely: Water resources, Non-renewable resources, Resource depletion, Climate change and Ozone layer depletion. A commonly used functional unit is x m^2. The companies would most value support in the development of a harmonized and by the sector endorsed method to conduct LCAs.

The survey results underline the importance of creating an easy accessible step in for companies who want to start with LCA. We would recommend to make one of the goals of the training and guidance document to create more familiarity with LCA within the labelling industry. The companies already using LCA stress the importance of a harmonized and by the sector endorsed method to conduct LCAs. Their experiences and current practices will be used for the development of the harmonized sector approach.

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Appendix A – Survey state of the practice

Example e-mail

Dear TLMI/FINAT members,

In recent years, there has been a growing demand for more sustainable labelling products driven by requests from governments, global brand owners and consumer groups. As a result a growing number of companies in the labelling industry have created transparency on the environmental impact of their products using Life Cycle Assessment (LCA). LCA is an internationally recognized method to assess the environmental performance of a product or service throughout its complete life-cycle, from raw material extraction, through production and use to its end of life. For example when a supplier reports the carbon footprint of his products, he is most likely using LCA as the methodology to calculate its carbon footprint.
These developments have resulted in various in-house tools and methodologies within the labelling sector. Without a common sector approach there is a risk of conflicting messages to customers and suppliers who are 'overloaded' by requests to calculate their environmental impact using various methods.

This has resulted in an understanding within the labeling industry that there is a need for:

- Creating a common understanding of Life Cycle Assessment (LCA) and the hotspots within the labeling value chain
- A harmonized LCA approach

Therefore a joint TLMI/FINAT project has been started with the following approach:

- Understand the LCA landscape of the production of self-adhesive labels
- Get insight into LCA specificities in the context of two practical case studies on self-adhesive label products
- Provide guidance on the LCA methodology and the reasons for conducting a LCA study
- Provide a harmonized LCA approach for the self-adhesive label industry and an overview of the available tools.
- Training on LCA tailored for the self-adhesive label industry

This survey is part of understanding the LCA landscape within the labelling sector. With this survey we aim to gain insight in:

- The current practices and whether there is already a common ground for a sector approach
- The needs for support within the labelling industry for (further) development of LCA practices.

Filling in the survey will assure that we can take in account your organizations practices in the development of the sector approach and anticipate on your organizations needs for support.

It would be greatly appreciated if you could help us by filling in the survey before **Wednesday the 3th of June**. By clicking this link you will gain access to survey. The survey will take approximately 8 minutes.

Yours sincerely, debilitating

The Survey questions

General

1. Please select the kind of organization you are representing:
    - Labels manufacturer
    - Printing/Converter
    - Equipment-Supplier
    - Material-supplier
    - Other namely

2. Please select the main markets in which your organization operates (multiple answers possible):
    - Europe
    - Northern America
    - Asia
    - Central America
    - South America
    - Other namely

3. Please select the topics on which your company has formulated sustainability policy goals (multiple answers possible):
    - Waste reduction
    - Energy use reduction
    - Recycling
    - Waste recovery
    - Emission reduction
    - Sustainable materials e.g. FSC paper and lightweight materials
    - Sustainable design
    - Reduction of environmental impacts e.g. 20% reduction of carbon footprint
    - None
    - Other namely

4. Please select the environmental certification programs your organization is applying:
    - Ecolabel
    - Carbon trust
    - FSC
    - PEFC
    - EMAS
    - L.I.F.E
    - Ecologo
    - ISO 14001
    - None
    - Other namely

5. Please select the topics on which your organization is requesting supplier information:
    - Energy use
    - Waste
    - Sustainable material selection
    - Carbon footprint/GHG emissions
    - Overall environmental impact (full LCA)
    - Water footprint
    - We are not requesting any sustainability information
    - Other namely

6. Please select the topics on which your customers are requesting supplier information:
    - Energy use
    - Waste
    - Sustainable material selection
    - Carbon footprint
    - Overall environmental impact (full LCA)
    - Water footprint
    - Other namely
    - Our customers are not requesting any information on sustainability

7. Are sustainability initiatives such as LCA supported by your senior management team
    - Yes
    - No

8. Are you using LCA to measure the environmental impacts of your products
    - Yes (go to section questions companies using LCA)
    - No (go to section questions companies not using LCA)

For companies not using LCA

1. Is your organization familiar with LCA and its applications?
    - Yes
    - No

2. Does your organizations use any other sustainable metrics, please select the relevant metrics:
    - Carbon footprint
    - Water footprint
    - Waste disposal
    - Energy use
    - Other namely
    - No sustainability metrics are being used in our organization

3. Does your company want to start measuring environmental impacts using LCA in the future?
    - Yes (go to question 5)
    - No (go to question 4)

4. Could you explain why your company doesn't have any ambitions to start using LCA *(end of survey for these respondents)*

5. Please select where ideally your organization would use the LCA results for
    - Improve operational performance
    - Input for product stewardship programs
    - Supply chain management- purchasing decisions
    - Corporate social responsibility program
    - Customer management- substantiation purchasing decisions
    - Transparency on environmental performance
    - Environmental certification e.g. Ecolabels
    - Development and design of sustainable products
    - Marketing and product branding (creating new markets)
    - Other namely

6. Could you please select the biggest hurdles in using LCA to measure the environmental performance of your products:
    - Lack of internal awareness/priority/knowledge
    - Constraints in time/budget
    - No dedicated personnel
    - Data confidentiality
    - Other namely

7. To start with LCA could you indicate what kind of support you would most value:
    - Training on how to conduct LCAs
    - Practical examples how LCA can be used
    - Materials to create awareness of the business value internally
    - A harmonized and by the sector endorsed methodology
    - Tools to make LCA application more efficient
    - Other namely

For companies using LCA

1. Please select the applications for which you are using the LCA results
    - Improve operational performance
    - Input for product stewardship programs
    - Supply chain management- purchasing decisions
    - Corporate social responsibility program
    - Customer management- substantiation purchasing decisions
    - Transparency on environmental performance
    - Environmental certification e.g. Ecolabels
    - Development and design of sustainable products
    - Marketing and product branding (creating new markets)
    - Other namely

2. Please select how your company conducts its LCAs:
    - in-house tool
    - manually by an in-house LCA expert
    - An external consultant
    - Other namely

3. Please select the impacts commonly measured with your company LCAs:
    - Non-renewable resources
    - Water resources
    - Land use
    - Climate change
    - Aquatic eutrophication
    - Acidification
    - Ecotoxicity
    - Human toxicity
    - Photochemical oxidation
    - Ozone layer depletion
    - Human Health
    - Ecosystem quality
    - Resource depletion
    - Total impact (single score)
    - Other namely

4. Please select the impact assessment method most commonly used for your lCAs:
    - TRACI
    - USEtox
    - Impact 2002+
    - GHG Protocol
    - ReCiPe
    - ILCD 2011
    - CML-IA
    - IPCC
    - Other namely

5. For secondary data needs commercial databases can be used. Please select which commercial databases are most commonly used in your LCA studies:
    - Ecoinvent
    - ELCD
    - GABI
    - USLCI
    - LCA food
    - GREET model
    - I-O data
    - Other namely

6. Please select the common scope of your LCAs:
    - Cradle to grave, thus including the entire life cycle
    - Cradle to (factory) gate, encompassing all supply chain activities up to the production of the label

7. Please select the constraints/hurdles your company is experiencing with the use of LCA:
    - Lack of internal awareness/priority/knowledge
    - Constraints in time/budget
    - No dedicated personnel
    - Data confidentiality
    - Other namely

8. In order to assess the environmental performance of a label the quantitative reference to which the calculation apply must be determined, this is the so-called functional unit. In communication materials and in-house tools often a standard functional unit is being used. For example: 50 m^3 of labels. Please describe the functional unit commonly used in your LCAs:

9. If you have a multi-functional process what approach do you apply:
    - System boundary expansion
    - Mass allocation
    - Economic allocation
    - Other namely
    - No multi-functional process in our models

10. To further develop LCA within your organization could you indicate what support you would most value:
    - Training on how to conduct LCAs
    - Practical examples how LCA can be used
    - Create buy-inShow business value to Top management leadership
    - Materials to create awareness of the business value to create value top management buy
    - A harmonized and by the sector endorsed methodology
    - Tools to make LCA application more efficient
    - Other namely

11. Please select which departments are using the LCA results
    - Sustainability department (CSR, Environmental department)
    - Product development
    - Supply Chain / operations
    - Marketing
    - General Management

- Research and development
- Other (Please specify)

12. An important part creating a harmonized sector approach is an understanding of how LCAs are already conducted. Insight in already available LCA reports is very valuable for this purpose. Does your organization have any LCA reports which you could be shared on a confidential basis with the consultants working on this project

    - Yes
    - No

13. We are very much interested in receiving your feedback regarding this project. Do you have any comments, suggestions or questions regarding this project?

Appendix B – Glossary

Allocation:	Partitioning the input or output flows of a process or other product system to the product system under study. The life cycle stages can lead to the co-production of energy and/or materials for other outlets. Therefore, it is important to coherently and relevantly allocate the fraction pertaining to the different outlets.
Assembly:	Can be understood as the definition of a product, containing all materials, transport, energy processes and subassemblies.
Acidification:	The impacts of the sulphur compounds in the lower atmosphere, measured based on the acidification potential of a given substance and expressed in kg SO2- equivalent.
Aquatic eutrophication:	The emissions of nitrogenous or phosphate substances into aquatic environments that foster the proliferation of microalgae and plankton and which lead to oxygen depletion, measured in kg PO43- equivalent.
Biogenic carbon:	Biogenic carbon is related to the natural carbon cycle, including also emissions from the combustion, harvest, combustion, digestion, fermentation, decomposition, or processing of biologically based materials.
BUWAL database:	An old database from the Swiss Agency for the Environment, Forests and Landscape (Bundesamt für Umwelt, Wald und Landschaft).
Carbon offsetting:	A carbon offset is a reduction in emissions of carbon dioxide or greenhouse gases made in order to compensate for or to offset an emission made elsewhere.
Carbon storage:	Carbon storage refers to storage of the carbon dioxide (CO_2) emissions produced from the use of fossil fuels in electricity generation and industrial processes, preventing the carbon dioxide from entering the atmosphere.
Capital goods:	Goods that are a one-off investment, like trucks or machines.
Category endpoint:	An attribute or aspect of natural environment, human health, or resources, identifying an environmental issue of concern.
Climate change:	Accounts for all of the substances known to contribute to global warming and adjusted based on their global warming potential (GWP). The impacts are expressed in kilograms of carbon dioxide (CO2) equivalent.
Cut-off criteria/rules:	Specification of the amount of material or energy flow, or level of environmental significance associated with unit processes or product system to be excluded from a study.
Damage analysis:	To find out the total damage a chemical substance can cause (how many people are affected and the severity of the disease).
Ecoinvent database:	Database managed by the Ecoinvent Centre (Swiss centre for Life Cycle Inventories). It is responsible for extending, updating and preserving the high quality of the Ecoinvent database. The data in this database is derived from different older LCI databases, mainly BUWAL and ETH-ESU 96, and covers many areas.
Ecosystem quality:	Accounts for the impacts on the natural environment, measured in the potentially disappeared fraction (PDF) of the species per surface unit used during a specific time period (PDF·m^2·year).

Ecotoxicity:	The impacts on terrestrial and aquatic ecosystems in terms of biodiversity loss caused by ecotoxic environmental emissions, measured in kg triethylene glycol equivalent.
Effect analysis:	To find out what effect a chemical substance can cause (what kind of diseases) with a specific concentration.
Endpoint:	A term introduced in (but unfortunately not defined in) ISO 14044. It refers to the final outcome of an environmental mechanism. For instance the outcome of climate change can be an increase of seawater level. In older LCA literature this was referred to as the safeguard subject; the issue society wants to protect (see also category endpoint).
End-of-life allocation:	Partitioning the input or output flows at the end of life to the life cycle under study, or the life cycle following the one under study. Think of e.g. material or energy recovery resulting from recycling or incineration (see also allocation).
Fate analysis:	To find out in which environmental compartment (air, water, soil) a chemical substance finally will turn up.
Functional unit:	The quantitative reference to which the inventory calculations and impact assessment apply.
Goal:	Before starting a life cycle assessment, it is important to define the goal of the study (a.o. intended application and audience, reasons and communication) as this can have important consequences for the execution of the work.
Global warming:	The global warming potential of greenhouse gases (GHG), calculated in kilograms of carbon dioxide (CO_2) equivalent and based on infrared radiative forcing data.
Human health:	Accounts for substances that present toxic (carcinogenic and non-carcinogenic) and respiratory effects, measured based on the gravity of potential illness in disability-adjusted life years (DALY), which reflects human health damage.
Human toxicity:	The impacts associated with the carcinogenic and non-carcinogenic impacts caused by pollutants released into the environment and coming into contact with humans through breathing, eating or drinking, measured in kg chloroethylene equivalent.
Impact category:	A class representing environmental issues of concern to which LCI results may be assigned.
Land use:	The total surface of land, calculated as part of the inventory and measured in unit area used during a specific time period (m^2·year). The reduction in biodiversity brought about by land use is also calculated and measured in the potentially disappeared fraction (PDF) of the species per surface unit used during a specific time period (PDF·m^2·year).
Library:	A place used to store background data and methodologies. This data can in a further stage serve as a resource for a project.
Life cycle:	Consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to final disposal.

Life Cycle Assessment: Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.

Life Cycle Impact Assessment: Phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts of a product system.

Life Cycle Inventory analysis: A phase of life cycle assessment involving the compilation and quantification of inputs and outputs, for a given product system throughout its life cycle.

Life Cycle Inventory Results: A list of emissions, resource use, land use, etc. that are collected, before impact assessment is applied.

Midpoint: An indicator that is somewhere along the environmental mechanism and the LCI parameter. For instance the CO_2 equivalents that express the radiative forcing is a midpoint. It is needed to calculate an endpoint indicator, such as increased seawater level, but additional modelling steps are needed. See also Endpoint.

Modeling approach: Term used to indicate how allocation is handled in a specific LCA.

Monte Carlo analysis: An analytical method that randomly generates values for uncertain variables by running a model fitted to an experimental dataset.

Multi-product processes: Processes that result in the production of different co-products raise the question how to allocate the input and output flows (see also allocation).

Normalisation: A procedure to show to what extent an impact category contributes to the overall environmental problem.

Non-renewable resources: The use of non-renewable energy sources and minerals extraction, quantified in megajoules (MJ) of primary energy.

Ozone layer depletion: The impacts caused by the reactions between the stratospheric ozone and chlorofluorocarbons (CFC) leading to ozone layer depletion and reduced ultraviolet ray filtration, measured in kg CFC equivalent.

Photochemical oxidation: All complex phenomena leading to the formation of ozone and other precursor oxidizing compounds in the ozone layer, measured in kg ethylene equivalent.

Product stages: Stages that are used to describe the composition of the product, the use phase and the disposal route of the product.

Product system: Collection of unit processes with elementary and product flows, performing one or more defined functions that models the life cycle of a product.

Reference flow: Measure of the outputs from processes in a given product system required to fulfil the function expressed by the functional unit.

Soil carbon: Soil carbon is the generic name for carbon held within the soil, primarily in association with its organic content.

System boundaries: The boundaries defining which life cycle stages and processes will be included in the life cycle assessment.

Water resources: The use of water from underground freshwater, surface and ocean sources for all types of needs (e.g. irrigation, process water, drinking water, etc.), calculated as part of the inventory and measured in equivalent litres of water (L or m^3 equivalent).

Weighting:	The process by which various indicators, resulting from an LCA study, are aggregated into one single figure (or a limited number of figures) through the use of subjective weighting factors.
Weighting factor:	A factor that is coupled to a certain impact category, which is determined by a panel, based on subjective opinions. The factor reflects the importance of the category.