Harmonized Life cycle assessment approach for the self-adhesive label industry

Prepared for

TLMi

FINAT
LINKING THE LABEL COMMUNITY

Developed by

PRé

Harmonized Life cycle assessment approach for the self-adhesive label industry

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1 General introduction to this document

This document has been developed by 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) to answer the self-adhesive label industry's need for a harmonized Life Cycle Assessment (LCA) approach, and to provide its members with a set of pre-competitive guidelines to analyze the environmental performance of their product life cycles and identify opportunities for improvement. These guidelines are part of a broader project in which the labelling sector aims to create a better understanding of the value and application of Life Cycle Assessment in the labelling industry.

1.1 FINAT and TLMI

FINAT

The world-wide association for manufacturers of self-adhesive labels and related products and services (FINAT) is an international organization recognized as the voice of the label industry, with approximately 500 members in 54 countries around the world. The aim of FINAT is to promote self-adhesive labels and related products in the widest sense and to represent the interests of all members, both converters and suppliers, wherever and whenever possible. FINAT, which is uniquely structured for an industry association, brings together both converters and suppliers, reflecting the partnership within the self-adhesive label value chain which has contributed to the dynamic development of the industry, and which keeps it at the forefront of innovation today.

TLMI

The Tag and Label Manufacturers Institute (TLMI) is the leading association for the narrow web tag, label and packaging industries. It is a member-driven association strongly committed to providing business solutions that enhance the prosperity of its members and the narrow web tag, label, and packaging industries. There are more than 300 members consisting of both converters and suppliers with the majority being based in North America. Through its meetings and programs TLMI offers members critical benchmarking tools and information resources to assist them in meeting the constantly shifting requirements of the marketplace, the opportunity to network with peers and to learn from one another and a platform conducive to establishing new partnerships and to strengthening existing relationships.

1.2 Backgound of the document

Labels play a critical role in the communication and marketing of products. The growing concern for the environment, combined with the visibility of labels, has led to an increasing number of requests from clients and stakeholders for insight in the environmental burdens of labels. Parallel to this trend, a growing number of players in the fast-moving consumer goods sector are integrating sustainability into their core business. A first step in this process is often to gain insight in the environmental performance of their suppliers. As a result, companies in the labelling sector are asked more often to give insight into their environmental performance and have discovered good environmental practices as a way to distinguish themselves from the competition.

Life Cycle Assessment (LCA) is a widely recognized and scientifically-sound methodology to measure environmental impacts. LCA takes into account the complete life cycle of a product, starting from the production of raw materials through to the final disposal of the product, thereby ensuring that potential impacts are not transferred from one life cycle stage to another. It makes companies aware of impacts caused by upstream and/or downstream activities.

Many companies use LCA to measure their environmental performance and that of their products. More background information on LCA and how it can be used can be found in the for FINAT and TLMI developed guidance document : *Life cycle assessment for the self-adhesive label industry .*

At the moment, the various actors in the labelling sector are taking different life cycle assessment (LCA) approaches to measure their environmental performance or are orientating themselves on the usefulness of LCA for their company. TLMI and FINAT have recognized the potential risk of multiple requests to suppliers and of conflicting messages to customers when different approaches are used.

In order to ensure one harmonized approach for conducting LCA studies of self-adhesive label products, TLMI and FINAT are developing a pre-competitive harmonized sector LCA approach. Such a harmonization is very important as it will likely:

- Avoid multiple data requests from various customers.
- Avoid a situation in which members of FINAT and TLMI are sending conflicting messages to customers and other stakeholders by setting fixed rules in advance that all should follow. For example, if one company has included the End of Life (EoL) recycling benefits in their assessment, while another company has attributed these benefits to the company using the recycled the material, the outcomes of the assessment can be very different.
- Make LCA accessible for the small and medium enterprises (SMEs) in the labelling sector. These guidelines are the first step towards this goal but the lack of accessible common Life Cycle Inventory (LCI) database, resources and LCA software can still be constraining factors for SMEs to take up LCA.
- Give a common understanding among members of FINAT and TLMI on what the environmental hotspots and improvement opportunities are in the label industry value chain.
- Create a level playing field for members of FINAT and TLMI supplying the same customer.
- Help identify data collection needs by focusing on the most relevant activities and processes.
- Ensure that relevant drivers are properly covered and assessed for each individual product life cycle.

These guidelines are aiming to be a first step towards comparability of product LCAs, but without for example a common LCI database and a standardized verification process, comparability cannot be guaranteed.

2 Scope

2.1 Definition and description of the product

This guidance is intended for self-adhesive/pressure sensitive labels. Self-adhesive/pressure-sensitive labels are defined in this guidance as follows:

> *"Plain or printed adhesive-coated film or paper materials which are pre-die cut and carried on a release coated liner web. The labels are dispensed from the release liner onto the container surface, manually or automatically"(FINAT,2009)*

In Europe, the technology is known as self-adhesive whereas in North America, South America and Asia the terminology pressure-sensitive is used. In this guidance the terminology self-adhesive is used but this term is interchangeable with the term pressure sensitive.

This guidance concerns printed self-adhesive labels consisting of three main components also shown in Figure 1:

- The printed face stock material with a clearcoat or overlaminate that carries the information
- Release liner
- Carrier layer containing a silicone release coating and a pressure-sensitive adhesive layer

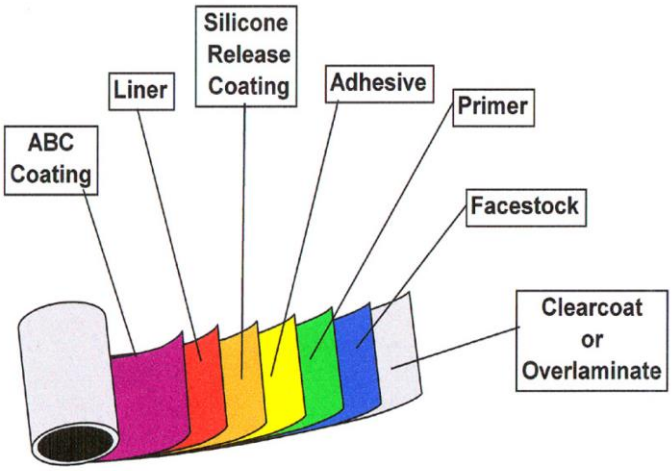

Figure 1: Generic composition of a self-adhesive label

This document represents self-adhesive labels made from paper (coated, uncoated, super calendared, etc.), film (PE, PP, PET, PVC, etc.) and specialty synthetics (acetates, aluminum foil, polyart, etc.).

2.2 System boundaries

We recommend a cradle-to-grave approach. This means that all activities throughout the life cycle of a label product will be included in the assessment, that is: the raw material acquisition and pre-processing, the production stage, the printing/converting, the application of the label to the final product, the use, the disposal of the waste at the end of life and the distribution needed between life cycle stages. Figure 2 shows an overview of the process in the life cycle of a label product. The colors represent the level of operational control of the labelling industry (dark blue for high level of control, light blue for low level of control, white for no control). When it is not possible to access data on downstream activities, e.g. application of the label to the final product, a cradle-to-gate approach may be chosen.

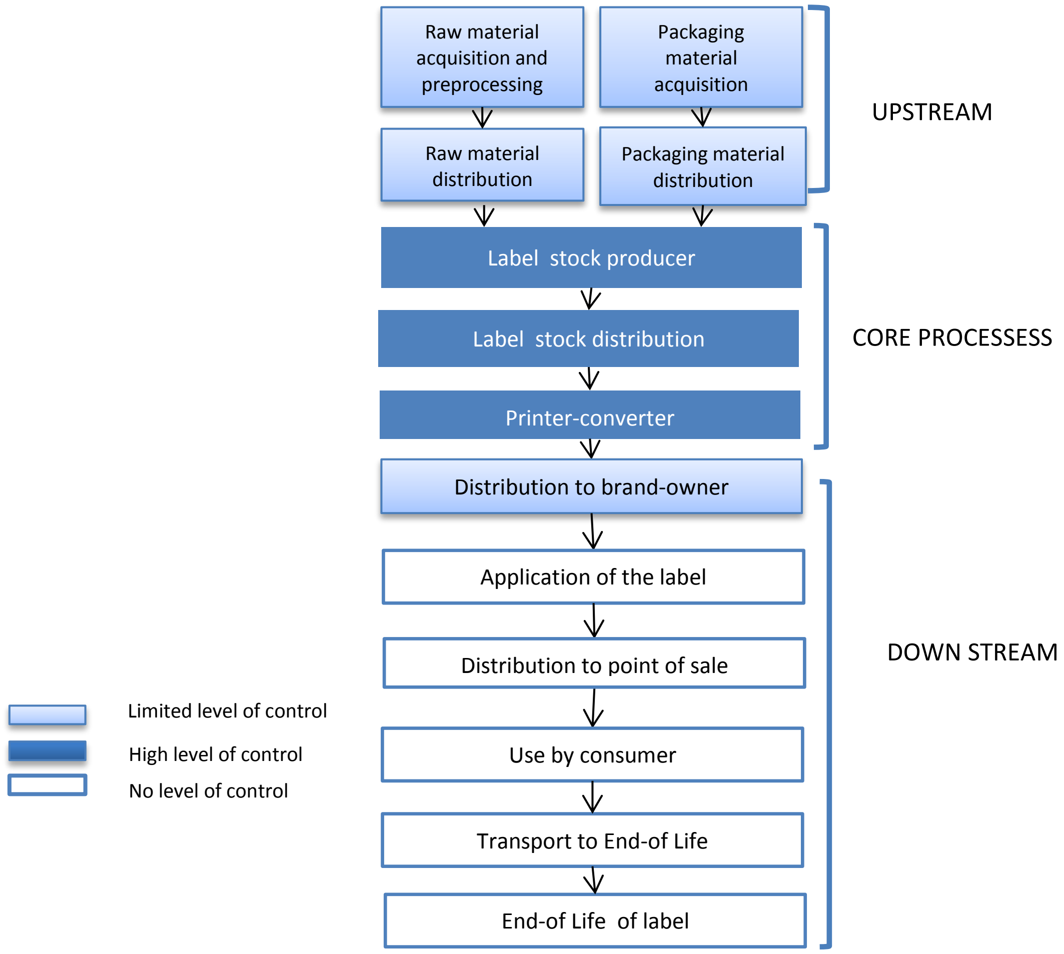

Figure 2:Overview of processes in the life cycle of a label product

Table 1 shows the processes to be included in a cradle-to-gate assessment for the label-stock producer and the printer-converter and the processes to be included for a cradle-to-grave assessment. Deviation from the default cradle-to-grave approach (e.g. exclusions of life cycle stages and processes) shall be reported and communicated clearly in the assessment.

Table 1:Llife cycle stages and processes to be included in the product system boundaries

Cradle-to-gate Label stock producer

Cradle-to grave

Cradle-to-gate printer-converter

Raw material acquisition and pre-processing	
Process to be included	- Raw material extraction - The production, pre-processing (if applicable) and transport of raw materials to the label stock producer (face material, release-liner, adhesive, silicone, etc.)
Output	- Label-stock raw material inputs, e.g. uncoated paper or PP
Label stock producer	
Process to be included	- Factory consumables (e.g. electricity, fuel consumption and water use) - Packaging and transport of label material from label stock producer to the printer-convertor - Treatment of waste generated during label material production - Emission to air, water and soil released during label stock production
Output	- Label stock laminate
Printer-converter	
Process to be included	- The production and transport of the inks and varnishes to the printer-converter - Factory consumables (e.g. electricity, fuel consumption and water use) - Emission to air, water and soil released during printing of label (particularly ozone as this is a known concern for printing) - Treatment of waste generated during printing (production waste and matrix waste[1]) - Packaging and transport of the label to the brand owners
Output	- Ready-made printed label at brand owner
Application of the label	
Process to be included	- Electricity use for application of the label on package - Treatment of liner waste
Output	- Ready-made printed label on package
Post consumer waste	
Processes to be included	- End-of-life waste management considering local and/or regional waste management practices

[1] Matrix waste is the by-product generated in the printing process of self-adhesive labels. It is the "skeleton", the non-label laminate, that is generated after die cutting and removed, leaving the printed label product sitting on the carrier, the release liner.

2.3 Processes considered out of scope

Capital goods needed for the production of the label (factory and machinery) are excluded except for printing tools, such as printing plates and die-cutting tools, which should be included in the assessment. Capital goods are considered out of scope because:

- Their contribution to the overall environmental impact is not significant,
- Data is difficult to obtain,
- There is no secondary representative data for capital goods of the self-adhesive label industry.

Sensitivity analyses[2] can be done including capital goods to test the relevance of capital goods for the specific label under study.

The printer-converter has, in most cases, no insight in what happens with the labels after they have been supplied to the brand-owner. Therefore, the following processes are considered out of scope and don't have to be taken into account in assessment:

- Inputs and emissions other than electricity use for application of the label (default values are provided for this in paragraph 3.2.1) and treatment of the liner at the brand owner (default values are provided for this in paragraph 3.2.3). It is important to be aware that the inputs and emissions at the brand owner could be significant for example to apply a labels glass bottles sometimes need to be wash at high temperatures with water and detergent These inputs and emissions shall be considered when a brand owner is involved in the assessment.
- Transport to the point of sale and transport by the consumer.
- Transport to the waste management and recycling center (collection and sorting).

2.4 Functional unit and reference flow

The functional unit describes qualitatively and quantitatively the function(s) or the service(s) provided by the product analyzed. The functional unit is used to define what the LCA is measuring, and provides a reference to which the inputs and outputs can be related. In order to assess the environmental performance of a label throughout its entire life cycle, the function and functional unit — the quantitative reference to which the life cycle assessment applies — must be determined.

Label stock manufacturers do not always have insight in to what kind of label the supplied label stock material is converted. Therefore three functional units have been defined: two for cradle-to-gate and one for cradle-to-grave assessments.

Functional unit	
Cradle-to-gate label stock manufacturer	*'1 m^2 of ready-made self-adhesive label stock material leaving gate at the label stock manufacturer'*
Cradle to gate printer-converter	*'1 m^2 ready-made printed label leaving gate at the printer-converter'*
Cradle-to-grave	*'1 m^2 ready-made printed label applied on package'*

2 A sensitivity analysis evaluates the influence the most important assumptions have the results (see paragraph 3.5)

The reference flow describes the amount of the product required to fulfil the functional unit. A reference flow is especially important in product comparisons. In many cases, one cannot simply compare products A and B, as they may have different performance characteristics. For example, label A might be more effective to apply, thereby needing less input (because there are less faulty applications) or the cutting of label A could be more effective thereby generating less matrix waste.

EXAMPLE: To fulfill the functional unit label A might require different amounts at the printer-converter to fulfill this functional unit to produce *1 m^2 of ready-made printed label applied on package* than Label B. For example:

Input needed for 1 m2 ready-made label on package	**Amount**	**Mass**
Ready-made label A printed	1,4 m^2	0,30 kg
Ready-made label B printed	1,2 m^2	0,25 kg

So to fulfill the function unit of 1 m^2 of ready-made printed label on package, label A will require 1,4 m^2 of label stock material input whereas only 1,2 m^2 of label B would be required.

2.5 Requirements for multifunctional products

In case of any by-products, so when during the production process more than one product is being produced, the environmental impacts of the production process need to be divided over these so-called co-products. This can be, for example, the case when during the production of the label heat is generated. The heat is a by-product when it is a secondary and inevitable product.

We recommend to use economic allocation to allocate the impacts between the co-products. With economic allocation the environmental impacts are allocated between co-products in proportion to the revenue of the products. We recommend to use a weighted average of the price over 2 years. The formula to calculate the economic allocation of product 1 (P1) is:

$$\text{Economic allocation}_{\text{P1}} = \frac{\text{Mass}_{\text{P1}} \times \text{Price}_{\text{P1}}}{\sum_{i=1}^{n} \text{Mass}_{\text{Pi}} \times \text{Price}_{\text{Pi}}}$$

Where Mass is the mass of the product (kg), Price is the price of the product (e.g. $/kg) and n is the total number of products resulting from the same multi-functional process. When by-products occur in the study it recommend to describe the co-products and the choices made to divide environmental impacts over both products in the goal and scope document of the study.

EXAMPLE: When the processing of 1 kg of product Z will result in two products namely product A and B. Product B will feed in to another supply chain. Therefore, the impacts need to be divided over these two products.

Multi-output process	Mass per kg of product Z	Price per kg co-product	Revenue allocation
Product A	0,3 kg	1,39 $^{\$}/_{kg}$	88%
Product B	0,51 kg	0,11 $^{\$}/_{kg}$	12%

2.6 Assumptions and limitations

It is important to document all the assumptions and limitations during your study. Some known limitations are:

- The electricity needed for application of the label at the brand-owner is an assumption.
- Indoor airborne emissions for example caused by the printing of the label are not taken into account in the current impact assessment methods and therefore their impact cannot be taken in the account in the assessment.
- Sometimes packaging cannot be fully recycled because of the label material. For example, in the case of glass bottles the label can prevent the glass from going to glass recycling. This impact of the packaging which cannot be recycled due to the labeling material is not taken into account in the assessment.

3 Life cycle inventory

3.1 Data collection

The second step, Life cycle inventory (LCI), involves the compilation and quantification of inputs (materials and resources) and outputs (emissions and waste) for the product throughout its life cycle (ISO,2009).

Within your operational control you have access to specific data, so primary data needs to be gathered, such as the bill of materials, transport distances, energy consumed, waste produced, etc. For the life cycle stages outside your operational control, such as the production of materials you purchase, production of energy, transport operation, etc., secondary data from available Life Cycle Inventory (LCI) databases can be used. Well known LCI databases include Ecoinvent, GaBi, PlasticsEurope, and USLCI.

When it is possible to work together with other actors, e.g. printer-converter, label stock producer, etc., then the process within their operational control will become specific and primary data will need to be gathered for these stages as well.

Different approaches on how data is collected can have a significant impact on the overall results. The case studies showed that measuring electricity use of individual machines versus taking into account the electricity use of the entire plant, will make a significant difference in the results. Therefore, these guidelines will describe a recommended approach. When a different approach for data collection is chosen, than this shall be mentioned clearly in the report, as well as an explanation for the deviation. Table 2 shows an overview of the processes which need to be considered when conducting an LCA for a self-adhesive label and the potential data sources.

Table 2: Data types and sources

	Input flows	Possible source
Label stock production		
Raw material acquisition and pre-processing	- Type of material - Recycled material content (pre-consumer/post-consumer) - Raw materials extraction - Energy consumption for pre-processing	LCI databases
Transport	- Transport distance of raw materials - Transport distance to printer converter	Data collection
	- Transport mode & load factor	LCI databases
Label stock production	- Type of inputs, amounts, mass volume e.g. adhesive, silicone - Laminating production process - Energy consumption - Water use - Natural heat use - Emissions - Waste streams	Data collection *For energy consumption and water use please use the total yearly factory use and attribute % based on specific yearly production of the label compared to total factory production. When energy and water data specific for a product (line) is collected than this should be reported clearly in the report.*
	- Electricity grid - Natural heat production - Water production - Waste treatment processes	LCI databases
Printer converter		
Printing/ converting label	- Type of inputs, amounts, mass volume e.g. inks, varnish - Production process - Energy consumption - Water use - Natural heat use - Emissions - Waste streams	Data collection *For energy consumption and water use please use the total yearly factory use and attribute % based on specific yearly production of the label compared to total factory production.*
	- Electricity grid - Natural heat production - Water production - Waste treatment processes	LCI databases
Transport	- Average distance to brand owner	Data collection
	- Transport mode & load factor	LCI databases
Application of the label		
Amount of electricity used at brand owner	- The amount of electricity used for application of the label	Data collection *Default averages used in the case-studies described in paragraph 3.2.1 may be used when no primary data is available.*
	- Electricity grid	LCI databases
Waste treatment of liner waste	- How is the liner waste treated e.g. landfill, incineration etc.	Data collection *Default averages used in the case-studies described in paragraph 3.2.3 may be used when no primary data is available.*
	- Management process : recycling, reuse, energy recovery, and/or landfilling	LCI databases
End of life at consumer		
End of life treatment of the label waste	- Management process : recycling, reuse, landfilling etc. - Recover rate - Energy recover rate	LCI databases *Default averages used in the case-studies described in paragraph 3.2.3 may be used when no primary data is available.*

3.2 Data gaps and default data

As already discussed in the previous sections, the various actors in the labelling sector do not generally have insight in what happens to the product after it leaves their factory gate. Therefore, it can be challenging to gather specific data over these life cycle stages, which could result in potential data gaps. When specific data cannot be gathered, sector (conservative) default values can be used. In the sections below the conservative sector default values , which can be used to fill in potential data gaps, are given.

3.2.1 Application and use stage

The energy use to apply the self-adhesive label to the packaging is based on estimates from label application machine manufacturers. Two considerations for this sector average data are:

- Large production facilities can process 72.000 packages per hour. This number might be smaller for medium to small sized production locations and should be adapted accordingly.
- Average data is given for drying of the label. Generally, self-adhesive labels are not dried, and therefore in most cases this data can be excluded.

Table 3 shows the default values which can be used to calculate the application and drying of the label at brand owner.

Table 3: Default values application of the label

	Paper label application	**Polypropylene label**
Average electricity use for label application of 1m2 ready-made label	12,1 kW	9,9 kW
Number of packagings per hour	72.000	72.000
Average electricity use for drying of 1m2 ready-made label	36 kW	36 kW

The formula below can be used to calculate the average electricity use of label applied to the packaging for applying and drying the label ($\text{Electricity}_{\text{applying and drying}}$ in kWh/m^2):

$$\text{Electricity}_{\text{applying and drying}} = \frac{\text{electricity}_{\text{application}} + \text{electricity}_{\text{drying}}}{\text{labels applied per hour} \times \text{label size}}$$

where $\text{electricity}_{\text{application}}$ and $\text{electricity}_{\text{drying}}$ are provided in kW, labels applied per hour is in h^{-1}, and label size is provided in m^2.

3.2.2 Transportation

For every transportation step, specific data should be used for transport distances and transportation mode (e.g. type of truck, cargo train, etc.). When specific data is not known, default values can be used (Table 4). It is recommended to use default data from inventory databases to model the transport modes and to use the average load rates, which are included in most LCI data sets.

Table 4: Default values transport

Transport modes per type of transport	Load rate	Default values if mode and distance are unknown
Local transport with truck, train or boat - Transport freight lorry 7,5-16 metric ton - Transport freight train - Transport barge	50% load rate and empty return	1.000 km of Transport freight lorry 7,5-16 metric ton
Continental transport e.g. from one EU country to another or across the US. - Transport freight lorry 16-32 metric ton (EU) - Transport freight lorry >32 ton (US) - Transport freight train - Transport barge	50% load rate and empty return	5.000 km of Transport freight lorry > 32 ton for US transport 3.000 km of transport 16-32 metric ton for EU transport
Extra-continental transportation (e.g. from one continent to another e.g. Asia to EU - Transport aircraft freight - Transport-ocean freighter - Transport freight lorry 7,5-16 metric ton (EU)	50% load rate and empty return	20.000 km with transport-ocean freighter and 1.000 km with a lorry 7,5-16 metric ton

3.2.3 Waste routes

For the waste streams specific data should be used for the situation under study. When it can be substantiated that in the country for the situation under study incineration with energy recovery is the standard practice, then this can be used as the default waste treatment instead. When specific data is not known default values can be used (Table 5). Sensitivity analysis[3] for alternative waste treatment destinations is encouraged if actual waste treatment is unknown.

Table 5: Default values waste streams

Origin of waste	Waste streams to be considered	Default values waste	Default waste treatment
Label stock manufacturer	Production waste	10 %	Incineration without energy recovery
Printer converter	Production waste	10%	
	Matrix waste	40%	
Brand owner	Liner waste	100%	
Post-consumer waste	Label waste	100%	Municipal waste treatment (50% landfill and 50% incineration without energy recovery)

[3] A sensitivity analysis evaluates the influence the most important assumptions have the results (see paragraph 3.5)

3.3 End of life material and/or energy recovery

Where there is material and/or energy recovery as a result of waste treatment(e.g. recycling or incineration) or when recycled content is used as input for production, there is a choice that needs to be made about how this will be modelled. End of life allocation in LCA is the way environmental burdens and benefits are attributed to either the life cycle of the product that contains recycled material or the life cycle of the product that makes material available for recycling. There are two main types of end of life allocation methods to choose from when performing an LCA of a recyclable or recycled product:

1. The **recycled content method** (100:0 allocation) includes the following rules:
    - The environmental benefits (credit of avoided virgin material) and burdens (collection and sorting activities) of the recycling processes are attributed to the product that uses the recycled material as an input.
    - The product that provides the material for recycling is not allocated any benefits or burdens for recycling processes, including for example the benefits of energy produced by waste incineration.

2. The **closed loop approximation** (0:100 allocation) includes the following rules:
    - It is assumed that the material being recycled is used to displace virgin material input with the same inherent properties.
    - The benefits and burdens are allocated to the product that makes material available for recycling, by simulating a closed loop.
    - If recycled content is used as input material for production, this is accounted as virgin material so no benefits or burdens are accounted.

At the moment, there is limited awareness in the labelling supply chain on the potential for recycling their waste, especially concerning the matrix and liner waste. The two generic case studies have demonstrated the potential of recycling on reducing the total environmental impact of labels. However, recycling only happens at a limited scale. Therefore, an important challenge for the labelling industry is to make the actors in the value chain aware of the environmental benefits of recycling.

Another consideration is that recycled materials are rarely used as input to produce label stock material. Taking this into consideration, the recycled content approach (100:0) would not be applicable for the self-adhesive label and will, therefore, not demonstrate the potential of recycling for the labelling industry. The closed-loop approximation approach (0:100) will show the effects of recycling as it will attribute both the benefits and burdens to the life cycle of the self-adhesive label. The closed-loop approximation method will also account for credits of energy recovery (electricity and/or heat) resulting from waste incineration.

The closed loop approximation approach is, therefore, the recommended approach to model material and energy recovery.

3.4 Data quality

While there is no quantitative method for data quality recommended in the ISO standards at this time, the quality of the inventory data should be assessed. For processes which contribute with more than 20% for any impact category, it should be stated what the representativeness of the data is on the following criteria:

- Temporal representativeness: Time span, for which the data was collected, reflects the situation under study. For example, data is 2 years older than timespan considered in the study.
- Geographical representativeness: Geographic area, for which the data was collected, reflects the situation under study. For example, data used is representative for the EU and dataset required is from Spain.
- Technological representativeness: The technology, for which the data was collected, reflects the situation under study. For example, the dataset used constitutes primary data for own process.

3.5 Sensitivity analysis

After calculating your default results and understanding where the hotspots are it is recommended to check the choices and assumptions of the study and test those which may have a substantial impact on the results, a so-called sensitivity analysis. A sensitivity analysis evaluates the influence of the most important assumptions and choices have on the results. The principle of sensitivity is to change the assumption and recalculate the LCA. For example, you can compare the results based on different allocation principles. Sensitivity analysis will help to gain a better understanding of how different assumptions and choices affect the results.

The outcome of the LCA can be quite heavily dependent on some of the assumptions. This does not need to be a problem as long as the conclusions the LCA are stable.

While collecting data and modelling, you will be faced with choices you'll need to make. For instance, if you select a proxy for a specific dataset you cannot find or if you use default data (provided in section 3.2), etc. We recommend you to write down your assumptions and choices during the study and evaluate the most relevant ones in the sensitivity analysis. Sensitivity analyses should always be carried out for the following scenarios:

- When a material is not available in the inventory database and a proxy is used from the database which is not representative for the material e.g. a varnish being used instead of printing ink.
- When assumptions have been made in the model for example when is assumed that the end-of-Life destinations of the liner waste is the same as of the matrix waste.
- When choices for allocation of multi-functional products (see section 2.5) have been made in the model .
- When the amount of a material is an estimation, for example when the transport distance to the brand-owner is an estimation and it has a relatively high contribution to the overall environmental impact.

4 Impact assessment

4.1 Default impact assessment

The advised Life Cycle Impact Assessment (LCIA) Method to be used is the ReCiPe method (2009), at endpoint level and with the Hierarchist perspective. ReCiPe proposes a feasible implementation of combined midpoint level (impact categories expressed in units of a reference substance) and endpoint level, linking all midpoint impact categories to three damage categories: human health (HH), ecosystem quality (EQ), and resources (R). Assessment per impact category is used for a more specific and detailed analysis, whereas damage categories are useful to communicate the results obtained to a broader audience. Additionally, we recommend the use of the IPCC 2013 to calculate the carbon footprint (in kg CO_2-eq) because this is often a Key Performance Indicator (KPI) for businesses and something companies measure at corporate level.

Normalization is available for this method at European or global level and allows the comparison of the results of a product to the reference situation, i.e. the yearly production of an average person in Europe or World. The average weighting set (0.4 HH : 0.4 EQ : 0.2 R) allows to come to a single score. Please, be aware that, according to the ISO 14040-44 (2006), single score cannot be used for communication of product comparisons to the general public.

4.2 Selection of most relevant impact categories

From the case studies we learnt that the following impact categories are the most relevant for the self-adhesive label life cycle and shall, therefore, be accounted for in communication:

- Fossil depletion: Resource depletion is caused by the consumption of fossil resources, thereby increasing the costs of production for future generations.
- Climate change: The global warming potential of greenhouse gases (GHG).
- Particulate matter formation: Particulate matter is made up of a number of components, including acids, organic chemicals, metals, and soil or dust particles, which are directly linked to the potential for causing health problems.
- Water resources: Currently, this is expressed in m^3 of water consumed but in the upcoming ReCiPe method update, the regional scarcity of water resources will be taken into account.
- Land use: The total surface of land, calculated as part of the inventory and measured in unit area used during a specific time period (m2*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*m2*year). Currently this expressed in the ReCiPe method in the impact categories agricultural land occupation and natural land transformation.
- 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.

Other impact categories may also be included in the assessment.

4.3 Additional environmental information

Additionally, we recommend to report separately on:

1. Emissions of Volatile Organic Compounds (VOC) and Hazardous Air Pollutants (HAP) to air.
2. Total solid waste production (% going to landfill, incineration and recycling).
3. Total energy consumption.
4. Recycled content in product.

These points are the calculated indicators from the TLMI Label Initiative for the Environment (LIFE). Thereby, the LCA can provide input for LIFE certification.

5 Reporting, Disclosure and Communication

In this chapter, reporting guidelines and requirements will be given to communicate the LCA results to different stakeholders (B2B[4] and B2C[5] as appropriate).

5.1 External reporting requirements – B2B communication

Companies shall publically report the following information when communicating externally about the results:

General information and scope

- Contact information.
- Studied product name and description.
- Cradle- to- grave or cradle- to-gate assessment.

Boundary setting

- A flow diagram of the production process under study.
- A description of the manufacturing process and end of life if applicable.
- Time period of the study.
- Applied functional unit.

Results

- The results for the mid-point impact categories: fossil depletion, climate change, particulate matter formation, water resources, agricultural land occupation and human toxicity.
- The carbon footprint

Optionally companies can report the following results:

- Emissions of Volatile Organic Compounds (VOC) and Hazardous Air Pollutants (HAP) to air.
- Total water use.
- Total solid waste production (% going to landfill, incineration and recycling).
- Total energy consumption.
- Recycled content in product

This external communication will be supported by a more extensive report in which the goal and scope, results, interpretation and sensitivity analysis are discussed in more detail.

[4] Business to Business
[5] Business to Consumer

5.2 Product comparison for internal communication

A life cycle assessment is complex and the results are dependent on inventory data used. When conducting a comparative LCA study of various products the guidelines[6] below should be followed:

- The functional unit of both products should be the same
- The system boundaries and temporal boundaries are equivalent
- The same allocation methods are used for similar processes
- The data types used, the data quality and uncertainty of the data should be reported and assessed to determine if a fair comparison can be made
- The temporal and geographical representativeness of the inventories should be assessed to determine if a fair comparison can be made.

Separately conducted LCA studies of products or services can never be compared, as there is no assurance that the guidelines above have been taken into account similarly. Only LCAs which have been set-up as comparative LCAs can be used for performance comparison.

5.3 Communication to the general public

No verification scheme has been set for these guidelines but we recommend to follow the ISO standards. The ISO standards recommend to review the LCA study if the LCA results are communicated to the general public e.g. press releases, corporate website, advertisements, etc. The critical review should ensure the robustness and the quality of the study. A critical review shall ensure that:

- The methods used to carry out the study are compliant with the ISO-14040-44
- The methods used to carry out the study are scientifically and technically valid
- The inventory data used are appropriate and reasonable in relation to the goal of the study
- The interpretation reflect the limitations identified and the goal of the study
- The study report is transparent and consistent

The recommended review is dependent on the type of LCA. According to the ISO 14040-44 (2006), a differentiation should be made between LCA studies that analyze one product and studies which compare products.

The use of LCA results to support product comparisons to be disclosed to the public requires a panel critical review, since the outcomes of the LCA will likely affect interested parties, external to the LCA. An external independent expert should be selected by the original study commissioner to act as a chairperson of the review panel of at least three members. The chair person should select other independent qualified reviewers.

For a single product LCA a critical review by a single independent internal or external expert is recommended.

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[6] Adapted from GHG protocol (2009)

5.4 Environmental product declaration

This document is not formally a product category rules (PCR) document for self-adhesive labels. Consequently, if an environmental product declaration (EPD) is needed, the Product Category Rules (PCR) for labels, sleeves or liner less made of paper, plastic or other materials (The International EPD System, 2015). needs to be followed. These guidelines differ from the PCR mainly in the following areas:

Topic	Guidelines	PCR
Declared/functional unit	1 m2 ready-made printed label on package	1000 units of product
Inventory data reported	- Emissions of (VOC) and (HAP) to air - Water usage - Total solid waste production - Recycled content in product - Multifunctional products	- Primary non-renewable resources - Primary renewable resources - Secondary resources - Recovered energy flows - Water use
Impact assessment method	ReCipe (H) & IPPC	CML & water footprint

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