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BACKGROUND REPORT

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Address: Joint Research Centre, Institute for Prospective Technological Studies, Edificio EXPO-C/Inca Gracilaso,3-E 41092 Seville

Authors: (1) Malgorzata Kowalska, Mauro Cordella (Task 3.1-3.3. support),Oliver Wolf

(2) Michael Ooms, Céline Alexandre, Matthieu Gillis

(1) JRC IPTS Seville

(2) RDC Environment

Contact information

Malgorzata Kowalska

Joint Research Centre, Institute for Prospective Technological Studies,

E-mail: Malgorzata-Agata.Kowalska@ec.europa.eu

jrc-ipts-footwear@ec.europa.eu

Tel +34-95-448 71 93

Fax +34-95-448 84 26

http://susproc.jrc.ec.europa.eu/

http://www.jrc.ec.europa.eu/

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ACRONYMS

ABS	Acrylonitrile Butadiene Styrene
ADEME	French Environment and Energy Management Agency
AFIRM	Apparel & Footwear International RSL Management Group
AFNOR	French Association of Normalisation
BAT	Best Available Techniques
BCI	Better Cotton Initiative
BIIR/CIIR	Halogenated Isobutylene Isoprene Rubber/Chlorinated
BR	Butadiene Rubber
BREF	Best Available Techniques Reference Document
CB	Competent Body
CEN	European Committee for Standardization
CLP	Regulation No 1272/2008 on Classification, Labelling and Packaging of substances and mixtures
CMR	Carcinogenic, Mutagenic or toxic for Reproduction
CN	Combined Nomenclature
COD	Chemical Oxygen Demand
COMEXT	Database from Eurostat providing statistics for international trade among countries of the European Union and between countries of the EU and non-EU countries
COTANCE	Confederation of National Associations of Tanners and Dressers of the European Community
CSR	Corporate Social Responsibility
DEFRA	Department for Environment, Food and Rural Affairs
EC	European Commission
ECAT	EU Ecolabel Catalogue
ECHA	European Chemicals Agency
EEC	European Economic Community
EIA	Environmental Impact Assessment
ELCD	European reference Life Cycle Database
EPD	Environmental Product Declaration
EPDM	Ethylene Propylene Rubber
EU	European Union
EU27	27 Member States of the European Union, up to 2013
EU28	28 Member States of the European Union, from 2013
EUEB	European Union Ecolabelling Board

Eurostat	Statistical Office of the European Union Database
EVA	Ethylene Vinyl Acetate
GHS	Globally Harmonised System
GOTS	Global Organic Textile Standard
GPP	Green Public Procurement
IED	Industrial Emissions Directive
ILCD	International Reference Life Cycle Data System
INESCOP	Footwear Technological Institute (Spain)
IPP	Integrated Product Policy
IPPC	European Integrated Pollution Prevention and Control
IPCC	Intergovernmental Panel on Climate Change
IPTS	Institute for Prospective Technological Studies
IR	Isoprene Rubber
ISO	International Organization for Standardization
IULTCS	International Union of Leather Technologists and Chemists Societies
JRC	Joint Research Centre
LCA	Life Cycle Analysis
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LWG	Leather Working Group
NACE	Statistical Nomenclature of economic Activities in the European Community
PCR	Product Category Rules
PE	Polyethylene
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
PFAS	Perfluorinated Alkylated Substances
PP	Polypropylene
PPE	Personal Protective Equipment
PRODCOM	Database from Eurostat providing statistics on the production of manufactured goods
PTFE	Polytetrafluoroethylene
PU	Polyurethane
PVC	Polyvinyl chloride
REACH	Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals
RSL	Restricted Substance List

SBR	Styrene Butadiene Rubber
SBS	Styrene Butadiene Styrene
SCP	Sustainable Consumption and Production
SIP	Sustainable Industrial Policy
SVHC	Substances of Very High Concern
TC	Technical Committee
TPU	Thermoplastic Polyurethane
TR	Thermoplastic Rubber
VOC	Volatile Organic Compound

The EU Product Policy Framework and Relevance to Footwear

The EU Ecolabel criteria form key voluntary policy instruments within the European Commission’s Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP) Action Plan (2008) and the Roadmap for a Resource-Efficient Europe (2020). It forms an important component of the European Commission’s broader strategy to support green growth and eco-innovation.

On 16 July 2008 the European Commission presented the Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP) Action Plan. The plan includes a series of proposals on sustainable consumption and production aimed at:

- improving the environmental performance of products;
- increasing the demand for more sustainable goods and technologies;
- stimulating innovation by EU industry.

The EU Integrated Product Policy (IPP) formed a key element of the Action Plan, which proposes a combination of voluntary and mandatory instruments seeking to reduce the environmental impacts arising from products and services along all the phases of their life-cycle. Two important voluntary policy instruments within the IPP and highlighted by the SCP/SIP are the EU Ecolabel and the EU Green Public Procurement (GPP); both are intended to promote products and services which demonstrate lower negative environmental impacts when compared with functionally alternative options belonging to the same product/service group. Both promotion schemes will help address the wider objectives of competitiveness and green growth within the EU.

The Roadmap for a Resource-Efficient Europe, published in September 2011 and integrated into part of the Europe 2020 Strategy, reinforces the role of the EU Ecolabel and EU Green Public Procurement (GPP). The goal of the Roadmap is to move the economy of Europe onto a more resource efficient path by 2020 in order to become more competitive and to create economic growth and employment. The role of the Ecolabel and GPP are highlighted as key actions that will help improve manufactured products and change consumption patterns to help drive resource efficiency. Accurate information based on the life-cycle impacts and costs of resource use is needed to help guide consumer decisions. Consumers can save costs by avoiding personal waste and buying products that last or can easily be repaired or recycled. New entrepreneurial models where products are leased rather than bought can satisfy consumer needs with less life-cycle resource use[1].

The SCP/IP highlights the EU Ecolabel role as complementing the information provided to consumers and acting as a ‘label of excellence’ that signals to consumers that labelled products perform better environmentally over the whole product life-cycle. By design, the Ecolabel criteria development

[1] Roadmap to a Resource Efficient Europe. Communication to the European Parliament. COM(2011) 571 final

process also provides useful information for other policy instruments, such the expanded Ecodesign Directive proposed within the Roadmap for a resource-efficient Europe.

The EU Ecolabel currently covers a wide, and expanding, list of products and services. In the 2009-2013 working-plan, the European Union Ecolabelling Board (EUEB) and the European Commission identified "footwear products" as a product category scheduled for the revision during 2011/12. A particular point of the revision was to assess the possibility and the suitability of extending the footwear Ecolabel scope to include other leather-made products.

Executive Summary

TASK 1 - Stakeholder survey, statistical and legal review, scope and definition proposal

Objectives

The main objective of Task 1 is to gather the following information:

- How the overview of the existing statistical and technical categories and relevant legislation and standards will support the proposal of the revised product group scope and definition;
- Whether the scope is correctly defined or should be adapted;
- Whether the scope should be enlarged (to non-footwear products);
- Stakeholder opinions (including Member State competent bodies and applicant companies) concerning the feasibility of complying with the criteria. both on the side of Member State competent bodies and applying companies,

Legislative background

Review of the EU Ecolabel criteria for the footwear product group relies mainly on Regulation (EC) 66/2010 on the EU Ecolabel. Article 6 within this regulation sets out the general requirements for criteria development.

On the other hand, there is no specific EU legislation that exclusively addresses the environmental performance of footwear or leather products. Nonetheless, the main EU legislation which may be significant to the EU Ecolabel footwear product group revision process and the footwear sector were outlined, including legislation pertaining to chemicals, the environment, and health and safety at work, among others. Additional legislation references have been added where relevant to the footwear criteria revision.

Definition and categorisation

The article 1 of the current EU Ecolabel criteria document for Footwear (Commission Decision 2009/563/EC) defines the product group scope as: "*The product group 'footwear' shall comprise all articles of clothing designed to protect or cover the foot, with a fixed outer sole which comes into contact with the ground. Footwear shall not contain any electric or electronic components*."

The segmentation of the product group footwear may be based on several aspects, including: material (leather, textile, plastics/rubber), destination (e.g., casual, sport, slippers, fashion, rain boots), age and gender (e.g., male, female, children), or price category (e.g., low, middle, high). The official statistical nomenclatures used by Eurostat (NACE[2] for production data and CN[3] for trade data) introduces the division of the product group footwear into different sub-categories according to the use category and material composition. The two above mentioned nomenclatures show substantial

[2] Statistical Nomenclature of economic Activities in the European Community

[3] Combined Nomenclature

differences, it is nevertheless possible to distinguish the following common categories, as indicated in Table 1.

Table 1: Statistical nomenclatures[4]

Material for soles	Material for uppers	Use	Gender
Plastic and rubber	Plastic and rubber	Sports / athletic	Men
Leather	Leather	Ski boots	Women
Wood	Textiles	Indoor	Children
Other	Other	Outdoor	
		Waterproof	
		Sandals (only NACE)	
		Protective (only NACE)	

Other market-relevant literatures generally make reference to (a subpart of) these nomenclatures: CBI[5], APICAPPS[6], IBISWorld[7], national statistics data, among others.

Maxwell[8] additionally mentions the category "therapeutic" which refers to a medical purpose and especially to orthopaedic footwear. In Eurostat, this type of footwear is actually included in the section related to the manufacture of medical and dental instruments and supplies.

Recommendations on the scope extension

Because leather has been chosen as a common characteristic and the basis for extending the scope, it is necessary that leather is the main material used for the products covered by the set of criteria of the EU Ecolabel for footwear and leather products. After considering the market situation, the other European and non-European Ecolabels, the existing LCA studies, and the feedback received from Competent Bodies and registered stakeholders, this study concludes that extending the scope is not recommended considering that:

1. The majority of contributing stakeholders were not in favour of extending the scope to other leather products.
2. The EU Ecolabel should define one product group that is clearly understood by the consumers. Leather-made products cover a broad range of different functions (from car upholstery, to fashion jackets and wallets), hindering the introduction of the comprehensive product group definition;

[4] Derived from Eurostat [change font]

[5] CBI, The Footwear In The EU, May 201

[6] APICCAPS, World Footwear, 2012 Yearbook, data up to 2011

[7] IBISWorld, Global Footwear Manufacturing, 2010

[8] http://www.maxwellinternational.com.my/business.html

3. Many of the so-called leather products are in fact composed of several materials, among which leather may be only a minor component. Indeed, in certain analysed product groups, there is a considerable rise in the use of leather/synthetic material combinations. It appears that, except for belts, leather is not the major constituent of the final product. Thus, there is a potential risk that if the wide range of articles apparently relevant to leather were covered by the scope, it would then include products that do not predominantly contain leather (or that only contain a minor quantity of it). Consequently, if all the products were to be considered within the scope, the majority of them would not meet the basic requirement: to be composed of leather. Thus, it would be necessary to introduce a restriction that imposes a minimum leather content requirement. However, in this case, the EU Ecolabel would not meet its original goal: to provide the consumer with the most environmentally friendly choice within the same product group category;

4. From a technological and processing perspective, leather used in footwear is the most diversified. Nevertheless, even if environmental requirements that refer to the tanning process are quite similar amongst leather products, the technical and performance requirements are very product specific. Thus, ensuring the product functional durability within the use phase is quite different from one product to another, hindering the possible introduction of a common set of criteria. It should be stressed that leather used in footwear manufacturing is the most diversified and fulfils the strictest and very product-specific technical requirements.

5. The goal of the Ecolabels is to help consumers choose the most environmentally friendly goods available on the market. When consumers look for a product, they actually seek for the specific function to fulfil (i.e., to eat, to dress). As with the LCA study, the EU Ecolabel should define a product category based on a common final utility. The ISO 14040:2006 and ISO 14044:2006 standards clearly state that environmental comparisons between systems shall be made on the basis of the same function(s), quantified by the same functional unit(s); it is not possible to compare articles of unrelated utility (e.g., a wallet vs a piece of furniture). In addition, the EU Ecolabel Regulation mentions that the criteria "should be market oriented and limited to the most significant environmental impacts of products during their whole life cycle." In other words, scope definition should enclose products of the same category and with the same identified environmental hot spots. Additionally, if the scope were extended, all the criteria that are product-specific would then have to be identified for each category of product covered by the analysis. This especially pertains to criteria related to the durability, use-phase, packaging and end-of-life, among others.

6. When referring to the leather market share it could be assessed that extending the scope to other leather goods would not necessarily mean considerable environmental savings, as footwear is the main leather-made product group. The leather-made goods that by way of similarities could be covered by the scope represent a small market share. Considering segmentation of all leather-made products (therefore including upholstery leather for car and furniture), from the global perspective footwear represents 52 % of intended leather destination, other leather products of possible interests (belts, bags) correspond to as little as 9.4% of global market share (13.8% if gloves are included)[9] . On the European level

[9] (International Council of Tanners, 2008)

footwear represents 41% of the main end use of leather produced. According to COTANCE the broad category of leather goods take up to 20% of Europe's leather production,[10] however high level of data aggregation does not enable to identify the specificity of products included in this category.

7. Other existing European and non-European Ecolabels did not manage to develop a single common set of criteria pertaining to the product category that includes leather and non-leather footwear and leather products.

Table 2 summarizes the argument in favour of and in opposition to the scope extension.

Table 2: Pros and cons for scope extension

	Arguments in favour of scope extension	**Arguments in opposition of scope extension**
Functional unit	The scope would cover a broader range of products. Possible confusion for the consumers if equivalent leather products cannot be labelled.	The scope is based on a consumer-oriented product category (possible confusion for the consumer because the products have very different functions). Product group is very large and not homogenous.
Market	Most retailers group leather goods into one product area so it would be useful to have a common standard.	Footwear covers around half the leather market.
		Footwear shows a diversified segmentation.
Materials	Same types of materials are used in footwear and small leather products.	Leather is not the main material used in leather products (except footwear and belts).
		A cut-off limit would exclude products of the same category, even footwear
Technologies	Different leather products show similar requirements for chemical and tannery emissions issue.	Performance specifications are product specific and diversified.
LCA		Different functional units for each products makes the comparison between products difficult

On the base of analysis conducted it is suggested that the scope of the product group Footwear includes all products covered by the non-exhaustive list set in the Directive 94/11/EC (EU Footwear Labelling). Occupational footwear should also be included. The possible inclusion of protective footwear that because of security reasons incorporates special construction elements (e.g. toe caps)

[10] (COTANCE, 2012)

should be further addressed during the upcoming AdHoc Working Group Meeting.This definition includes all categories of footwear detailed in chapter **1.3.3** of the present document.

TASK 2 – Market analysis

Objectives

This task provides an overview of the market features for the EU Ecolabel revision for the Footwear product group. Simultaneously, and considering the original proposal of the scope extension to other leather goods, it outlines the main aspects relevant to the leather market segmentation. This overview verifies and supports the proposed scope and definition of the EU Ecolabel product group and shows associated eco-innovations relevant to the current market situation, in line with the Regulation (EC) No 66/2010.

Market data are either expressed according to value (EUR) or according to volume (amount of pairs). It is important to distinguish these two indicators as the ratio can be significantly different depending on geographical areas and types of footwear. For the purpose of the EU Ecolabel criteria revision for footwear, volume figures are the focus.

Complementary to the official statistical data, stakeholders' inquiry feedback and market reports of relevance are also used throughout this chapter to cover missing information and to supplement and help interpret the results obtained. Additionally, three relevant sources of market knowledge were particularly used: APPICAPS Yearbook 2012 (APICCAPS, 2012), CBI Market Intelligence Reports (CBI, 2010), and IBISWorld Report on Global Footwear Manufacturing (IBISWorld, 2010).

Global footwear market

Industry revenue for the Global Footwear Manufacturing has increased 2.2% in 2012 to total USD 122.9 billion, up from USD 107.4 billion in 2011: this represents an annual growth of 2.7% over the last 5 years (IBISWorld, 2012)[11].

According to APPICAPS estimates (APICCAPS, 2012), world-wide production of footwear reached 21 billion pairs in 2011. When referring to the quantity of shoes produced, about 87% of the manufacturing takes place in Asia, mainly China (60.5%), followed by India (10.4%), Vietnam (3.8%), Pakistan (1.4%), and Bangladesh (1.3%)[12]. The Indian footwear industry has grown considerably over recent years due to overseas investment from US, Europe, and Taiwan, which focussed on concentrating production of mid-priced shoes in the country (IBISWorld, 2010).

South America accounts for 5% of global production, 3.8% of which comes from Brazil. The European footwear production accounts for approx. 3 % of the world total, followed by the North America (2%). Africa shows a slight increase in the production (currently 3%) with respect to previous years.

In 2011 Asia was also the biggest consumer of footwear volume accounting, for 47% of world total, followed by Europe (21%), North America (17%), South America (8%), Africa (6%), and Oceania (1%). China accounts for 15.9% of global footwear apparent consumption (in volume), followed by the United States (12.9%), and India (12.7%).

[11] http://www.ibisworld.com/industry/global/global-footwear-manufacturing.html , last access September 2013

[12] Data refer to the number of pairs

European footwear market

European Production

Southern Europe, especially the Mediterranean region, is the main European footwear manufacturing area. Italy, Spain, Portugal and Romania together represent approximately 76% of the overall European production value, and 72% of production volume in 2011 (Eurostat).

The European footwear industry dominates production of high quality products in the medium to elevated price category. The average European production price has increased from 21.39 EUR in 2007 to 25.65 EUR in 2012. Because it has the highest share of the European market value (48 %) and volume (34 %)[13], Italy leads the EU27 in manufacturing medium to highly-priced shoes.

Romania, Bulgaria, Hungary, Slovakia have also recorded a decrease in production. Despite benefiting from increased market demand due to the market extension after the EU entrance, they competed poorly against Asian suppliers, many of whom have both lower cost bases and are technologically well developed (CBI, 2010).

European footwear production experienced an overall decrease of 22 % volume and 6 % value within the last 5 years, particularly in Italy, Spain, and Portugal, due to the economic recession and intense competition within the footwear industry. Notwithstanding the global footwear market redistribution, the top European producers have not changed much since 2002.

Trades

Comparing intra- and extra- European trade shows that more than half of the imports and exports of European production are destined to another European country. Consequently, according to the data set in the Table 3, most of the European-manufactured footwear remains in Europe[13].

Table 3: Intra and extra European trade (EUR millions)[14]

	Imports 2011 into EU27 countries	Exports 2011 from EU27 countries
With non-EU27 countries	14037	5944
With EU27 countries	18134	21308
Percentage of internal trade	**56%**	**78%**

China is the main non-EU27 country supplier, accounting for 50 % of the overall European import value in 2012. Between 2007 and 2012, the import value of Europe increased by about 22% with a decrease in 2009 due to the economic recession. The share of import volume from China is much higher than the share of import value, suggesting a lower product cost. On the other hand, unit cost actually increased 44% between 2007 and 2012 regarding China (from 3.14 to 4.52 EUR/pair), and increased 34 % for all non EU27 countries (from 5.06 to 6.78 EUR/pair).

Cambodia and Indonesia represent fast-emerging European suppliers; between 2007 and 2012 the import value from these countries grew 183% and 90%, respectively. With respect to the period

[13] In theory, the values of imports and exports within EU27 countries should be balanced. However, this is not the case in practice, due to loans and changing stocks.

[14] Eurostat

2002-2006[15], the main suppliers for Europe did not change considerably, except for Romania which became a European Union Member State in 2007.

European apparent consumption

The apparent consumption is calculated by using Eurostat data, as follows: production + imports – exports. It is the best figure available to represent what quantity the consumers actually use in the different countries.

EU27 consumed in 2011 2,864 thousands pairs of footwear corresponding to 21,145 million Euros. Germany, France, Italy, Spain and the UK are the top-5 European footwear consumers (from 10 to 15 % of the market each), supporting the observation that population intensity is one of the main driving factors of the footwear market.

Overall European footwear consumption has been stable except for 2009, which is characterized by a small decrease due to the global recession. However, this general conclusion should not be extrapolated to individual countries, and each country should be assessed separately.

Figure 1 contrasts the volume of apparent consumption with production in the top-10 European footwear consumers in 2011. From Figure 1, it is apparent that the national consumption volume dwarfs production mainly due to intensive intra-European trade and massive import of cost competitive products from outside Europe. Following the same line of reasoning, the EU 27 apparent consumption is almost 5 times higher than production volume.

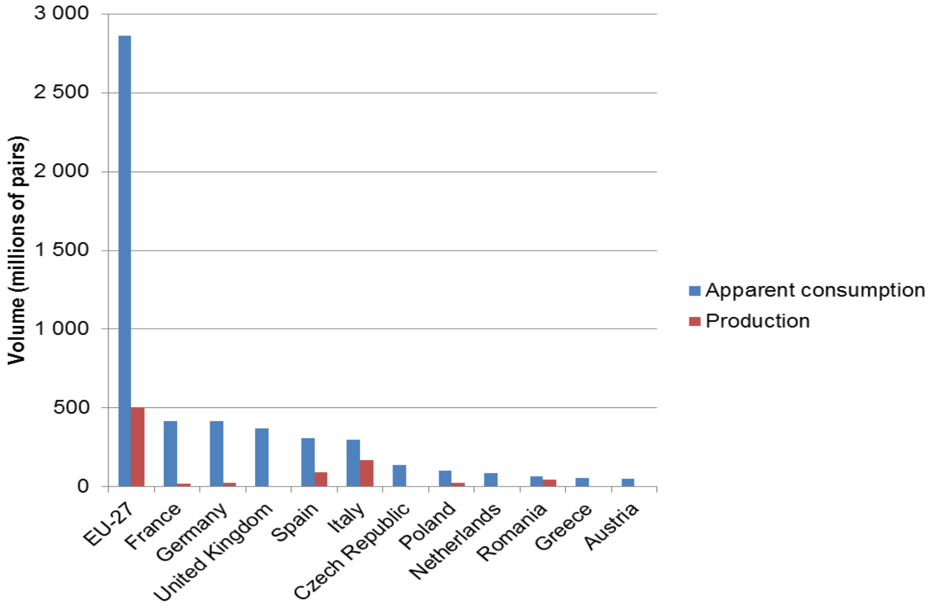

Figure 1: European production vs. apparent consumption 115

[15] (Life Cycle Engineering, 2008)

European market forecast

Market performance, drivers, and prospects

Population growth is the key driver in the footwear industry that leads toward greater demand for consumer products, particularly for basic necessities such as discretionary footwear. A projected overall European population increase of around 3%[16] within the upcoming decade should therefore act as a future stimulus to the footwear market.

On the other hand, several other factors have been identified to influence as the intensity of footwear consumption:

- household income level on quantity, quality and design,
- seasonal changes of design, especially for woman footwear,
- weather conditions on the types of shoes
- age of population on the types of shoes demanded
- quality of locally made shoes, influencing the loyalty towards native companies

Market segmentation

Global market segmentation

Using the World Footwear 2012 Yearbook Data (APICCAPS, 2012) as the basis for the global shoe market segmentation overview, leather footwear represents approximately half of the world exports value (16% in terms of volume). The noticeable decrease in leather trading has been accommodated by gains in other footwear types (except the residual category "others", if measured in volume). Special attention is warranted for the notable increase in rubber and plastic footwear export, representing the main volume share (56%).

European footwear consumption segmentation

Regarding the material segmentation, the Figure 2 below highlights footwear with leather uppers as the major type in terms of value, representing 60% of the 2011 European consumption. Between 2007 and 2011, the total consumption (value based) of footwear with rubber, plastics and textiles uppers grew by 32 %, whereas, consumption of other types declined by about 7-8 %.

In this sense, footwear with rubber or plastic uppers were identified as of the major group based on volume, accounting for 43 % of the European consumption. Volume-based consumption of footwear with leather uppers or wooden soles declined by 20%, whereas, footwear with plastic, or rubber and textiles uppers increased by 6-7%.This highlights the current tendency towards purchasing cost-competitive products made of synthetic materials and textiles rather than high-quality, more expensive leather footwear.

[16] EUROSTAT

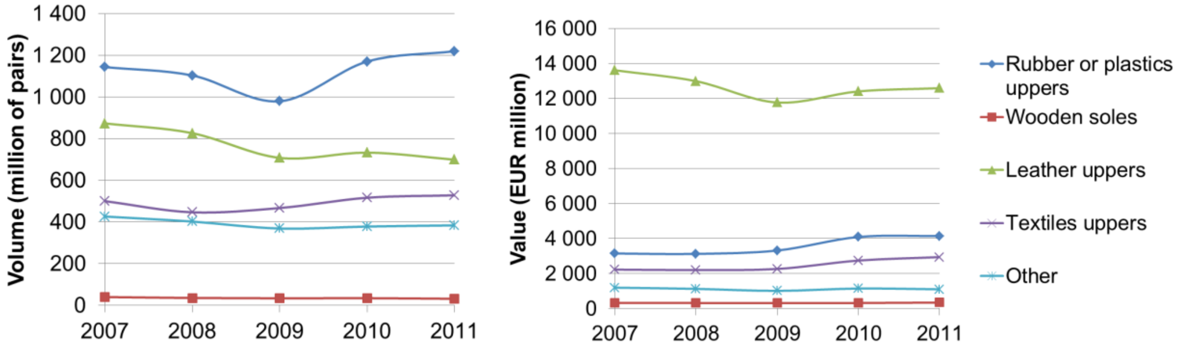

Figure 2: Materials segmentation in EU27 (consumption value and volume)[118]

Figure 3 summarizes the intended use segmentation data; it shows town footwear as the major footwear type consumed, representing 60% of total European volume-based consumption, and 73% of value-based consumption.

Between 2007 and 2011, volume-based consumption of different types of footwear showed a general decrease (e.g., 3 % for protective footwear to 24 % for sports footwear); the exceptions were sandals for which consumption remained stable, and waterproof footwear for which consumption increased 46%.

The value-based consumption for footwear types increased between 2 to 76 %, except for sandals which decreased by 9 %. The 76 % increase in waterproof footwear consumption is of relatively insignificant considering the total sales value between 2007 and 2011.

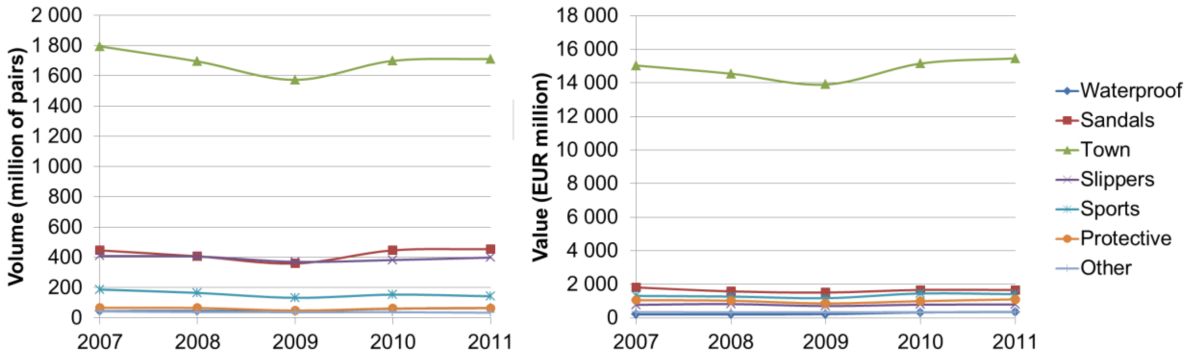

Figure 3: Use segmentation in EU27 (consumption volume and value)[118]

Leather market

Most of European bovines and calves leather is produced in Italy, with 70.3 % of European share. The other types of leather are also in most part produced in Italy (68.6 % for sheeps and goats, and 49.3 % for other animals).

European turnover accounts for 26.7% of the world leather production. China is the leader with approximately 29.5% of the leather production (COTANCE, 2012).

According to the EUROSTAT statistical data for 2011, Italy accounted for approximately 67% of the European leather production value (6,730 million euros), Spain is a distant second with 6%; France and Germany each account for 5%.

The Figure 4 presents the typical European segmentation: footwear sector is the main destination of leather (41%), followed by furniture (17%) and car upholstery industry (13%), The broad category of leather goods take up 20% of Europe's leather production and garments 8%, the rest 3% are considered niche products (COTANCE, 2012).

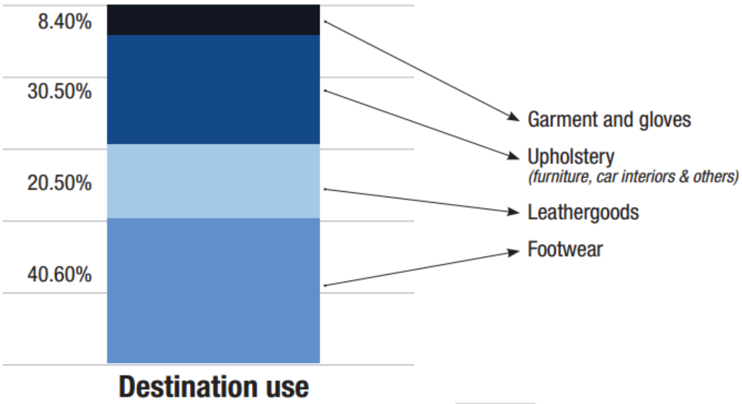

Figure 4: Estimated production share of the key leather segment [17]

On the other hand, the International Council of Tanners estimated in 2007 that the global production of leather was used in the following end-products:

- 52 % in footwear ;
- 14 % in furniture ;
- 10.2 % in autos ;
- 10 % in garments ;
- 4.4 in gloves ;
- 9.4% in other leather products.

Market penetration of the EU Ecolabel

Currently there are eight Ecolabel licences that cover 65 products (ECAT)[18]:

- 1 licence in Sweden;
- 2 licences in Spain;
- 1 licence in Finland;

[17] (COTANCE, 2012)

[18] http://ec.europa.eu/ecat/#

- 4 licences in Italy.

The statistical analysis shows limited market penetration of the EU Ecolabel for the product group under revision (the number of EU Ecolabel awards to footwear represents 0.4 % of the overall number of the EU Ecolabelled products).

Market penetration of other Ecolabel schemes

Identification of the most important schemes related to the footwear sector has been conducted within the framework of “Task 1: Stakeholder survey, statistical and legal review, scope and definition proposal” of the present report.

Table 4 summarizes the penetration of other type I ecolabel schemes of relevance for the on-going revision of the EU Ecolabel for Footwear.

Table 4: Penetration of other ecolabels in the footwear sector

ecolabel	Number of licences for footwear
Nordic Swan	11 licences (expiry date 2013-12-31) for textiles and leather products[19]
Blue Angel	2 for soles with bamboo fibres
Environmental Choice New Zealand	1 for textiles and leather
Japan Eco Mark – criteria "143 Shoes and Footwear"	8 products[140]
Other ecolabels	Information not available

Product innovations

Application of best practices can take the form of improved products and processes that reduce environmental impact, new technologies and services, and new work strategies, but key to transitioning toward more eco-friendly products is the combination of cleaner technologies, new business models and sustainable behaviours[20]. In general manner, mechanisms applied by retailers to drive environmental improvement across product supply chains include: product certification; environmental criteria for suppliers; dissemination of better management practices across the supply chain; promoting ecolabelled products; eco design; application or subsidization of clean technologies; local or regional sourcing; optimization of logistics [21].

Considering the current state of market knowledge about ecolabels and eco-innovation, it is not feasible to obtain substantial data on the scale of ecolabelled footwear market penetration, i.e.,

[19] Personal communication with a person from the Japanese Eco Mark in July 2013

[20] EIO (2013). Europe in transition. Paving the way to a green economy through eco-innovation. Annual Report 2012. European Commission Report.

[21] Styles, D. Schoenberger H., Galvez-Martos, J.L. (2012) Environmental improvement of product supply chain: Proposed best practice techniques, quantitative indicators and benchmarks of excellence for retailers. Journal of Environmental Management 110, pp. 135-150

regarding the proportion of footwear and related products that carry eco-innovations and their overall market impact; however, it is still possible to address common strategies that have been introduced to the market:

- Improvement of the supply chain control by imposing material and process requirements to master the multi-supply chain;
- Use of more sustainable materials;
- Minimisation of the use of adhesives, leather coatings and solvents;, or using solvent-free products to reduce net VOC emissions;
- Optimisation of material cutting and assembly to minimize the quantity of material used and reduce the quantity of waste generated;
- Establishment of waste management programmes;
- Minimisation of hazardous substance use.
- Establishment of end-of-life programs for used footwear

Other eco-innovations that may be applied include: use of green energy or more eco-friendly transportation and packaging systems. We anticipate that additional investigation of best-practices and their market relevance will be conducted with input from industry stakeholders.

Management of the materials supply chain is one of the emerging strategies being used to master environmental performance of products and improve material traceability, mainly by introducing clear management rules such as specific guidelines of environmental product performance requirements. Facing this challenge, globally leading shoe manufacturers – including Adidas, Inditex Group, PUMA, Nike, Hugo Boss, Timberland, Mark and Spencer, , among others –have committed themselves to bring forward environmentally friendly actions in their product lines. Following the information gathered as part of the on-going revision process, we have observed a similar tendency among footwear intermediate material producers to improve the environmental performance of production[22,23,24,25,26].

However, it is noteworthy that according to the information gathered from the registered stakeholders, effective control along the supply chain is more feasible for the globally recognized footwear and apparel companies; whereas, this is very difficult to achieve for SMEs, which constitute the majority of European footwear industry - with average production rates of 100.000 -150.000 pair of footwear per year[27]. Similar observations have been reported for tanneries, where many of

[22] Rydin, S. (2011) Risk Management of Chemicals in the Leather. Sector: A Case Study from Sweden. In: B. Bilitewski et al. (eds.), Global Risk-Based Management of Chemical Additives I:Production, Usage and Environmental Occurrence, Hdb Env Chem, Springer-Verlag Berlin Heidelberg 2011

[23] BREF Tanning (2013)

[24] BREF Textile

[25] (COTANCE, 2012)

[26] BREF Polymers

[27] Personal communication

chemical products purchased are preparations (mixture or solution composed of two or more substances).

Our review of the list of different ecolabels and strategies towards more sustainable production, both private and independent, indicates that an industry needs to promote and document the environmental profile of its products in order to be effective in the marketplace. Consequently, a number of independent, government and industry-led labelling and auditing initiatives have emerged in order to drive performance improvement, provide market differentiation and enable verification of best-practices. The focus varies among labels or certification schemes, with some placing the emphasis on the material origin and processing (e.g., organic cotton, Leather Working Group certificate), chemical performance (Restricted Substances Lists, Schadstoffgeprüft), whereas, others place more emphasis on ethical aspects (e.g., Global impact, CSR). Limited information is currently available about the market penetration of these initiatives, although clearly some appear to be more significant than others, particularly those with considerable industry engagement. The EU Ecolabel and national ecolabels coexist well and are developing a policy of cooperation and coordination. Article 11 of the EU Ecolabel Regulation (EC) 66/2010 introduces measures to encourage harmonisation between ecolabel schemes, particularly in selection of product groups and development and revision of the criteria. Within the process of criteria development, existing requirements developed by other national ecolabelling schemes (EN ISO 14024 type I) in the Member States should also be analysed.

Table 5 presents a summary of the best practices identified through this tasks.

Table 5: Summary of best practices

Life cycle stage	Type of best practice	Examples	Some figures
General	CSR program	Global Compact program of the United Nation	Less than half the stakeholders(30-40%) have signed a declaration such as "Global Compact", or equivalent
	Improve environmental standards and legislative compliance	ShoeLaw Platform	40 selected companies achieved 6% overall environmental legal compliance improvement
Leather	Certification	Rainforest Alliance for Sustainable cattle raising	40-50 % of consumer awareness in UK, Ireland, Germany, Nordic Countries, and Australia
		Leather Working Group Certification	Audited 2 billion square feet of leather, which corresponds to slightly over 10% of global production 140 member companies from 21 countries.
		"SG-label" Institutional	
	Processing	Chrome-free tanning	10-20 % of the global leather production (BREF, 2013).
Synthetic materials and plastics	Bio-based materials	Bioplastics	1.2 million tonnes produced in Europe in 2011 5 % represents consumer products

Life cycle stage	Type of best practice	Examples	Some figures
		ecoTPU	5,000 tons Reducion of 25,000 tons of CO2[28]
	Recycled materials	Plastics and rubber	Up to 50 % incorporation for some brands
		Tyres	Using 1 kg of recycled rubber can save 1 kg of CO2 emissions compared to using 1 kg of synthetic rubber (reRUBBER[29],)
	Better materials	Natural rubber	
		Restriction of PVC	
Textiles	Certification	GOTS	80 countries, accounting for 2714 GOTS certified facilities in 2011
		Better Cotton Initiative	In 2012, 15% of global cotton production represented
		Gigg Indec from Sustainable Apparel Coalition	Group of over 100 leading apparel and footwear brands
		OEKO-TEX	More than 9,500 manufacturers in more than 90 countries are approved and 95.000 products
		Bluesign	
	Recycled materials	Recycled polyester	Among other categories, achievement of natural resources and GHGs emissions savings by 40-85% and 25-75%[30]
	Better materials	Hemp	Hemp-based composites is 45 to 90 % of those for to petrol-based composites (not including the carbon stored in the hemp) (EIHA[31])
Chemicals	RSL from brands	AFIRM the global RSL for footwear and apparel	95 % of stakeholders inquired use RSLs
Assembly of footwear	BAT	Optimization of assembly to reduce the quantity of raw materials	
		Assembly modification to eliminate unwanted substances (solvent replacements)	
		Promotion of end-of-life separation (use of seams)	
		Promotion of waste recovery and recycling	
Packaging	Use of recycled and recyclable materials	Recycled paper	
		Recycled plastics	

[28] http://www.ecotpu.eu

[29] http://www.rerubber.com/environmental-impact/

[30] http://www.adidas-group.com/en/sustainability/Environment/Archive/2010_recycled_polyester.aspx - (Utrecht University, 2010)

[31] European Industrial Hemp Association: http://www.eiha.org/

Life cycle stage	Type of best practice	Examples	Some figures
End of life	Increase the feasibility of reusing and recycling old shoes		95 % of the shoes purchased end up in the municipal waste stream[32]

TASK 3 – Technical analysis

Objectives

The general aim of this task is to assess the environmental impacts of footwear in a way that allows identifying the areas with the highest improvement potential. Relevant non-environmental impacts (e.g., health related issues) need to be assessed as well.

This task aims at investigating the environmental performance of footwear product group as characterized in the previous tasks. This includes three elements:

1) Literature review: Literature regarding the environmental assessment and improvement potential of the product group are reviewed; results are compared and critically assessed regarding robustness of the results (methodology, data quality, age, etc.).
2) Analysis of the environmental impacts of footwear along the life-cycle is performed based on collected data and other available data, standards, and tools. Wherever possible, the methodological guidelines provided by the Product Environmental Footprint (PEF) are followed. The assessment is performed in a way that is representative for the scope of the product group as defined in the previous tasks. Additional data collection has been proposed to the registered stakeholders in order to increase the reliability and relevance of the results.
3) Identification and assessment of environmental impacts which are not detected through standard LCA tools, or non-environmental impacts of relevance (e.g., health related issues). This is done through regulation and literature reviews, and stakeholder dialogue. Specifically, a discussion is included on hazardous substances and the potential to substitute them with safer components or via the use of alternative materials or designs, wherever technically feasible, particularly with regard to substances of very high concern referenced in Article 57 of the Regulation (EC) No 1097/2006 (REACH).

[32] Fry, C. (2010). Shoe recyclers aim to kick the landfill habit. Engineering and Technology magazine, 18 October 2010. Available at: http://eandt.theiet.org/magazine/2010/16/shoe-recyclers.cfm

Literature review

Selection of studies

From preliminary review of 22 papers of plausible relevance to the environmental impact of footwear, 13 studies have been further analysed because they assess quantitatively environmental impacts of footwear or leather.

The studies selected for further assess:

- Leather as an intermediate material (7 out of 13),
- Footwear using leather as the main material (4 out of 13),
- Footwear using different materials: leather, textiles, and synthetic materials (1 out of 13),
- Footwear using synthetic materials (1 out of 13).

Quality assessment

In order to develop valuable conclusions, the LCA literature needs to be assessed with respect to the data quality, assumptions and environmental indicators. Only studies that achieve adequate quality in these areas were further considered. Following this purpose, a semi-quantitative approach, similar to the one proposed by PEF, has been used.

Table 6 indicates the scoring calculated for each existing pre-selected LCA literature following the guidelines of quality assessment and the minimal requirements.

Table 6: Scores of existing LCA literature

#	Author	SCORE total	Scope	Data quality	Impact categories	Outcomes	Robustness	Review
1	BLC (Leather Technology Center)	Disregarded - functional unit is not properly defined. The study gives relative results but the functional unit is not given.						
2	BRUNO et al.	**18.4**	3	3.4	1	5	5	1
3	Center of Environmental Studies	Disregarded - insufficient broadness with respect to the 6 impact categories identified. 3 out of 6 of the selected impact categories are displayed.						
4	**Cheah et al.**	**25.8**	5	4.8	3[33]	5	5	3
5	CPI (Cleaner Production Institute)	Disregarded - insufficient broadness with respect to the 6 impact categories identifies. None of the selected impact categories are displayed. The study uses own categories and scores.						
6	DANI	**18**	5	5	1	3	1	3
7	Herva et al.	Disregarded - insufficient broadness with respect to the 6 impact categories identified. None of the selected impact categories are displayed. The study uses own categories and scores.						

[33] Only one category (climate change) is displayed but has a score "A" according to ILCD Handbook

#	Author	SCORE total	Scope	Data quality	Impact categories	Outcomes	Robustness	Review
8	Kebede Bekele	**16**	3	3	1	5	3	1
9	**Milà et al.**	**20**	5	3	1	5	3	3
10	**Milà et al.**	**24.6**	5	3.6	1	5	5	5
11	NIKE	Disregarded - insufficient broadness with respect to the 6 impact categories identified. 1 out of 6 of the selected impact categories is displayed.						
12	**Rivela et al.**	**20**	3	3	1	5	5	3
13	**University of Santa Barbara, California.**	**20.9**	5	3.9	1	5	3	3

Based on the scoring results, it is determined that 5 studies with a score equal or higher than 20 will be further analysed, following the prioritization from the highest to the lowest score ranked as follows:

1. Cheah et al.
2. Milà et al. (2002)
3. University of Santa Barbara, California (2008)
4. Milà et al. (1998)
5. Rivela et al (2004)

Table 7 presents the environmental hot spots highlighted by the relevant footwear LCA studies.

Table 7: Footwear - Highlighted hot spots[34]

Life cycle stages		Milà et al.	Simple shoes	Cheah et al.
Agriculture, breeding and slaughtering		++	--	Out of scope
Production of input materials	Synthetic materials	Out of scope	+	+
	Leather	++	++	Out of scope
	Natural fibres	Out of scope	+	Out of scope
Manufacturing and assembling	Energy consumption	++	--	++
	Other	--	--	--
Distribution	Packaging	--	-	-
	Transport	-	-	-
Use phase		Out of scope	Out of scope	-
End of life		-	-	-

[34] Legend: ++: very relevant; +: quite relevant; -: not relevant; --: not highlighted by the study

Specific LCA analysis

Objectives

In addition to the literature review, a specific LCA was performed in order to assess the previously highlighted findings. This additional LCA assesses the environmental impacts of an average pair of shoes based on the material segmentation established in Task 2: Market analysis.

More precisely, the study will focus on the following points:

- Identify the "hot spots" of the studied system, i.e., critical stages, processes and materials which contribute significantly within each environmental impact category.
- Conduct a sensitivity analysis for relevant key performance parameters (e.g., energy consumption, amount of materials used) along the life cycle and identify the most relevant ones. The values considered for the sensitivity analysis take into account different sets of parameters defined as variable from one pair of footwear to another.
- Develop conclusions that address the most important criteria areas of relevance for the revision, including their priority and feasibility.

Because the goal of the study is not to quantify in absolute terms the environmental performance of a pair of shoes, the analysis will focus on relative figures (percentage of contribution). However, absolute results will also be displayed for the completeness of the study.

Background information

The system boundaries considered are presented in the Figure 5.

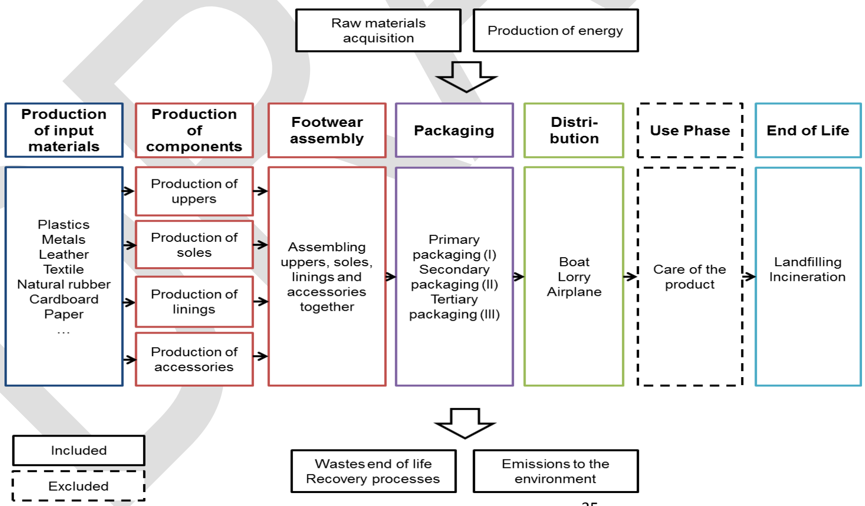

Figure 5: System boundaries[35]

The use phase is excluded from the current analysis, as suggested by the findings extracted from the literature review.

[35] Source: RDC Environment

In order to have relevant and reliable data for evaluating the environmental impacts of footwear, a questionnaire was developed and sent to registered stakeholders. The total number of response was 13. Of these, four did not provide any quantitative information, but rather general comments on the LCA performing.

Results

Figure 6 shows the relative results for each environmental category for average values of parameters.

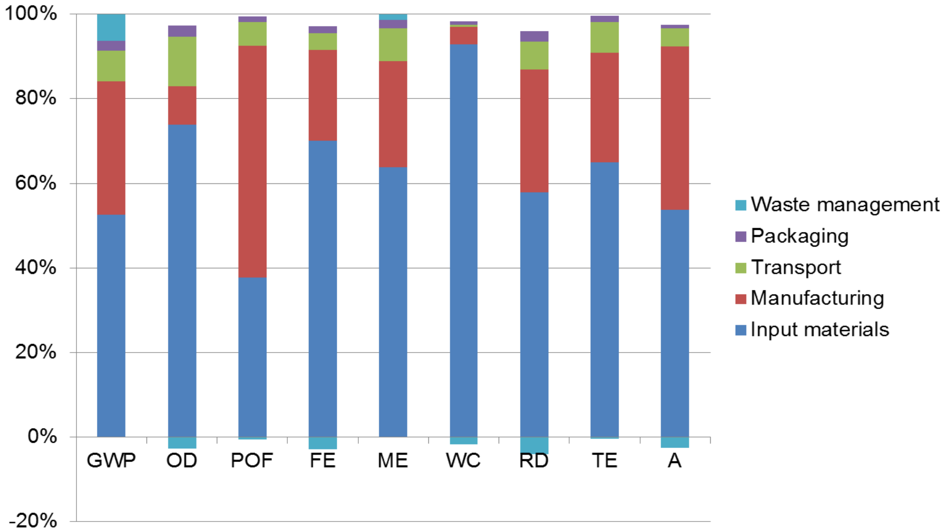

Figure 6: Relative results – Average scenario

As indicated in Figure 6 and Table 8, the impacts are mostly due to the production of input materials (40 to 90 %), mainly influenced by the mass of the footwear (i.e., the quantity of input materials required) and the wastage rate. The manufacturing of footwear accounts for 5 to 60 % of overall impact and is generated mainly by the energy consumption and the emissions of Volatile Organic Compounds (VOC). Distribution has an impact of 2 to 15 % on the overall results, mainly due to air transport contribution.

In general, the conclusions are quite similar to the ones drawn from the LCA literature review. However, additional special focus is on VOC emissions is necessary mainly due to the use of organic solvents during footwear assembly.

The most sensitive parameters are the following (the most important first):

- Energy consumption (manufacturing);
- Electricity mix (manufacturing);
- Mass of footwear and choice of input materials;
- Wastage rate;
- Share of airplane for intercontinental transport;
- Incineration rate at end of life;
- Quantity of VOC emissions.

The impacts of agriculture, breeding and slaughtering may also be relevant for the life cycle of footwear, depending on the allocation rule chosen. Therefore, careful consideration should be given to whether leather is assumed to be considered as a co-product or by-product of meat and milk industry.

Table 8: Highlighted hot spots from additional LCA

Life cycle stages		Environmental relevance[36]
Agriculture, breeding and slaughtering		- to +++
Production of input materials		+++
Manufacturing and assembling	Energy consumption	++
	VOC emissions	+
Transport by plane		+
End of life of footwear		-

Durability of footwear is also a key parameter as it multiplies the results.

Based on the results of the LCA analysis performed and on the outcomes from the current LCA review, the following criteria areas should be addressed in the revision of the EU Ecolabel:

- The footwear should achieve a certain durability considering its resistance to mechanical degradation,
- The input materials should be carefully chosen with a focus on the use of sustainable materials (e.g., recycled materials),
- The mass of footwear should be minimised[37],
- For the production of leather, hides and skins should come from the meat and milk industries in order to ensure that impacts of farming can be mostly attributed to meat and milk,
- The wastage should be minimised during material processing and footwear manufacturing,
- The energy consumption should be minimised for footwear manufacturing (including uppers, soles, and linings manufacturing, and footwear assembly),
- The VOC emissions should be minimised during footwear manufacturing.

Environmental issues of hazardous substances

[36] +++: proportional to LCA results; ++: very significant on LCA results; +: quite significant on LCA results; -: not significant on LCA results.

[37] This criterion must not be reached at the expense of durability of footwear

In this task a number of the environmental issues not specifically addressed or highlighted by the LCA studies reviewed in the previous section but identified by the cross-checking of analysed literature were explored in greater detail, with reference to the Commission Statements and initial stakeholder feedback. Several areas of concern were preliminarily identified as being of significance and requiring addition detail regarding their environmental and human health impacts, considering their implications for the criteria revision in line with Article 6 (Paragraphs 6 and 7) of the Ecolabel Regulation (EC) 66/2010 which established the requirements that no product awarded the Ecolabel should contain:

- Substances or preparations/mixtures that are restricted under Article 57 of the REACH Regulation (EC) No 1907/2006;
- Substances or preparations/mixtures that have been identified according to the procedure described under Article 59 of the REACH Regulation (EC) No 1907/2006 and which have been subsequently classified as Substances of Very High Concern;
- Substances or preparations/mixtures that are classified as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction (CMR), in accordance with Regulation (EC) No 1272/2008.

For each area, additional supporting evidence is introduced in order to inform discussion regarding the possible direction of the criterion revision. The potential for harmonisation with other labelling or certification schemes that address specific environmental issues is also considered. Identification of the additional environmental issues and selection of the most relevant chemicals related to footwear has been cross-checked in different sources of relevance:

- Legal requirements in the European Union and Member States
    - REACH Regulation (EC) No 1907/2006
    - SVHC list from ECHA
    - CLP Regulation (EC) No 1272/2008
    - Biocidal products Regulation (EU) No 528/2012
    - Persistent Organic Pollutants Regulation (EU) No 850/2004
    - Commission Decision of 17 March 2009
- EU Ecolabel regulation and existing ecolabels
    - EU Ecolabel Regulation
    - Current EU Ecolabel for footwear
    - On-going revision of the EU Ecolabel for Textile
    - Existing EU Ecolabels of relevance
    - Restricted Substances lists from 14 companies

- Commission Statement 19 March 2009/ ENV G2
- Initial stakeholder feedback
- Analysis of available scientific literature, reports and publications

The chemical substances used in materials manufacturing, finishing, and footwear assembly might be present in the final product. Some of these substance are classified as hazardous according to the CLP and REACH regulations. The key objective of the screening was to identify the potential use and presence in the final product of these groups of substances from an overall supply chain perspective, focussing mainly on the material and process criteria, i.e., in which material processing or process stage there is a risk of possible involvement of the identified substance(s).

Substances listed in the Restricted Substances List (RSL) may be banned from the finished products or accepted based on the condition that their concentrations in the product are below certain concentration limits Some restrictions follow only the legal restrictions imposed on the substance, but some corporations have stricter limits than regulations because they have to be compliant with the regulations of multiple countries or because they want to obtain certain labels[38].

The results of the analysis are summarized in Table 100 (Annex X Hazardous substances potentially present in footwear). The main issues of concern identified are discussed further in the following chapters either because of identified frequency of possible occurrence or supported by analysis of other ecolabels of relevance. These substances are:

- Biocides, preservatives, and antibacterial substances
- Dyes and pigments
- Organic solvent
- Plasticizers and elastomers
- Flame retardants
- Impregnation agents
- Auxiliary
- Nanomaterials
- PAHs
- Formaldehyde

TASK 4 – Improvement potential

Objectives

The aim of this chapter is to translate the main LCA findings into Ecolabel criteria. The analysis performed provides an estimate of the necessary improvement potential to support discussions and consultation related to on-going revision of the EU Ecolabel criteria for the Footwear product group as introduced by the Commission Decision 2009/563/EC. Therefore, the overall goal of this Task is to

[38] Consultation with footwear testing expert from Intertek

highlight possible environmental benefits related to the previously identified impacts, and to prioritize them according to:

- The main environmental issues;
- The technical and economical feasibilities.

The potential for improvement of the environmental hot spots is calculated per functional unit[39] and aggregated to the EU27 level on the basis of the market figures. The improvement potentials derived in this chapter are given in percentages obtained through direct comparison with the results of the baseline scenario (based on an average pair of footwear).

In general terms, it is very complicated to quantitatively evaluate the market diffusion of a series of identified best practices at the European level. However, as the results are expressed in percentage of improvement, the results are also valid at European level under assumption that the related improvement is applied uniformly across the EU28. In general terms, the improvement potential at European scale is proportional to the one estimated for one pair of footwear and to the market penetration. (

Market diffusion and possible barriers and opportunities within the proposed analysis areas are considered and, whenever possible, are augmented with numerical estimates.

Conclusions

Figure 7 summarizes the improvement potentials that have been quantitatively evaluated in this section for one pair of footwear. Improvements related to energy consumption clearly appear as the major ones. Reduction of wastage, followed by the reduction of VOC emissions, restriction on airplane transport, and reduction of footwear mass.

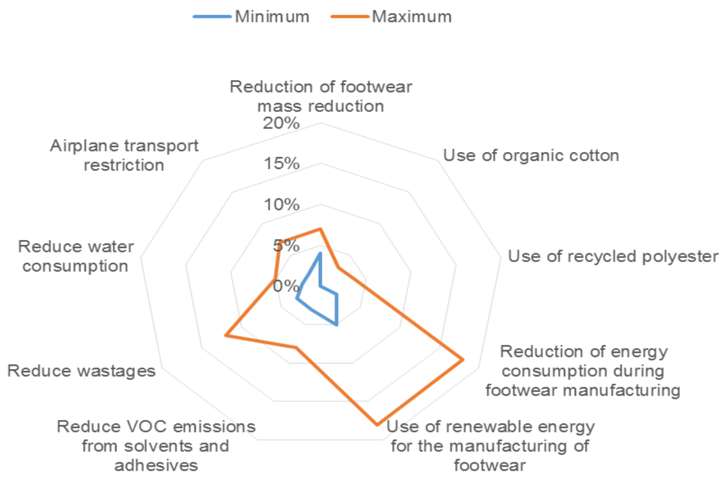

Figure 7: Summary of improvement potentials quantitatively evaluated

[39] "To use and wear appropriately footwear in good conditions during one year."

Based on the analysis of the potential improvements, the Table 9 summarizes the environmental relevance of possible improvements, the market penetration of these practices, and potential improvements that should, or could be, included in the criteria.

Table 9: Improvement potential – Inclusion in criteria area

Life Cycle stage	Potential improvements	Environmental relevance per functional unit[40]	Market Penetration[41]	Criteria integration/ revision[42]	Feasibility of criteria implementation[43]
Input materials	Reduction of footwear mass reduction	++	-	No	-
	Use of organic cotton	-	+++	Discussion	+
	Use of recycled polyester	-	+++	Discussion	+
	Use of bio-based materials	Not assessed quantitatively	+	Discussion	+
	Use of recycled plastics	Not assessed quantitatively	++	Discussion	+
	Exclusion of PVC	Not assessed quantitatively	+	Discussion	++
	Emissions to water	Not assessed quantitatively	+	Discussion	++
	Limitation of hazardous substances	Not assessed quantitatively	++	Yes	+
Manufacturing	Reduction of energy consumption during footwear manufacturing	++	-	Discussion	+
	Use of renewable energy for the manufacturing of footwear	++	-	Discussion	+
	Reduce VOC emissions from solvents and adhesives	+	+++	Yes	+
	Reduce wastages	+	+	Yes	+
	Reduce water consumption	+	-	Discussion	+
Distribution	Airplane transport restriction	+	-	Yes	++
Fitness for use	Improvement of footwear durability	+++	-	Yes	+
End of life	Improve end of life management	Not assesses quantitatively	++	Discussion	-

[40] +++: LCA results are proportionally related to the parameter; ++: very significant on LCA results; +: quite significant on LCA results; -: not significant on LCA results.

[41] +++: best practice often declared to be used by producers; ++: best practice sometimes declared to be used by producers; +: best practice used by few producers; -: best practice not identified within the chapter 2. Task 2: Market analysis

[42] Yes: the action should be integrated/revised in the criteria area; No: the action must be integrated/revised in the criteria area; Discussion: the action would need feedback from working group to decide whether to include/revise it or not

[43] ++: quite feasible because the criterion is straightforward; +: feasible but needs to set the scope and/or specific limits; -: difficult to set a quantitative criterion.

1 Task 1: Stakeholder survey, statistical and legal review, scope and definition proposal

The first part of Task 1 describes the policy framework for revising the EU Ecolabel footwear product group. It identifies the legislative issues and standardization processes relevant to the revision process (see chapter 1.2); summarises the scope of the current criteria and the possible product group classification (see chapter 1.3); it presents the other existing Ecolabels (see chapter 1.4); and it discusses the feedback gathered from stakeholders and the EU Ecolabel Board concerning the feasibility of the proposed scope extension to other leather products (see chapter 1.5). The feedback includes a preliminary review of the statements made by the Commission[44] when the current criteria were adopted and an analysis of the responses collected from a questionnaire sent out to Competent Bodies and stakeholders registered to take part in the revision process.

1.1 Objective

The main objective of Task 1 is to gather the following information:

- How the overview of the existing statistical and technical categories and relevant legislation and standards will support the proposal of the revised product group scope and definition;
- Whether the scope is correctly defined or should be adapted;
- Whether the scope should be enlarged (to non-footwear products);
- Stakeholder opinions (including Member State competent bodies and applicant companies) concerning the feasibility of complying with the criteria. both on the side of Member State competent bodies and applying companies,

The proposal to broaden the footwear product group scope to include other leather products is very sensitive. Among several arguments reflected in a dedicated Report[45], so-called leather products actually cover a broad range of different applications (from wallets and jackets to upholstery) and include a vast variety of non-leather materials (in particular, textiles and plastics). Therefore, the possible scope extension requires a very specific cross-analysis of different technical aspects.

1.2 Legislative background

1.2.1. EU Ecolabel Regulation

Review of the EU Ecolabel criteria for the footwear product group relies mainly on Regulation (EC) 66/2010 on the EU Ecolabel. Article 6 within this regulation sets out following general requirements for criteria development:

- It shall cover the most significant environmental impacts, in particular, the impact on climate change, the impact on nature and biodiversity, energy and resource consumption, generation of waste, emissions to all environmental media, pollution through physical effects and use, and release of hazardous substances;

[44] Commission Statement of 19 March 2009 (ENV G2)

[45] (Technical Support for the Revision of the EU Ecolabel criteria – Product group "Footwear", Preliminary Proposal with Recommendations on the Scope Revision, February 2013., 2013), http://susproc.jrc.ec.europa.eu/footwear/whatsnew.html

- It shall encourage reduction of hazardous substance use by: 1) substitution of hazardous substances by safer substances, 2) use of alternative materials, design or technologies which eliminate the need for hazardous substances, wherever technically feasible;
- The potential to reduce environmental impacts due to durability and reusability of products shall be proved;
- the net environmental balance between the environmental benefits and burdens shall be covered, including health and safety aspects, at the various life stages of the products;
- Where appropriate, social and ethical aspects shall be covered as well, e.g., by referencing to related international conventions and agreements, such as relevant ISO standards and codes of conduct;
- To enhance synergies, criteria established for other environmental labels shall be considered, particularly labels that are officially recognised (nationally or regionally) and EN ISO 14024 type I environmental labels where they exist for that product group;
- As far as possible, the principle of reducing animal testing shall be addressed.”

In addition to these conditions, the Article 6(4) requires that EU Ecolabel “fitness for use" criteria shall also be included. Additional provisions are made in Article 6(6) and 6(7) regarding the substances contained in the product. Accordingly, the EU Ecolabel shall not be awarded to products containing:

- Substances or preparations/mixtures meeting the criteria for classification as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction (CMR), in accordance with Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures;
- Substances referred to in Article 57 of Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency;
- Substances or preparations/mixtures that have been identified according to the procedure described under Article 59 of the REACH Regulation No 1907/2006 and which have been subsequently classified as Substances of Very High Concern.

Article 6(7) allows derogations for substances only if it is not technically feasible to substitute them with safer chemicals, or obviate the need for the substance by using alternative materials, designs products which have a significantly higher overall environment performance compared with other goods of the same category. However, no derogation shall be given for substances that:

- meet the criteria of Article 57 of Regulation (EC) No 1907/2006;
- are identified according to the procedure described in Article 59(1) of that Regulation
- present in mixtures, in an article or in any homogeneous part of a complex article in concentrations higher than 0,1 % (weight by weight).

1.2.2. Legislation for environmental performance of footwear

There is no specific EU legislation that exclusively addresses the environmental performance of footwear or leather products. Nonetheless, this section outlines the main EU legislation which may be significant to the EU Ecolabel footwear product group revision process and the footwear sector, including legislation pertaining to chemicals, the environment, and health and safety at work, among others. Additional legislation references have been added where relevant to the footwear criteria revision.

1.2.3. EU Footwear Labelling Directive

Directive 94/11/EC, also called EU Footwear Labelling Directive, is specifically related to the European market on the approximation of the laws, regulations and administrative provisions of the Member States relating to the labelling of materials used in the main components of footwear for sale to the consumer[46]. For the purposes of the Directive, ‘footwear’ shall mean all articles with applied soles designed to protect or cover the foot, including parts marketed separately as referred to in Annex I of the Directive, and recalled on Figure 8. Respective labels must contain information related to the main footwear component parts, such as: the upper, the lining and insole sock, and the outer-sole. Materials must be labelled in one of four ways: leather; coated leather; natural, synthetic and non-woven textile; and all other materials. The labelling shall provide information on the material covering at least 80% of the surface areas or 80% of the volume of the outer-sole. If several materials account for this 80 %, information should be given for the two main materials composing of the footwear. The information must be conveyed by means of approved pictograms or textual information, as defined by the Directive. The label must be legible, firmly secured and accessible, and the manufacturer or his authorized agent established in the Community is responsible for supplying the label and for the accuracy of the information contained therein. Only the information required by the directive need be supplied. There are no restrictions preventing additional information from being included on the label.

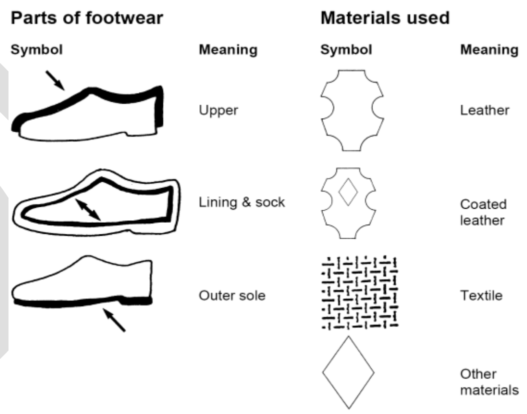

Figure 8: Footwear Pictograms in line with the Directive 94/11/EC

For the purpose of the scope analysis of the EU Ecolabel for footwear, it is important to mention that according to Annex II of the Footwear Labelling Directive, a non-exhaustive list of the footwear products includes:

[46] OJ L 100,19/04/1994,p. 0037 - 0041

- flat or high-heeled shoes for ordinary indoor or outdoor wear;
- ankle-boots, half-boots, knee-boots, and thigh boots;
- sandals of various types, 'espadrilles' (shoes with canvas uppers and soles of plaited vegetable material), tennis shoes, running and other sports shoes, bathing sandals and other casual footwear;
- special sports footwear which is designed for a sporting activity and has, or has provision for the attachment of spikes, studs, stops, clips, bars or the like, and skating boots, ski boots and cross-country ski footwear, wrestling boots, boxing boots and cycling shoes. Also included are composite articles made of footwear with (ice or roller) skates attached;
- dancing slippers;
- footwear formed from a single piece, particularly by moulding rubber or plastics, but excluding disposable articles of flimsy material (paper, plastic film, etc., without applied soles);
- overshoes worn over other footwear;
- disposable footwear with applied soles, generally designed to be used only once;
- orthopaedic footwear.

The following type of footwear shall be excluded from the Directive:

- second-hand, worn footwear;
- protective footwear covered by Directive 89/686/EEC (1);
- toy footwear.

Additionally, Article 12 of the EU Textile Labelling Regulation (1007/2011)[47] specifies: *“the presence of non-textile parts of animal origin in textile products shall be indicated by using the phrase*: ‘Contains non-textile parts of animal origin’ on the labelling or marking of products containing such parts whenever they are made available on the market”. Following the same Regulation, marking the fabrics composition used in textile footwear parts is not mandatory.

1.2.4. Other relevant European environmental policy and legislation

Several Directives and legal instruments regulate the footwear and leather products supply chain in order to prevent potential harmful impacts to human health and the environment and to improve resource efficiency. The main regulatory framework which appears relevant for the product group Footwear is briefly described in this section.

I. Framework Directives

- **Waste Framework** Directive 2008/98/EC sets the basic concepts and definitions related to waste management, including definitions of waste, recycling, and recovery. It explains

[47] OJ L 272/1,18.10.2011, p

when waste ceases to be waste and becomes a secondary raw material (so called end-of-waste criteria), and how to distinguish between waste and by-products. The Directive establishes some basic waste management principles requiring waste to be managed without endangering human health and harming the environment; that is, without posing risk to water, air, soil, plants or animals, without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest. It mandates that waste legislation and policy of the EU Member States shall apply the waste management hierarchy (prevention, preparing for re-use, recycling, recovery, and disposal). The development of criteria on the end of life could be considered within the revision process, as e.g. the innovations in the recycling of footwear and footwear parts is supported by waste hierarchy .

- **Water Framework** Directive 2000/60/EC establishes the objectives for water protection for the future to promote cleaner rivers and lakes, groundwater and coastal beaches. This Directive is important when considering manufacturing processes of key materials used in footwear industry (e.g., leather tanning), where significant amounts of water and chemicals are used and emitted into environment with or without treatment.
- **Landfill** Directive 99/31/EC's aims to prevent or reduce negative effects on the environment by introducing stringent technical requirements for waste and landfills. This Directive is worth mentioning as across the Member States footwear is mainly treated as household waste. Among other requirements, Member States shall set requirements or limitations on the amount of organic matter in the waste and on the biodegradability of the organic waste components.
- **Incineration** Directive 2000/76/EC sets emissions limits and monitoring requirements for pollutants to air. It also seeks to control releases to water resulting from the treatment of waste gases by pollution control equipment. This is relevant because footwear components may contain substances that could undergo chemical reactions or transformations during the combustion process, producing harmful substances that may be discharged via process exhaust gases and/or bottom ashes.
- **Environmental Impact Assessment (EIA)** Directive 2011/92/EU contains a legal requirement to conduct an environmental impact assessment (EIA) of public or private projects that are likely to have significant impacts on the environment, prior to their authorisation. The main objective of the Directive is to harmonise the principles of environmental assessment throughout the EU by the introducing a set of minimum requirements concerning the type of projects subject to assessment, the main developer's obligations, the content of the assessment, and the participation of the competent authorities and the public. The Directive designate plants for the tanning hides and skins as projects that Member States have discretion to determine whether the projects shall be subjected to an environmental impact assessment.
- The Directive on **Personal Protective Equipment (PPE)** 89/686/EEC harmonises products to ensure a high level of protection for citizens throughout Europe[48]. Those products have to meet this challenge: to ensure the user's safety and health in specific

circumstances. The manufacturer must inform the user about the type of hazards against which his product protects and the product must have the EC mark of conformity (e.g., the outer-soles for footwear designed to prevent from slipping must be so designed, manufactured or equipped with added elements, to ensure satisfactory adhesion by grip and friction having regard to the nature or state of the surface[49]).

II. Industry specific Directives

- **Integrated Pollution Prevention and Control** Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008, covers integrated pollution prevention and control. It focuses on minimising pollution from various industrial sources throughout the European Union. Among others, the following plants are subjected to the IPPC Directive:
    - Plants for tanning of hides and skins where the treatment capacity exceeds 12 tonnes of finished products per day **;**
    - Slaughterhouses with a carcass production capacity greater than 50 tonnes per day.

  Furthermore, according to the IPPC Directive, permit conditions must be based on Best Available Techniques (BAT). The Reference Document on Best Available Techniques for the Leather Industry (BREF Tannery) has been adopted in 2013. This document provides general information on the leather sector and on the industrial processes used by tanneries. It provides data and information concerning emission and consumption levels and describes the emission reduction and other techniques that are considered to be most relevant for determining BAT and BAT-based permit conditions.

- **Industrial Emissions** Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 addresses industrial emissions. The IED will replace the IPPC Directive and the sectorial directives, effective 7 January 2014; the LCP Directive[50] is exempt from this replacement and it will be repealed effective1 January 2016.
- **Toy Safety** Directive 2009/48/EC of the European Parliament and of the Council of 18 June 2009 addresses toy safety. This Directive applies to products designed or intended, whether or not exclusively, for use in play by children under 14 years of age. Accordingly, some footwear products are covered by the scope definition (e.g., baby footwear could easily come into contact with a baby's mouth). The new Directive establishes concentration limits for chemicals and substances used in toy component materials.
- **Azo Dyes** Directive 2002/61/EC of the European Parliament and of the Council of 19 July 2002 amends for the nineteenth time Council Directive 76/769/EEC relating to restrictions on the marketing and use of certain dangerous substances and preparations (azocolourants).
- **VOC Solvents Emissions** Directive 1999/13/EC is the main policy instrument for the reduction of industrial emissions of volatile organic compounds (VOCs) in the European

[50] 2001/80/EC

Union. It covers a wide range of solvent using activities, e.g., printing, surface cleaning, vehicle coating, dry cleaning, and manufacture of footwear and pharmaceutical products. Some plants covered by the VOC Solvents Emissions Directive are also covered by IPPC Directive. In these cases, the VOC Solvents Emissions Directive only sets minimum obligations which are not necessarily sufficient to comply with the IPPC Directive.

III. Regulations and Decisions

- **Animal by-products** Regulation (EC) No 1069/2009 established animal health and public health rules for the collection, transport, storage, handling, processing, and use or disposal of animal by-products.
- Commission Decision of 28 May 2009 amended Council Directive 76/769/EEC regarding restrictions on marketing and use of **organostannic compounds** for the purpose of adapting its Annex I to technical progress.
- Commission Decision of 17 March 2009 requires Member States to ensure that products containing the biocide **dimethylfumarate** are not placed or made available on the market (2009/251/EC).
- The convention on trade in endangered species (CITES), which includes Council Regulations (EC) No 338/97, addresses leather products containing material from endangered species.

1.2.5. Chemicals management

REACH Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerns the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishes a European Chemicals Agency, amends Directive 1999/45/EC and repeals Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94, as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.

The main objectives of REACH are to ensure a high level of protection of human health and the environment from the risks that can be posed by chemicals, to promote alternative test methods, to ensure free circulation of products on the internal market and to enhance competitiveness and innovation of the EU chemicals industry.

REACH makes industry responsible for assessing and managing the risks posed by chemicals and for providing appropriate safety information to their users. In parallel, the European Union can take additional measures on highly dangerous substances, where there is a need for complementing action at EU level.

Current restricted substances, those where the marketing or use of the substance is controlled, are already listed in Annex XVII of the REACH text, but it is expected that this list will increase as REACH progresses.

In relation to footwear and leather, several substances related to footwear manufacture are currently restricted by Annex XVII of REACH; some substances are already addressed under the current EU Ecolabel criteria for footwear.

ECHA, the European Chemicals Agency is the driving force among regulatory authorities in implementing the EU's ground-breaking chemicals legislation for the benefit of human health and the environment, as well as for enhancing EU innovation and competitiveness. ECHA helps companies to comply with the legislation, advances the safe use of chemicals, provides information on chemicals and addresses chemicals of concern. Substances recommended for inclusion are selected by the ECHA from a priority list, the “Candidate List." Once sanctioned by the European Commission, the substances are banned from use unless an authorization for a certain use is temporarily granted to an individual company. Requests for authorization of banned substances must be submitted to ECHA and final decisions are made by the European Commission. Substances listed under Annex XIV, will become restricted from use after the end of a transitional period called “Sunset Date".

Among others, in accordance with Article 59(10) of the REACH Regulation, ECHA publishes the Candidate List of Substances of Very High Concern (SVHC) for authorisation. The authorisation procedure aims to assure that the risks from SVHC are properly controlled and that these substances are progressively replaced by suitable alternatives while ensuring the proper functioning of the EU internal market. Substances with the following hazard properties may be identified as Substances of Very High Concern (SVHCs):

- Substances meeting the criteria for classification as carcinogenic, mutagenic or toxic for reproduction category 1A or 1B in accordance with Commission Regulation (EC) No 1272/2008 (CMR substances);
- Substances which are persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) according to REACH (Annex XIII);
- Substances identified on a case-by-case basis for which there is scientific evidence of probable serious effects that cause an equivalent level of concern as with CMR or PBT/vPvB substances.

After a two-step regulatory process, SVHCs may be included in the Authorisation List and become subject to authorisation. These substances cannot be placed on the market or used after a given date, unless an authorisation is granted for their specific use or the use is exempted from authorisation. Manufacturers, importers or downstream users of a substance on the Authorisation List can apply for authorisation.

As previously discussed, substances that form part of the SVHC (Substances of Very High Concern) Candidate List should be excluded from Ecolabelled products. The list is dynamic and is updated with new substances as candidate substances are identified, testing is conducted and evidence is published.

The full Candidate List of SVHC can be consulted on: http://echa.europa.eu/web/guest/candidate-list-table.

CLP Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 addresses classification, labelling and packaging of substances and mixtures. It amends and repeals Directives 67/548/EEC and 1999/45/EC, and amends Regulation (EC) No 1907/2006 (GHS Regulation).

The CLP Regulation ensures that the hazards presented by chemicals are clearly communicated to workers and consumers in the European Union through classification and labelling of chemicals.

Before placing chemicals on the market, the industry must establish the potential risks to human health and the environment of such substances and mixtures, classifying them in line with the identified hazards. The hazardous chemicals also have to be labelled according to a standardised system so that workers and consumers know about their effects before they handle them.

The CLP Regulation became effective in January 2009, and the method of classifying and labelling chemicals it introduced is based on the United Nations' Globally Harmonised System (GHS).

Biocidal products Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 addresses marketing, sale and use of biocidal products. The Regulation repeals and replaces Directive 98/8/EC becomes effective on 1 September 2013. The objective of the new Regulation is to improve operation of the internal market for biocidal products and correct a number of weaknesses that were identified during the 11 years of implementation of the current Directive 98/8/EC.

Persistent Organic Pollutants Regulation Regulation 850/2004 covers chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment. This group of priority pollutants consists of pesticides (such as DDT), industrial chemicals (such as polychlorinated biphenyls PCBs and perfluorooctanesulfonique acid - PFOS), and unintentional by-products of industrial processes (such as dioxins and furans). With respect to the footwear product group, PCBs can for example be used as additive in plastics or as adhesive. In 2010, PFOS became controlled across Europe by the Persistent Organic Pollutant Regulation. With certain limited exceptions, its production, supply and use are now banned.

1.2.6. European and International standards

This section presents a summary of the main international standards relevant to the footwear and leather sectors.

I. CEN – European Committee for Standardization

CEN is officially recognized as a European standards body by the European Union. CEN has signed the 'Vienna Agreement' with the International Organization for Standardization (ISO), through which European and International standards can be developed in parallel.[51] Footwear-relevant CEN standards are presented below:

- CEN/TC 289 – Leather
- CEN/TC 309 – Footwear
- CEN/TC 161 – Foot and leg protectors, including safety footwear and protective footwear
- CEN/TC 162 – Protective clothing including hand and arm protection and life jackets
- CEN/TC 193 – Adhesives
- CEN/TC 217 – Surfaces for sports areas
- CEN/TC 248 – Textiles and textile products

[51] http://www.cen.eu/cen/aboutus/pages/default.aspx

II. ISO – International Organization for Standardization[52]

- **TC 120 Leather** Standardization addresses the field of raw hides and skins, including: pickled pelts; tanned hides and skins and finished leather; leather products (including testing methods for leather products). Excluded are the following: testing methods for raw hides and skins, including pickled pelts, tanned hides and skins, and finished leather, which is within the domain of the IULTCS[53]; footwear, which is within the purview of ISO / TC 216; protective clothing and equipment, which is within the purview of ISO / TC 94.
- **TC 216 Footwear** addresses standardization of test methods, terminology and performance requirements for components for footwear, and test methods and terminology for whole shoe. Excluded are footwear for professional use (already covered by ISO / TC 94) and sizing system designation and marking for boots and shoes (addressed by ISO / TC 137).
- **TC 137 Footwear sizing designations and marking systems** addresses the following: standardization of footwear sizing systems based on the measurement of the foot, and designation and marking of such sizes; standardization of sizing ranges (unit and intervals); standardization of a system for calibrating the equipment and terminology.
- **TC 45 Rubber and rubber products** addresses standardization of terms and definitions, test methods and specifications for rubber in any form, rubber products (including their dimensional tolerances) and major rubber compounding ingredients. By agreement with ISO / TC 61, coated fabrics, flexible cellular materials, footwear and hose, whether made of rubber or plastics, are also addressed in ISO / TC 45.

III. IULTCS - International Union of Leather Technologists and Chemists Societies

The IULTCS test methods are accepted by the International Organisation for Standardisation (ISO) and, following agreements in 1990 and re-affirmed in 2005, the ISO recognises IULTCS as an International Standardising Body. ISO has assigned responsibility for establishment of test procedures for leather to IULTCS and the resultant test method documents are published as a joint IULTCS and ISO Standards. The European Committee for Standardisation (CEN) has, through the CEN/TC 289 Technical Committee "Leather" (Secretariat: UNI Italy), jointly adopted many of the IULTCS / ISO Standards. Once formally accepted, the CEN Standards are mandatory in all EU member countries[54]. The standard methods address:

- Physical test methods
- Chemical test methods
- Fastness test methods

These regulations and standards illustrate the diversity of technical requirements related to footwear and leather products. Thus, a broad scope extension would make the criteria related to the performance tests more complicated. Accordingly, it is unlikely that development of common fitness-

[52] www.iso.org

[53] *International Union of Leather Technologists and Chemists Societies*

[54] http://www.iultcs.org/pdf/IULTCS%20-%20OFFICIAL%20METHODS_March-2012.pdf

for-use criterion will be possible. That would have to be resolved by the division in different sub-criteria for footwear and leather products.

1.3 Definition and categorisation

The Article 1 of the current EU Ecolabel criteria document for Footwear (Commission Decision 2009/563/EC) defines the product group scope as: "*The product group 'footwear' shall comprise all articles of clothing designed to protect or cover the foot, with a fixed outer sole which comes into contact with the ground. Footwear shall not contain any electric or electronic components*."

Additionally, the framework of the Decision establishes the following cut-off limit: "*Any upper shoe components weighing less than 3 % of the whole upper part shall not be taken into account for the application of the criteria. Any sole shoe components weighing less than 3 % of the whole outer sole shall not be taken into account for the application of the criteria*."

Even if the primary purpose of wearing footwear has historically been foot protection, shoes have evolved with time into an important component of fashion industry, therefore, adornment or defining style has become their additional and significant function. Footwear manufacturing is perceived as a short turn-out products industry, subject to the seasonal change and current fashion trends. There are then many types of footwear--shoes, boots, sandals, slippers, wellington shoes, safety footwear, espadrilles, etc., being further categorized into many more sub-types. Hence there are a variety of common shoe classes to consider within this product group. We should stress the existence of a clear division between "common use" and "special" footwear designed for a specific purpose, e.g., medical (orthopaedic or diabetic shoes) or safety (protective) footwear. These products are often not considered as standard shoes subjected to very specific performance criteria.

The possible scope extension to "other types of leather products", encompasses the vast quantity of different articles to be included, especially in terms of their function, intended use, and manufacturing technology. Nevertheless, leather used in footwear production is the most diversified and fulfils the strictest, very product-specific technical requirements[55]. Therefore, the specific product group segmentation is concentrated on footwear which represents the main destination for intended use of leather. The most common footwear categorization addresses the product group specification on the basis of material composition and product intended use.

1.3.1. General description of footwear

Despite the existence of different shoe segmentation (style, destination, material, among others) it is possible to specify basic footwear anatomy that could be representative for the product group under analysis.

[55] Except from upholstery and automotive leather that must fulfil specific technical and security requirements

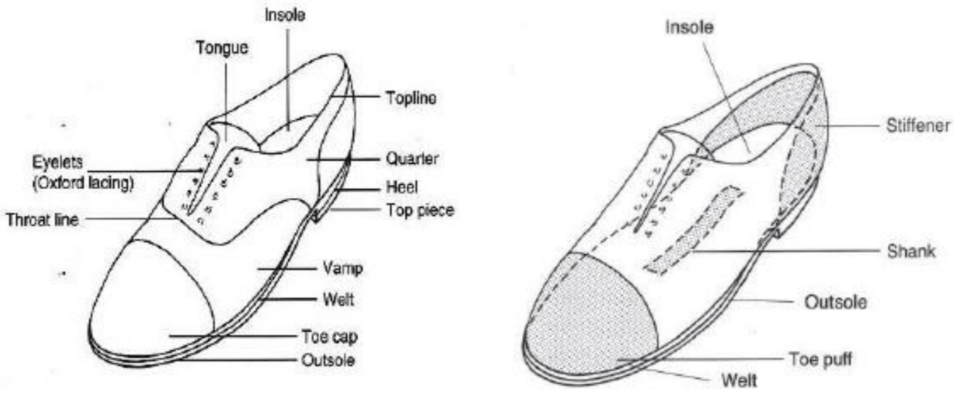

Figure 9: Structure of footwear[56]

Upper: refers to the part or parts of footwear that cover the toes, top of the foot, sides of the foot, and back of the heel. Depending on the footwear design, the upper can be made of a single piece, or composed of several parts assembled together (by stitching or gluing). The shoe upper can include the vamp, the heel counter, and the tongue, among other components, as show on Figure 9. The tongue is designed to open and close the shoes. In the most simple cases (sandals or flip flops), the upper consists of a simple strap going through the toes. In some types of footwear (boots), the upper goes up the leg as a protective or supporting function, or for design. In general terms, the uppers is the part of footwear that is most influenced by the design and fashion.

Lining: refers to the inside material that touches the sides of the foot, the top of the foot, and/or the back of the heel. Again, it can be made of several parts assembled together. Materials for the lining are chosen mainly for their flexibility, softness, breathability, and waterproof character.

Sole: refers to the bottom part of the footwear in direct contact with the ground. It can be made of several layers and of various materials, aiming at a specific characteristic, such as: flexibility, shock absorption, friction resistance, waterproofness, etc. Leather and natural rubber have historically been used as the main material for sole production; nowadays, synthetic materials are more common. The sole may consist of one or several pieces. The multi-piece sole will generally consist of an outer-sole, mid-sole and insole. The insole is the part of the shoes that comes in direct contact with the foot; therefore, it must be comfortable and avoid moisture accumulation and bad odour generation. It can be made of paperboard or textiles (synthetic or natural) and can generally be replaced after being worn for a long time. The mid-sole is generally designed as a shock absorber, particularly in athletic footwear. Some soles may include heels or be designed for high traction and slip resistance properties for specific purposes (e.g., football shoes, walking shoe, etc.).

Accessories: refer to small adornments or functional pieces such as laces, eyelets, zips, buttons, Velcro, decorations, etc.

[56] Rossi, W.A. (2000) The Complete Footwear Dictionary. Malabar: Kreiger Publishing Co. Picture taken from Staikos and Rahimifard (2007)

1.3.2. Footwear Manufacturing

Footwear manufacturing is, in general terms, the process of designing, engineering, and finally joining together prepared components into an upper, insole, outsole and heel around a wood, plastic or metal last (form that represents foot shape) by gluing, stitching, moulding, heating, or foaming . Automated systems assist the manufacturing processes; however, it is still a labour intensive industry that requires manual operation.

After product designing and pattern cutting, the last is the first stage of shoe assembly that determines the fit and feel of shoes, their performance, and size. Modern lasts for mass production are generally made from high density polyethylene allowing their multiple uses and subsequent recycling.

The method used to connect the upper and the sole influences shoe's functionality and maintenance[57]:

- Glued shoes - The most common technology that connects sole to the upper by gluing. The glued seam may fail if exposed to moisture, sweat, or may mechanically separate.
- Flexible shoes - Very comfortable, lightweight and flexible shoes, with attractive sewn-through edges. Their flexibility stems from direct sewing of upper to the sole without an insole. They are characterized by limited water-tightness, thus being used mostly on indoor/dry environment shoes.
- Moulded shoes - The sole is pressed, injected, or moulded to the upper. Moulding is mostly used on sports and leisure shoes. The quality of sole and "connection" depends on the material used. Direct injection moulding speeded up the process, with a roughly-shaped block being turned down to an accurate last[58]. In some cases, such as for rain boots, the shoe may be moulded in one piece so that all the parts of footwear (especially the upper and the sole) are not independent.
- Welted shoes - The upper/sole joint is sewn through a welt. This technique provides durable and strong joint. The Welt is a strip of leather (or other material) that is stitched between the upper and insole of a shoe, as an attach-point for the sole. The space enclosed by the welt is then filled with cork or some other filler material. This construction allows multiple sole replacements, extending the life of the footwear.

Sport shoe are usually performed by direct formation of the bottom, connected to the top by injection moulding, or compression. Rubber and plastic footwear have vulcanized, moulded or cemented components.

The following table shows the manufacturing stages for the production of footwear and the possible processes related to those stages.

[57] www.bata.com

[58] http://www.satra.co.uk/bulletin/article_view.php?id=297

Table 10: Possible footwear manufacturing processes[59]

Manufacturing stages	Possible processes
Upper fabrication	Hand-cut, vibrating cutting machine, die cutting machine, cutting machine in continuous fixed blade, ultrasonic cutting machine, laser cutting machine, jointing preparation, splitting, skiving, trimming, hemming.
Insole fabrication	Hand-cut, vibrating cutting machine, die cutting machine, cutting machine in continuous fixed blade, ultrasonic cutting machine, laser cutting machine.
Outsole fabrication and preparation	Injection moulding, cutting hell, wedge application, heeltap application, welt preparation.
Production of other auxiliary components	Pieces cutting, stamping, splitting, textile and fabrics coupling, box manufacturing.
Assembly of the upper with the other parts	Rope warping, tacks warping, staple warping, double warping, turned warping, warping with iron wire, Strobel warping, gluing, stitching, nailing, vulcanization, injection.
Finishing and packing	Insole application, Accessories application, Polishing, Details painting. Laces application

As to the most commonly used method for upper and sole attachment, the global shoe industry uses around 150,000 Mg of adhesives per annum to bond a wide range of different materials[60]. The adhesives applied in manufacturing process can be generally group into solvent and water based; less frequently used are hot-melts and radiation cured (UV/EB) adhesives.

Solvent based adhesives are composed of polymer dissolved in a solvent (e.g., toluene), typically in a ratio of one part polymer to three or four parts of solvent. There are two main types of polymer used: polychloroprene rubber (generally known as Neoprene) and polyurethane (PU). PU adhesives are the most popular because they are compatible with a large number of different materials commonly used in footwear industry. However, some materials require pretreatment to enable the PU to bond to the surface. For example, rubbers must be pretreated with a chemical solution in halogenation process. Neoprene adhesives, on the other hand, are not compatible with some materials such as PVC. Water-based adhesives are in the form of an emulsion (polymer suspended in water); PU is the most commonly used[61].

1.3.3. Product group segmentation

The segmentation of the product group footwear may be based on several aspects, including: material (leather, textile, plastics/rubber), destination (e.g., casual, sport, slippers, fashion, rain boots), age and gender (e.g., male, female, children), or price category (e.g., low, middle, high). The

[59] www.environdec.com/

[60] Dunn David J., Adhesives and Sealants-Technology Applications and Markets, Rapra technology Limited, Shawbury, Shropshine, UK, 162 p.

[61] Intertek, 2010, Footwear Materials: Adhesives https://www.wewear.org/assets/1/7/2010November.pdf

official statistical nomenclatures used by Eurostat (NACE[62] for production data and CN[63] for trade data) introduces the division of the product group footwear into different sub-categories according to the use category and material composition. The two above mentioned nomenclatures show substantial differences, it is nevertheless possible to distinguish the following common classification:

Table 11: Statistical nomenclatures[64]

Material for soles	Material for uppers	Use	Gender
Plastic and rubber	Plastic and rubber	Sports / athletic	Men
Leather	Leather	Ski boots	Women
Wood	Textiles	Indoor	Children
Other	Other	Outdoor	
		Waterproof	
		Sandals (only NACE)	
		Protective (only NACE)	

Other market-relevant literatures generally make reference to (a subpart of) these nomenclatures: CBI[65], APICAPPS[66], IBISWorld[67], national statistics data, among others.

Maxwell[68] additionally mentions the category “therapeutic” which refers to a medical purpose and especially to orthopaedic footwear. In Eurostat, this type of footwear is actually included in the section related to the manufacture of medical and dental instruments and supplies.

For the reasons of this study the product categorization is meant to combine the official nomenclature from Table 11 with emphasis on the type of materials used since it will be one of the main drivers for environmental performance.

I. **Materials**

As previously mentioned, a broad variety of materials with very specific characteristics can enter footwear production. Their number and nature generally depend on technology used, current fashion trends and specific shoe intended use (athletic, casual, slippers, medical, etc.). Therefore, the simplest possible shoe may consist of two components (e.g., flip-flops and rainboots); in contrast , some shoes can involve a complex construction, which in the case of an athletic shoe can comprise 65 (or more) discrete parts, often material blends, requiring more than 360 processing steps to

[62] Statistical Nomenclature of economic Activities in the European Community

[63] Combined Nomenclature

[64] Derived from Eurostat [change font]

[65] CBI, The Footwear In The EU, May 201

[66] APICCAPS, World Footwear, 2012 Yearbook, data up to 2011

[67] IBISWorld, Global Footwear Manufacturing, 2010

[68] http://www.maxwellinternational.com.my/business.html

finalize its assembly[69] [70]. A typical sport shoe with the labelling of main elements and corresponding commonly used materials is shown on Figure 10.

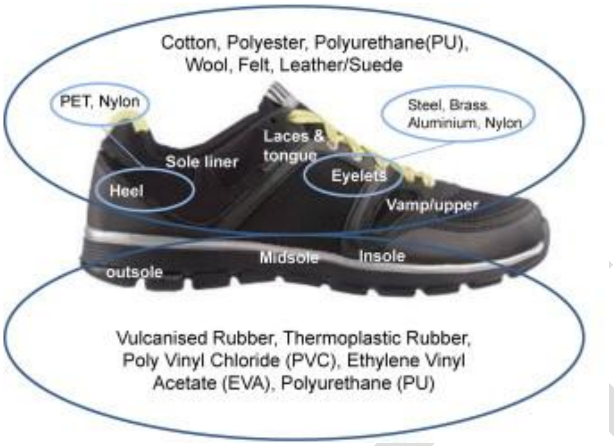

Figure 10: A typical sport shoe with main parts and commonly used materials[69]

The shortage in leather supply pushed the development of synthetic materials that imitate leather, usually fabrics coated by polyurethane and PVC (e.g., leatherette). It is also important to stress that polymeric and plastic materials, especially thermoplastic materials and rubbers[71], currently dominate the production of shoe soles, outsoles and insoles, as indicated on Table 12[72].

Table 12: An average percentage of materials used for manufacturing soles[73]

Soiling Material	Percentage of use (%) w/t
Resin Rubber	20
PVC and blends	19
Thermoplastic Rubber (TR)	15
Direct Vulcanised (DV) Rubber	8
Direct Injection Moulded (DIM) PVC and blends	8
Leather	7
Micro Ethylene Vinyl Acetate (EVA) Rubber	7
Polyurethane	7
Other (wood, cork, textile, etc)	5
Vulcanized Rubber	4

[69] Lee, J.L. and Rahimifard, S. 2012. An air based automated material recycling system for postconsumer footwear products. Resource, Conservation and recycling 69, pp 90-99

[70] Cheah, L., Ciceri, N.D., Olivetti, E., Matsumara, S., Forterre, D., Roth, R., Kirchain, R. 2013. Manufacturing-focused emissions reductions in footwear production. Journal of Cleaner Production 44, pp 18-29

[71] Stakes, T., Rahimifard, S. 2007. An End-of-Life Decision Support Tool for Products Recovery Consideration in Footwear Industry. International Journal of Computer Integrated Manufacturing 20, pp 602-615

[72] Wilson, M., Abbot, S., Tame, R. .1997. Moulded-on Soling. Modern Shoemaking 53, SATRA Technology Centre. Data taken from Staikos and Rahimifard (2007)

[73] Wilson, M., Abbot, S., Tame, R. (1997) Moulded-on Soling. Modern Shoemaking 53, SATRA Technology Centre. Data taken from Staikos and Rahimifard (2007)

Following the same line, it is possible to approximate the most common materials used. According to Weib (1999)[74]Error! Bookmark not defined. there are approximately 40 different components commonly useed n shoe manufacturing process, mainly: leather, polyurethane foam, rubber, EVA, textile and fabrics, and PVC. Additionally, there are also numerous elements incorporated into shoe, mainly metallic or plastic components, commonly referred to as grindery that includes visible metallic parts, such as metal eyelets, buckles and decorative components, and also structural parts of footwear body such as toe puffs, stiffeners, and heel supports.

Leather

Leather is historically the major material used for the production of footwear uppers. It was the material of choice for soles or lining until being in continuous substitution by synthetic materials and rubber. Leather is made from animals' hides and skins. Bovine hides are the most commonly used, but the animal of origin may also be ovine, pig, and even exotic species. After slaughtering, the raw hides and skins are sold to tanners.

The tanning process is a complex mechanical and chemical treatment of raw hides and skins to produce a useful and fashionable material of unique character. The tanning agents used may be mineral, vegetal or synthetic and the tanning agent used gives the leather different properties.

Chromium tanning by means of chromium(III) salts, is the most common method, representing 80 – 90%[75] of the global market. Semi-finished leather resulting from this process is also known as wet-blue for its specific colour. Hazards may come from the chromium (III or VI), if the tanning process is not managed correctly.

Vegetable tanning is an alternative to chromium tanning that makes use of plant tannins (e.g., oak, chestnut, mimosa, etc.). They have the potential to cause degrade surface waters. Problems arise due to the low biodegradability of the tannins and their toxicity to aquatic life[75].

Aldehyde tanning is another alternative of chromium tanning; glutaraldehyde is the most commonly used compound in this category. Aldehydes react completely with the proteins found both in the hides/skins and in the effluents. Therefore, this tanning process usually does not create an environmental problem during treatment and discharge of tannery waste water.

In order to produce a variety of goods, finished leather may be sold in different forms; the most common leather classification[76] is presented below:

- Aniline leather: natural grain is clearly and completely visible and where any surface coated with a non-pigmented finish is less than or equal to 0,01 mm thick;
- Semi-aniline leather: has been coated with a finish containing a small amount of pigment, so that the natural grain is clearly visible;
- Pigmented and pigmented split leather[77]: natural grain (3.2.1.1) or surface is completely concealed with a finish containing pigments;

[74] Weib, M. 1999. Recycling alter schue. Shue Technic, pp 26-29

[75] Source: BREF, 2013

[76] According to ISO EN 15987:2011

- Coated and coated split leather: the surface coating, applied to the outer side, does not exceed one third of the total thickness of the product but is in excess of 0,15 mm;
- Patent and patent split leather: with generally a mirror-like effect, obtained by application of a layer of pigmented or non-pigmented varnishes, or synthetic resins, whose thickness does not exceed one third of the total thickness of the product;
- Nubuck: leather buffed on the grain side to produce a velvety effect, where the grain layer is still visible;
- Suede/velour leather or split: leather which wearing surface has been mechanically finished to produce a velvet-like nap.

Rubbers

Almost all natural rubber is extracted from one biological source: the Brazilian rubber tree (*Hevea brasiliensis*). Latexes from the other sources have disadvantages such as low rubber and high resin contents and difficulties in extraction. About 10% of the global production of natural rubber is processed as preserved and concentrated latex. Natural rubber is characterized by elevated deformability. It consists of very high molecular mass molecules that can be cross-linked to form a network. If the crosslink density is not too high, the material will retain a memory of its original unstressed state and will return to its original dimensions when external forces are removed, even after strains as high as 100%[78]. There is currently no viable substitute for natural rubber that could be used as a replacement in all its applications. That means that the only way to find alternatives to the South-East Asia oligopoly is by expanding natural rubber production to other regions of the world[79]. The availability of natural rubber is therefore becoming more and more problematic. Its shortage accelerated the use of synthetic substitutes, made mainly from non-renewable resources such as fossil fuels. Today almost 70% of rubbers (elastomers) used are synthetic[80]; these include butadiene rubber (BR), isoprene rubber (IR), ethylene propylene rubber (EPM)/EPDM, styrene-butadiene rubber (SBR), halogenated isobutylene isoprene rubber/chlorinated IIR (BIIR/CIIR) and styrene-butadiene-styrene block copolymer (SBS).

Plastics and synthetic materials

Increasing production of genuine leather and natural rubber substitutes has become a priority to confront the insufficient supply of natural materials, coupled with constantly increasing worldwide demand for leather goods.

The first attempt to produce a leather-like material involved bonding a textile base to a polymeric coating. Among different types of synthetic leather used in the footwear industry, the following warrant mention:

- **Leatherette** is commonly referred to as artificial leather. It is usually prepared by covering a fabric base with a pyroxylin coated sheeting of various weights and leather-

[77] Split leather is formed from the fibrous part of the hide left, once the top-grain of the rawhide has been separated from the hide.

[78] White, J.R., De, S.K. (Eds) (2001) Rubber Technologist's Handbook. RAPRA Technology Ltd. UK, 559 pp

[79] European Tyre and Rubber Manufacturers Association (ETMA) Annual report 2010/2011

[80] http://www.satra.co.uk/bulletin/article_view.php?id=297

like textures. It does not have the flexibility or the same characteristics as genuine leather[81].

- **Poromerics** (microporous synthetic leather substitutes) were developed in the 1960s and 1970s, and were intended to be an improvement over coated fabrics. Poromerics used a nonwoven fabric impregnated with polymer (usually PU), thus, producing a more leather-like material. The nonwoven substrate offered the closest simulation to the fibre structure of leather, but required significant levels of binders[82] .

Apart of leather imitation, synthetics are principally used in production of soles, and uppers accessories such as buttons and zippers may also be made of plastics. Among the many forms of plastic in use today, the following are the most common[83]:

- **Ethylene-vinyl-acetate** (EVA) is the copolymer of ethylene and vinyl acetate. EVA is used as waterproof, hot-melt adhesive as well as expanded rubber or foam rubber typically used as a shock absorber in sports shoes. EVA slippers and sandals are currently very popular because of key properties, including light weight, mouldability, anti-odour property, glossy finish, and low cost compared to natural rubber.
- **Styrene-butadiene rubber** (SBR) is a copolymer derived from styrene and butadiene which has good abrasion resistance and good aging stability when protected by additives. It is used as a substitute for natural rubber for the production of soles and heels.
- **Polyurethanes** (PU) polymers are formed by reacting an isocyanate with a polyol. Most polyurethanes are thermosetting polymers that do not melt when heated. In the footwear industry, polyurethanes are used in the manufacture of flexible, high-resilience foam seating, synthetic fibres (e.g., Spandex), and high performance adhesives. PU is also used to produce a leather-like material substitue for leather. It is frequently used as an alternative to leather in the manufacturing of footwear. PU is light, flexible and durable. It is also used in the production of outsoles.
- **Thermoplastic Polyurethane** (TPU) is any of a class of polyurethane plastics with many useful properties, including elasticity, transparency, and resistance to oil, grease and abrasion. Technically, TPUs are thermoplastic elastomers consisting of linear segmented block copolymers composed of hard and soft segments. Unlike the thermosetting PU, TPU can be re-melted.
- **Acrylonitrile-butadiene-styrene** (ABS) is a common thermoplastic. ABS is a terpolymer made by polymerizing styrene and acrylonitrile in the presence of polybutadiene. ABS's light weight and ability to be injection moulded and extruded make it useful in manufacturing products such as footwear soles.

[81] (Farrugia, K.J., Bandey, H., Dawson, L, Daeid, N.N. (2012). Chemical enhancement of soil based footwear impression on fabrics. Forensic Science International 219, pp 12-28)

[82] http://www.satra.co.uk/bulletin/article_view.php?id=297

[83] Sources: http://www.plasticseurope.org/what-is-plastic/types-of-plastics.aspx; feedback from stakeholders, http://plastics.americanchemistry.com/, http://www.materiautech.org/

- **Polyvinyl chloride** (PVC) is the third-most widely produced plastic. In footwear, it can be used instead of natural rubber or to manufacture a leather-like material.
- **Polyethylene** (PE) is the most extensively produced plastic in the world. Polyethylene can be processed into soft and flexible products, as well as into tough, hard and strong products, such as footwear soles.

Bonded leather

Bonded leather (also called reconstituted leather) is not a genuine leather but a man-made, partially synthetic material composed of leather fibres manufactured from recovered shavings, cuttings, and trimmings, from the leather and footwear production process, held together with a suitable binder (e.g., adhesives, resins, or similar) and formed into boards. Its main destinations are: furniture, belts, footwear (insoles, midsole, bottom soles, counters and toe puffs, heels, counters, welts, uppers of open sandals), and leather goods such as purses, wallets, jewellery boxes, hand bags, sunglasses cases, watch straps, etc. In 2011 the European Committee for Standardization published EN 15987:2011 'Leather - Terminology - Key definitions for the leather trade' to stop further confusion about bonded leather. Therefore, according to the mention ISO standard the term 'leather fibre board' applies to material where tanned hides or skins are disintegrated mechanically and/or chemically into fibrous particles, small pieces or powders and then, with or without the combination of chemical binding agent, are made into sheets. If there is any other component apart from leather fibre, binding material and leather auxiliaries, then this should be declared as part of the description. The minimum amount of 50 % by weight of dry leather is needed to use the term *leather fibre board*. According to the same standard, if the tanned hide is disintegrated mechanically and/or chemically into fibrous particles, small pieces or powders and then, with or without a binding agent is made into sheets, such sheets are not leather. For the above mentioned reasons, and since being neither genuine leather nor entirely synthetic material, it should be classified separately.

Textile

According to the Regulation (EU) No 1007/2011 of the European Parliament and of the Council, 'textile product' means any raw, semi-worked, worked, semi-manufactured, manufactured, semi-made-up or made-up product which is exclusively composed of textile fibres, regardless of the mixing or assembly process employed. Generally, fabric fibres can be segmented according the feedstock of origin into: natural fibres (e.g. cotton, wool), man-made fibres manufactured from either natural or synthetic polymers, synthetic fibres (e.g., polyester, nylon), and regenerated fibres (e.g., cupro, viscose). Fabrics are used alone (textile footwear uppers, lining) or in combination with leather or plastic (summer or sport footwear). Some of the more commonly used fabrics include cotton, wool, flex, polyester, nylon and viscose, among others.

Man-made fibres include:

- **Nylon** is commonly used in footwear synthetic fibre formed from the condensation reaction of a diamine and dicarboxylic acid.

- **Polyester** technically refers to different types of polymers containing the ester functional group; it is derived from the condensation reaction between an acid and an alcohol[84]. The term "polyester" material most commonly refers to polyethylene terephthalate (PET). Fabrics woven or knitted from polyester thread or yarn are used for production of uppers, linings, and other accessories, such as laces.
- **Ppolytetrafluoroethylene** (PTFE) commonly used to produce GORE-TEX® fibres is used to produce micro-porous fabrics that allow the textile to be waterproof. In addition, PTFE has high thermic resistance and flammability[85].

Natural fibres are used mainly in the production of uppers and linings, especially in indoor footwear, such as slippers and espadrilles, which are the most common[86]:

- **Cotton**: is probably the oldest type of fibre and the most representative. It is used to make soft, breathable textile.
- **Jute**: is a long, soft, shiny vegetable fibre that can be spun into coarse, strong threads. Jute is one of the most affordable natural fibres and is second only to cotton in amount produced and variety of uses of vegetable fibres. Its soft fabric structure is known to be very comfortable to the wearer.
- **Flax**: It is a food and fibre crop that is grown in cooler regions of the world. Flax fibres are naturally smooth and straight.
- **Wool**: is a generic term referring to fibres made from the hair and fur from animals, most commonly sheep. However, wool can originate from different kind of animals and it is generally branded according to its animal origin (e.g., angora, cashmere, mohair).

Regenerated or artificial fibres are produced by dissolving a natural material (such as cellulose), then regenerating it by extrusion and precipitation (e.g. viscose).

Other materials

Wood is used in the production of soles, particularly heels. Historically, clogs are traditional footwear made entirely of wood, and often worn for heavy labour purposes. Today they remain in use as protective clothing in agriculture and in some factories and mines.

Cork may be used in the production of soles because it is naturally elastic and absorbs shocks. In addition, it is durable, comfortable and allows the feet to breathe.

Shoes with wood/cork (or cork decorated) soles are used in production of leisure/town footwear, where upper part is made of leather or other material. Its market supply is subject to current fashion trends and related demand.

Paper board / cardboard may be used for the production of insoles.

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[84] Farrugia, K.J., Bandey, H., Dawson, L., Daeid, N.N. (2012) Chemical enhancement of soil based footwear impressions fabricForensic Science International 219. Pp 12-28

[85] http://www.gore.com/

[86] Sources: http://www.naturalfibres2009.org/

Metals, including aluminium, zamac, brass copper, are used mainly used for accessories such as eyelet, and buckles Metal may also be used for shoe construction parts such as toe-cap for protective footwear.

II. **Use**

As already mentioned, shoes are designed differently depending on the intended use. The most common types of footwear are described below. These categories can generally be produced for the different genders and age groups (man/woman, adult/child), thus, requiring specific features and design aspects.

Outdoor and town

Outdoor or town footwear is meant for daily use and common purposes; thus, it represents the broadest category that encompasses all types of footwear, unless specifically reflected in other typology:

- Dress and casual: Some designs of dress shoes can be worn by all genders. The majority of dress shoes have an upper covering, commonly made of leather, enclosing most of the lower foot, but not covering the ankles. This upper part of the shoe is often made without apertures or openings, but may also be made with openings or even consist of a series of straps, e.g., an open toe featured in women's shoes. Shoes with uppers made high to cover the ankles are also available; a shoe with the upper rising above the ankle is usually considered a boot, but certain styles may be referred to as high-topped shoes or high-tops. Usually, a high-topped shoe is secured by laces or zippers; although some styles have elastic inserts to ease slipping the shoe on.
- Boots are worn both for their functionality, protecting the foot and leg from water, snow, as well as for reasons of style and fashion.
- High-heeled shoes raise the heels, typically 5 cm or more above the toes, and are commonly worn by women for formal occasions or social outings. Variants include kitten heels.

Children footwear

Children footwear is designed and manufactured as suitable for everyday wear by children between the sizes 16 to 22 (Paris point)[87].

Indoor

Indoor footwear is generally referred to as slippers; typically, these are semi-closed shoes, consisting of a sole held to the wearer's foot by a strap running over (or between) the toes or instep. Slippers are soft and lightweight compared to other types of footwear. They are mostly made of soft or comforting materials that allow a certain level of comfort for the wearer. This material can range from faux fur to leather.

[87] Paris Point is a unit of measurement of shoe length equalling to 6.6 mm. Increase in length corresponds to an increase in width of 5 mm.

Sports / athletic

Sports or athletic footwear are specifically designed to be worn for participating in various sports. In general, athletic shoes are designed with specific features (running shoes, football shoes, roller skates. For example, friction between the foot and the ground is an important force in most sports. Therefore, modern athletic shoes are designed to maximize this force, and materials, such as rubber, are used. Although, for some activities such as dancing or bowling, sliding is desirable, so shoes designed for these activities often have lower coefficients of friction.

Sports footwear is nowadays commonly used as casual footwear, often referred as sneakers.

Waterproof

Waterproof footwear is designed to protect against water intrusion. The most well-known waterproof boot is the Wellington boot which allows walking in the water.

Sandals

Sandals are an open type of outdoor footwear, consisting of a sole held to the wearer's foot by straps passing over the instep and, sometimes, around the ankle. While the distinction between sandals and other types of footwear can sometimes be blurry, the common understanding is that a sandal leaves most of the upper part of the foot exposed, particularly the toes.

Protective / occupational

Protective footwear is used for professional purposes. It has a protective reinforcement in the toe which protects the foot from falling objects or compression, usually combined with a mid-sole plate to protect against punctures from below. Although traditionally made of steel, the reinforcement can also be made of a composite material, a plastic such as thermoplastic polyurethane (TPU) or even aluminium. Safety footwear now comes in many styles, including sneakers and clogs. Some are quite formal, for supervising engineers who must visit sites where protective footwear is mandatory.

Footwear for working circumstances can be divided into safety footwear, protective footwear and occupational footwear. Light industrial shoes, or occupational footwear, can be further segmented into:

- Special occupational footwear protecting the wearer from injury: footwear without toecap, but with skid resistant, anti-static or similar characteristics.
- Standard occupational footwear, of low protective strength. Often part of uniformity (e.g. in public services or retail trade) and not, or hardly, different from casual footwear.

In general, (light) industrial shoes are normal shoes but stronger than usual. Safety and protective footwear in the official EUROSTAT statistics is limited to footwear incorporating a protective metal toe cap:

- Footwear, incorporating a protective metal toe-cap, with outer soles of rubber, plastics, leather or composition leather and uppers of leather (Prodcom: 19303150, CN Code: 64034000)
- Footwear, incorporating a protective metal toe-cap, with outer soles and uppers of rubber or plastics (Prodcom: 19301210, CN Code: 64023000)

Orthopaedic

Orthopaedic shoes are specially-designed footwear to relieve discomfort associated with many foot and ankle disorders, such as blisters, bunions, calluses and corns, hammer toes, or heel spurs. They may also be worn by individuals with diabetes or people with unequal leg lengths. These shoes typically have a low heel, tend to be wide with a particularly wide toe box, and have a firm heel to provide extra support. Some may also have a removable insole, or orthotic, to provide extra arch support.

III. **Quality and price**

CBI (2010) makes 4 distinctions regarding the quality and the price of footwear:

- Luxury: This segment comprises fashionable footwear being close to perfection. Its design is often refined and elegant and is mainly worn on special occasions or when going out.
- Fine: It comprises well-designed branded footwear that is accessible to a wider consumer group at affordable prices (between € 100 and 300). Consumers in this segment are willing to pay for quality footwear, but buy less frequently than consumers in the other segments.
- Medium: It includes trendy and comfortable footwear of a medium to good quality. Brands are important but not crucial for purchasing decisions, as consumers now want to pay the lowest possible prices. Footwear in the medium segment is sold by footwear specialists, non-specialists and online sellers.
- Economical: The economical segment is dominated by footwear of a lower quality. There is a wide range of footwear varying from locally produced footwear of a reasonable quality to cheap imported footwear. Designs are influenced by popular (branded) footwear in the medium and fine segments that are often imitated. Demand from the economical segment is instant and inexpensive items are often bought impulsively.

1.4 European and non-European Ecolabels

The International Organization for Standardisation (ISO) has identified three broad types of voluntary labels, with Ecolabelling fitting under the Type I designation[88]:

- Type I: voluntary, multiple-criteria based, third party program that awards a license that authorises the use of environmental labels on products indicating overall environmental preferability of a product within a particular product category based on life cycle considerations. ISO14024 lists the guiding principles for Type 1 Ecolabels;
- Type II: self-declared environmental claim, i.e. environmental claim that is made, without independent third-party certification, by manufacturers, importers, distributors, retailers or anyone else likely to benefit from such a claim, in line with ISO 14021;
- Type III: voluntary programs that provide quantified environmental data of a product, under pre-set categories of parameters set by a qualified third party and based on life cycle assessment, and verified by that or another qualified third party in line with ISO 14025.

The different label types have been identified by the ISO as sharing a common goal:"...*through communication of verifiable and accurate information that is not misleading on environmental aspects of products and services, to encourage the demand for and supply of those products and services that cause less stress on the environment, thereby stimulating the potential for market-driven continuous environmental improvement*."

For the specific aim of the analysis of the product group scope and definition, the following paragraph introduces the main European and non-European Ecolabel schemes and standards that address both footwear and/or leather containing product group(s). The labels shown have been selected due to their market penetration, their recognition on the market and because they are usually used as benchmarks during the EU Ecolabel criteria development process. The way in which the scope of analysed labels is defined brings up additional indication on the possible scope recommendation. The Ecolabels considered are set in the Table 13 in accordance with the scope enclosure and criteria area covered.

1.4.1. The Nordic Swan

General description

The Nordic Ecolabel is the official Ecolabel of the Nordic countries and was established in 1989 by the Nordic Council of Ministers with the purpose of providing an environmental labelling scheme that would contribute to a sustainable consumption. It is a voluntary, positive Ecolabelling of products and services. The Nordic Ecolabel was also initiated as a practical tool for consumers to help them actively choose environmentally-sound products. It is an ISO 14024 type 1 Ecolabelling system and is a third-party control.

Scope

The Nordic Ecolabel has about 70 different product groups covering many kinds of products for consumers as well as professionals.

[88] Definitions from ISO 14021, 14024, and 14025

Regarding Footwear, the Nordic Ecolabel did not develop any criteria and made reference to the EU Ecolabel for Footwear.

1.4.2. Environmental Choice New Zealand

General description

Environmental Choice New Zealand is a type I environmental labelling programme which has been created to help consumers find products that ease the burden on the environment. The programme results from a New Zealand Government initiative and has been established to improve the quality of the environment by minimising the adverse environmental impacts generated by the production, distribution, use and disposal of products. The programme is managed by the New Zealand Ecolabelling Trust (the Trust).

Scope

The programme covers 18 different product groups and includes a set of criteria specific to textiles, skins and leather, but these are not specific to footwear.

1.4.3. Blue Angel

General description

The Blue Angel is the first and oldest environment-related label for products and services in the world. It was created in 1978 on the initiative of the German Federal Minister of the Interior and approved by the Ministers of the Environment of the federal government and the federal states. It considers itself as a market instrument of environmental policy designed to distinguish the positive environmental features of products and services on a voluntary basis. The Blue Angel is an ISO 14024 type I Ecolabelling system.

Scope

Blue Angel has around 100 product criteria documents, including footwear, textiles, and upholstery leathers.

1.4.4. Japan Eco Mark

General description

The Eco Mark program undertaken by the Japan Environment Association is managed in accordance with the standards and principles of International Organization of Standardization (ISO) (ISO 14020 - An environmental label and declaration, a general principle, ISO 14024 - An environmental label and declaration, a type I environmental-label display, a principle and procedure).

Scope

The Japan Ecomark provides criteria for 53 products categories, including two sets of criteria relevant within this context: "Shoes and Footwear" and "Leather Clothes, Gloves and Belts".

1.4.5. Environmental Friendly Products Ecolabel

General description

The ecolabel "Ekologicky setrny vyrobek" is the official registered label of The Czech ecolabelling programme (National Programme for Labelling Environmentally Friendly Products). It was launched in 1994. The programme is administered by CENIA, Czech Environmental Information Agency. The guarantor of the programme is the Ministry of the Environment. In 2004, the scope of the programme was extended by the opportunity to certify services, beginning with tourist accommodation services. At the same time, a new version of the Ecolabel (Ekologicky setrna sluzba / Environmentally Friendly Service) was introduced.

Scope

At present, the Czech Ecolabel covers 41 categories of products and two categories of services. About 400 products and services bearing the label are on the market, representing about 100 companies. In particular, they have one set of criteria for footwear aligned with the under revision EU Ecolabel for footwear.

1.4.6. Scope and criteria covered by the existing Ecolabels

Following the Nordic Swan and New Zealand specification, leather is included in the common group of textile, skins and leather. Blue Angel covers leather material by the product group of Footwear RAL-UZ 155 (2 licenses) and upholstery leather RAL-UZ 148 (10 licenses). Japanese Eco Mark makes a clear division between Footwear (Category No 143) and Leather clothes, gloves, and belts (Category No 144). Distintiu de garantia de qualitat ambiental apply the criteria that cover 'all products made of leather'. Here, the set of criteria only apply to leather itself, and not to other materials or the final product. Additionally, the schemes that cover products of common feature set as being made of leather, also define a minimum quantity of leather that should be present in the end product. It should additionally be stressed that the performance tests for leather products are the ones related to leather and not to the finished products, the criteria are therefore not product specific, but rather general or material oriented.

The Table 13 summarizes the existing Ecolabel of relevance to leather and/or footwear, together with the criteria areas covered.

Table 13: European and non-European Ecolabels[89]

Ecolabel name & logo		Scope	Materials	Sustainable resource use	Energy management	Air and water pollution	Substance restriction	Social and ethical	Fitness for use	End of life
EU Ecolabel		Footwear	Leather Textile Rubber		X	X	X		X	
Nordic Swan		Textiles, Skins and Leather (footwear out of scope[90])	Textile Leather	Natural fibres, recycled content	X	X	X		X	
Environmental Choice New Zealand (New Zealand)		Textiles, Skins and Leather	Textile Leather	Recycled content	X	X	X		X	
Blue Angel		Footwear	Leather Rubber & Plastics Textile			X	X	X	X	
Environmental Friendly Products Ecolabel (Czech Republic)		Footwear			X	X	X		X	
Japan Eco Mark (Japan)		Footwear	Leather Rubber & Plastics	Recycled material		X	X		X	

[89] NB: The Netherlands (Milieukeur) and India (Eco Mark) also had Ecolabels related to leather, but they are no longer active.

[90] because of being covered by the EU Ecolabel for Footwear

Ecolabel name & logo		Scope	Materials	Sustainable resource use	Energy management	Air and water pollution	Substance restriction	Social and ethical	Fitness for use	End of life
			Textile							
Distintiu de garantia de qualitat ambiental (Catalunya)		Leather	Leather							
Japan Eco Mark (Japan)		Leather products	Leather Rubber & Plastics Textile	Recycled material		X	X		X	
Blue Angel		Upholstery leather	Leather			X	X	X	X	

1.5 Need for the product group definition update

In conjunction with the adoption of the current criteria document on March 2009 (decision No 2009/563/EC), several statements were submitted by Member States relating to issues that should be addressed/investigated further in the next revision. Thus, the revision of the EU Ecolabel for Footwear must at least address the following concerns raised by the Commission Statement (19 March 2009/ ENV G2):

- the use and environmental impact of all fluorinated substances (e.g., including PFAS) which might be used for the footwear (e.g., for impregnation) need to be assessed in the revision;
- stricter limits on emissions should be based on the best value in BAT/BREF;
- emissions related to synthetic materials, i.e., plastic/polymers, should be addressed;
- waste phase of materials should be included in the evaluation;
- materials that are problematic in the waste phase should be regulated or excluded;
- PFAs and the related environmental problems should be evaluated;
- PVC and the related environmental problems should be evaluated;
- Formaldehyde in leather and the related environmental problems should be evaluated.

Revision of the scope and definition of the Footwear product group was not specifically mentioned by the Commission Statement. However, based on a separate proposal, it appears necessary to evaluate the feasibility of the scope extension to other leather products. In order to limit the number of different EU Ecolabel product groups, to ensure coherency, and to avoid redundancy, it is preferable to tend towards aggregating within the same product group category similar articles for which analogous criteria could apply. The definition given by the current EU Ecolabel for footwear (cf. chapter 1.3) is firmly based on very specific product function for which a consumer is looking (to protect and cover foot). This is a key approach to be considered, being mindful that the EU Ecolabel is designed to help consumers identifying products and services of environmental excellence among the whole group of articles of analogous destination.

1.5.1. Methodology

Before discussing anything else, the scope of the EU Ecolabel must be clearly defined because all other aspects depend strongly on it. Therefore, a preliminary study[91] was performed in order to assess the possible scope extension, putting in light several arguments[92]:

- Market analysis of leather and leather-made products;
- Existing Ecolabels (presented as well in the present report – see chapter 1.2.4);

[91] (Technical Support for the Revision of the EU Ecolabel criteria – Product group “Footwear”, Preliminary Proposal with Recommendations on the Scope Revision, February 2013., 2013)

[92] Main conclusions of this analysis are summarized below, but more extensive information can be consulted in the scope analysis report.

- Technical aspects and differences of leather between leather-made products;
- LCA discussion.

The preliminary analysis conducted within the current study showed a very broad group of products that may be possible to include when enlarging the product group scope and definition.

Consequently, the scope revision proposal supported by preliminary analysis was addressed during the EU Ecolabel Board Meeting in March 2013, conclusions of which are presented in this report.

From this standpoint, the decision was made to conduct the analysis of such feasibility considering from one side the technical nature of proposed extension, followed from another side, by the particular rationales expressed by Member States and registered stakeholders whether or not to enlarge the product group to "footwear and leather products". The first questionnaire was then sent to stakeholders to gather feedback on:

- The possibility to extend the scope to non-footwear leather products;
- The need for criteria revision (to change, remove them or to add new ones);
- National market figures for footwear and leather products;
- Other relevant information (current license holders, environmental innovations, information on hazardous substances…).

Among stakeholders consulted, 26 stakeholders answered the first questionnaire, of which:

- 10 are representatives of industries;
- 6 are representatives of associations of industries;
- 6 are representatives of research centres;
- 4 represent Competent Bodies

Feedback from the stakeholders is presented later in this chapter.

The final scope recommendation develop in the current report is the output of the threefold consultation process.

1.5.2. Supporting information

I. Preliminary study on the scope specification

Technical analysis

The leather production-consumption chain consists of three main stages: hides and skins recovery as a by-product of meat industry, leather tanning and finishing, and final product assembly. The market is dominated by light bovine leather, used to make shoe uppers and other finished goods.

The raw material of leather is characterised by its heterogeneous nature especially considering that hides and skins can be procured from a variety of animals which creates different types of raw material designated for the production of a broad range of end-products. These differences are further amplified by the existence of numerous intermediate processing stages, thus, the type of leather produced will depend on the requirements of the ultimate user as well as the type of raw material utilized.

Generally, skins differ in total thickness, fibre bundle size and grain pattern, offering material from which the tanner can select the skin best suited for a particular end use. The animal origin of the skin will influence the assignment of type and quality of product to be created, thus, the decision about the characteristic and destination of final product is taken at the very early stage of the leather supply chain. The production process and the origin of the hides or skins will differ depending on the type of leather that the tanner is asked to make.

The elemental classification of leather is mainly related to: tanning process used (chromium, vegetable, aldehyde), product destination (handbag, wallet, saddlery, footwear, jacket, furniture, automotive, etc.), leather origin (bovine, sheep, goat, kid, etc.), quality of leather desired and style (branded vs. commodity product), and technical requirements that are subjected mainly to the end-product requirements defined mainly by its function/destination.

When considering the production stage, the environmental requirements for the processes are quite similar among different leather products (chemicals, tannery emissions…); however, the technical and performance specifications are product-oriented. Infrequently footwear leathers may be similar in appearance and handle/feel to some garment and auto leathers, but they would never fulfil the same performance specifications as for garments and auto.

The preliminary study on the scope specification addressed technical analysis of footwear and leather products supported by key output from preliminary personal (phone calls), and electronic (e-mail) communication with thirteen stakeholders who represented leather and footwear sector (technical centres, tannery, manufacturers). These stakeholders were inquired after the feasibility and possible range of the current scope extension and range of products that by mean of technical similarities could be covered by the revised scope and definition. In general, contributing stakeholders were not in favour of extending the scope to other leather products, with a possible exception for very similar articles such as belts or handbags. Even in this case, some criteria would have to be accurately specified (cf. Table 14).

Table 14: Review of feedback received from experts about scope extension

Analysis of scope extension		Leather experts	Tanneries	Testing laboratories	Technology Centre	Leather Association	Manufacturers
CONS	Footwear is an extensive and miscellaneous product group difficult enough to be covered	x					
	Leather is used in a very broad range of different products with various final function					x	
	Difficult to define generic criteria for some parameters due to high diversity of leather	x		x	x		
PROS	Footwear is the most important section in leather industry and leather is the most diversified for footwear	x					
	Different leather products have similar requirements for chemical and tannery emissions issue		x	x			
	Requirements for leather related to footwear are more strict than for other product				x		
General feedback		No	No	/	Yes/No	No	No
Scope extension to other products : belt & handbags							
CONS	Different leather products may need different set of technical and performance criteria per type of product	x		x			
	Considerable fashion/decorative requirement, often requiring compromises for technical specifications	x					
	Requirements for leather related to footwear are more strict than for other product	x			x		
PROS	No relevant technical difference among leather materials	x			x		
	Same type of material used	x			x		
General feedback		Yes/No	/	Yes/No	Yes/No	/	Yes but focus on Leather/ No

Preliminary market analysis

In addition to the stakeholder consultation, a preliminary market analysis was performed to assess the market share of each type of product among the so-called "leather products" as well as to assess the importance of leather use among these products. Among others, this analysis highlighted that footwear is the major leather-made end product, sharing around half the global leather production. It is also important to emphasize that footwear is considered in many studies and statistical databases (e.g., Eurostat) as specific and separate product group, classified as a unique product category.

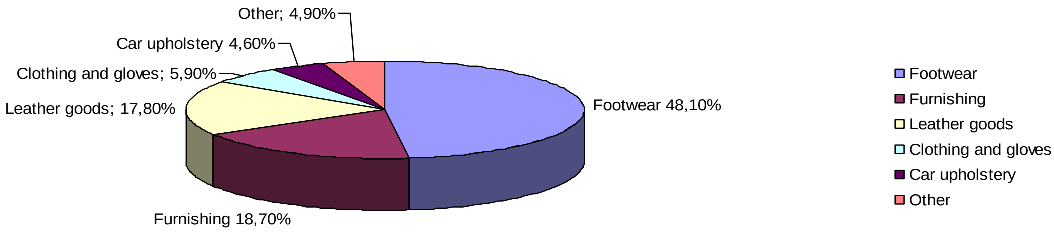

Figure 11: Italian production by sector of intended use (% incidence)[93]

According to the market segmentation run by CBI (2010), it appears that, except for belts, leather is not the major constituent of the other types of products (small leather goods, bags, etc.), and that the leather content varies depending on the product sub-group[94]. Therefore, if there was a criterion that imposes a minimum leather content this would exclude products of the same category. Additionally, when referring to the leather market share it could be assessed that extending the scope to other leather goods would not necessarily mean considerable environmental savings, as footwear is the main leather-made product group. The leather-made goods that by way of similarities could be considered to be covered by the scope represent a small market share.

The CBI study does not consider automotive and upholstery leather as a part of leather goods, thus reaffirming the general impression that these products are to be considered as a separated group of leather-made articles. Moreover, for these two sectors, it is quite clear that leather is not the main material used during the assembly phase. Additionally, the official European trade and production statistics do not introduce a detailed division of leather garments. According to the CBI reports, leather garments mainly cover different kinds of leather jackets and coats. This category is estimated to account for 85% of the EU leather garments market. The remaining 15% consists primarily of trousers, leggings, skirts, dresses, body warmers, waistcoats, underwear and bikinis[95].

Preliminary LCA analysis

A preliminary LCA literature review was also performed in order to support the scope discussion. Existing LCA studies either treat leather or a specific product. This is mainly due to the functional unit that must be precisely defined. In the case of leather as an intermediate product, 1 kg or 1 m² or leather is normal functional unit used. For LCA analysis of the end-products, the functional unit corresponds to unique item produced, e.g., a pair of shoes, a belt.

[93] (UNIC, 2009)

[94] CBI, The Luggage And Leather Goods Market In The EU, March 2010

[95] Extensive market analysis is referred to in chapter Task 2: Market analysis

Based on the information gathered, this study concludes that extending the scope to cover a broad range of leather products is not recommended. Accordingly, the study findings maintaining the current product group definition:

“*The product group ‘footwear’ shall comprise all articles of clothing designed to protect or cover the foot (…)”*

However, if the first option were perceived to be too narrow, the closest products to footwear were proposed to be considered:

“*The product group ‘footwear and leather products’ shall comprise all articles of clothing or accessory*

- *Either designed to protect or cover the foot,*
- *Or made of leather and designed as a decorative or functional accessory, such as belts, bags, articles normally carried in the pocket…"*

II. EUEB Meeting

The output of the preliminary study on the feasibility of the scope extension was presented during the EUEB Meeting in March 2013 (Brussels). Two proposals presented as specified beforehand:

1. Not to extend the scope,

2. To extend the revised scope of the product group to decorative or functional accessories.

After the short presentation, one CB expressed interest in broadening as much as possible the quantity of different products covered by the revised scope definition, in order to promote the green market. Another CB expressed interest in developing an EU Ecolabel for upholstery leather.

III. Feedback from stakeholders

One of the key concerns of the questionnaire sent after the EUEB Meeting in March 2013 was to gather opinions regarding the previously proposed optional scope definitions. The written feedback was received from 4 Competent Bodies, and 22 registered stakeholders who represent the footwear and leather industry, industry associations, research and technical centres, and NGOs. With regard to the statistical analysis methodology applied, only those responses that answered the specific questions were taken into account.

Fourteen out of 22 (64%) of stakeholders who answered the question, find the current definition of the criteria document adequate and precise. Thirteen out of 23 (57%) of stakeholders who answered the question are clearly not in favour of the scope extension. Three stakeholders who participated in the query did not address the question. In general terms, Competent Bodies and stakeholders who supported the scope extension expressed their interest to include a broader range of leather products in the revised scope to promote a greener market. Simultaneously, they suggested the need for equal requirements among all leather goods. From another side, some questionnaire responses suggest the existence of general interest in covering leather products by the EU Ecolabel scheme, but not necessarily within the extension of footwear product group. In practice, by the way of similarity to the EU Ecolabel for textile and following the Nordic Swan approach, specific set of criteria for "leather products (or leather)" could be proposed to be developed separately instead of including them in one unique product group 'Footwear and leather products'.

Current requirements are based on shoe size 40 Paris point. For children's shoes the requirements apply for a size 32 Paris point (or the largest size in the case of maximum sizes smaller than 32 Paris point). Most of the stakeholders (67%) find the functional unit adequate and precise. Some of them think that 37 (or 38) for women, 42 for men and 32 for children are more appropriate sizes, being most representative for the current size of feet.

In regard to the current revision of the scope definition, several stakeholders also pointed out the need for additional product group scope and definition clarification, such as footwear moulded in one piece (such as rain boots) for which it is unclear whether there is “fixed outer sole”.

1.5.3. Recommendation on the product group scope and definition

Because leather has been chosen as a common characteristic and the basis for extending the scope, it is necessary that leather is the main material used for the products covered by the set of criteria of the EU Ecolabel for footwear and leather products. After considering the market situation, the other European and non-European Ecolabels, the existing LCA studies, and the feedback received from Competent Bodies and registered stakeholders, this study concludes that extending the scope is not recommended considering that:

1. The majority of contributing stakeholders were not in favour of extending the scope to other leather products.
2. The EU Ecolabel should define one product group that is clearly understood by the consumers. Leather-made products cover a broad range of different functions (from car upholstery, to fashion jackets and wallets), hindering the introduction of the comprehensive product group definition;
3. Many of the so-called leather products are in fact composed of several materials, among which leather may be only a minor component. Indeed, in certain analysed product groups, there is a considerable rise in the use of leather/synthetic material combinations. It appears that, except for belts, leather is not the major constituent of the final product. Thus, there is a potential risk that if the wide range of articles apparently relevant to leather were covered by the scope, it would then include products that do not predominantly contain leather (or that only contain a minor quantity of it). Consequently, if all the products were to be considered within the scope, the majority of them would not meet the basic requirement: to be composed of leather. Thus, it would be necessary to introduce a restriction that imposes a minimum leather content requirement. However, in this case, the EU Ecolabel would not meet its original goal: to provide the consumer with the most environmentally friendly choice within the same product group category;
4. From a technological and processing perspective, leather used in footwear is the most diversified. Nevertheless, even if environmental requirements that refer to the tanning process are quite similar amongst leather products, the technical and performance requirements are very product specific. Thus, ensuring the product functional durability within the use phase is quite different from one product to another, hindering the possible introduction of a common set of criteria. It should be stressed that leather used in footwear manufacturing is the most diversified and fulfils the strictest and very product-specific technical requirements.
5. The goal of the Ecolabels is to help consumers choose the most environmentally friendly goods available on the market. When consumers look for a product, they actually seek for the specific function to fulfil (i.e., to eat, to dress). As with the LCA study, the EU Ecolabel

should define a product category based on a common final utility. The ISO 14040:2006 and ISO 14044:2006 standards clearly state that environmental comparisons between systems shall be made on the basis of the same function(s), quantified by the same functional unit(s); it is not possible to compare articles of unrelated utility (e.g., a wallet vs a piece of furniture). In addition, the EU Ecolabel Regulation mentions that the criteria “should be market oriented and limited to the most significant environmental impacts of products during their whole life cycle.” In other words, scope definition should enclose products of the same category and with the same identified environmental hot spots. Additionally, if the scope were extended, all the criteria that are product-specific would then have to be identified for each category of product covered by the analysis. This especially pertains to criteria related to the durability, use-phase, packaging and end-of-life, among others.

6. When referring to the leather market share it could be assessed that extending the scope to other leather goods would not necessarily mean considerable environmental savings, as footwear is the main leather-made product group. The leather-made goods that by way of similarities could be covered by the scope represent a small market share.
7. Other existing European and non-European Ecolabels did not manage to develop a single common set of criteria pertaining to the product category that includes leather and non-leather footwear and leather products.

Table 15 summarizes the argument in favour of and in opposition to the scope extension.

Table 15: Pros and cons for scope extension

	Arguments in favour of scope extension	**Arguments in opposition of scope extension**
Functional unit	The scope would cover a broader range of products. Possible confusion for the consumers if equivalent leather products cannot be labelled.	The scope is based on a consumer-oriented product category (possible confusion for the consumer because the products have very different functions). Product group is very large and not homogenous.
Market	Most retailers group leather goods into one product area so it would be useful to have a common standard.	Footwear covers around half the leather market.
		Footwear shows a diversified segmentation.
Materials	Same types of materials are used in footwear and small leather products.	Leather is not the main material used in leather products (except footwear and belts).
		A cut-off limit would exclude products of the same category, even footwear
Technologies	Different leather products show similar requirements for chemical and tannery emissions issue.	Performance specifications are product specific and diversified.
LCA		Different functional units for each products makes the comparison between products difficult

The definition of the scope is then suggested as follows and is close to the current definition in the Decision 2009/563/EC: "***The product group 'footwear' shall comprise all articles of clothing designed to protect or cover the foot, with a sole which comes into contact with the ground. Footwear shall not contain any electric or electronic components*.**"

The new definition does not use the term "fixed outer sole" which leads to confusion when considering articles of footwear moulded in one piece.

Footwear includes all products covered by the non-exhaustive list set in the Directive 94/11/EC (EU Footwear Labelling). Occupational footwear should also be included. The possible inclusion of protective footwear that because of security reasons incorporates metal toe caps should be further addressed during the upcoming EUEB AdHoc Working Group Meeting as well as the protective footwear. In other words, this definition includes all categories of footwear detailed in chapter 1.3.3 of the present document.

2 Task 2: Market analysis

2.1 Introduction

2.1.1. Objectives

This section provides an overview of the market features for the EU Ecolabel revision for the Footwear product group. Simultaneously, and considering the original proposal of the scope extension to other leather goods, it outlines the main aspects relevant to the leather market segmentation. This overview verifies and supports the proposed scope and definition of the EU Ecolabel product group and shows associated eco-innovations relevant to the current market situation, in line with the Regulation (EC) No 66/2010.

The overall objective of market analysis is to substantiate the product group market knowledge in order to characterize current tendencies at a quantitative and qualitative level. Specifically, the goal is to highlight:

- The market structure and drivers;
- The EU27 production;
- The trades and the apparent consumption;
- The market segmentation regarding the use and the materials composition;
- The EU Ecolabel market penetration;
- The existing best practices.

2.1.2. Methodology

The analysis takes into consideration the EU27 market data, being supported by additional references and it analyses the EU market with regards to the globally observed sector trends.

Most of the data presented have been extracted from the EU official production statistics (EC, Eurostat):

- PRODCOM is the database from Eurostat providing statistics on the production of manufactured goods;
- COMEXT is the database from Eurostat providing statistics for international trade among countries of the European Union and between countries of the EU and non-EU countries.

PRODCOM and COMEXT consider distinct categories of the product group footwear and use different statistical nomenclatures, i.e., NACE[96] and CN[97], respectively.

According to NACE nomenclature, footwear products are included in the activity code 15 (“*Manufacturer of leather and leather related products”*), and the sub-category 15.20, which includes

[96] Statistical classifications of economic activities in the European Union

[97] Combined Nomenclature

manufacturing of footwear and related products. According to the CN terminology, footwear belongs to the section XII, group 64. The selected classification that reflects specific product categories covered by the analysis conducted is presented in Table 16.

Table 16: Eurostat databases and selected nomenclature

Database	PRODCOM	COMEXT
Nomenclature	NACE	CN
Used for	Production, consumption, and market segmentation	Trade (imports and exports)
First level of interest	Group 15: Manufacture of leather and related products	Section XII: Footwear, headgear, umbrellas, sun umbrellas, walking sticks, seat-sticks, whips, riding-crops and parts thereof; prepared feathers and articles made therewith; artificial flowers; articles of human hair
Second level of interest	15.20: Manufacture of footwear	Group 64: footwear, gaiters and the like; parts of such articles
Third level of interest	15.20.11: Waterproof footwear, with outer soles and uppers of rubber or plastics, excluding footwear incorporating a protective metal toe-cap 15.20.12: Footwear with outer soles and uppers of rubber or plastics, excluding waterproof or sports footwear 15.20.13: Footwear with uppers of leather, excluding sports footwear, footwear incorporating a protective metal toe-cap and miscellaneous special footwear 15.20.14: Footwear with uppers of textile materials, other than sports footwear 15.20.21: Tennis shoes, basketball shoes, gym shoes, training shoes and the like 15.20.29: Other sports footwear, except snow-ski footwear and skating boots 15.20.31: Footwear incorporating a protective metal toe-cap 15.20.32: Wooden footwear, miscellaneous special footwear and other footwear, not classified elsewhere	6401: Waterproof footwear (including protective footwear) 6402: Footwear with outer soles and uppers of rubber or plastics 6403: Footwear with outer soles of rubber, plastics, leather or composition leather and uppers of leather 6404: Footwear with outer soles of rubber, plastics, leather or composition leather and uppers of textiles materials 6405: Footwear with uppers of other materials than rubber, plastics, leather or textiles materials

The group 15.20[98] of PRODCOM, and 64[99] of COMEXT also contain other related sub-categories which do not refer to finished footwear, but rather to its components. Accordingly, to circumvent any possible results multiplication, these sub-categories were dismissed from the market analysis, except for the data related to the structural business of footwear (cf. chapter 2.2.1), which contains aggregated information. .

The detailed nomenclatures (NACE and CN) are available in Annex I and Annex II.

Market data are either expressed according to value (EUR) or according to volume (amount of pairs). It is important to distinguish these two indicators as the ratio can be significantly different depending on geographical areas and types of footwear. For the purpose of the EU Ecolabel criteria revision for footwear, volume figures are the focus.

Complementary to the official statistical data, stakeholders' inquiry feedback and market reports of relevance are also used throughout this chapter to cover missing information and to supplement and help interpret the results obtained. Additionally, three relevant sources of market knowledge were particularly used: APPICAPS Yearbook 2012 (APICCAPS, 2012), CBI Market Intelligence Reports (CBI, 2010), and IBISWorld Report on Global Footwear Manufacturing (IBISWorld, 2010).

2.2 Footwear market

2.2.1. Structure of footwear market

I. Structural business for footwear

The data presented in this chapter are extracted mainly from Eurostat[100], including the latest update for 2010[101].

Twenty-one thousand EU27 enterprises indicated footwear manufacturing as their main activity in - 2010. Together they employed 260 000 persons, corresponding to 0.1 % of the total number of manufacturing sector employees, and generating 0.4 % of the manufacturing sector turnover (EUR 6.410 million).

[98] 15.20.40: Parts of footwear of leather[do you mean: leather parts of footwear?]; removable insoles, heel cushions and similar articles; gaiters, leggings and similar articles, and parts thereof

[99] 6404: Uppers and parts thereof

[100] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Manufacture_of_leather_and_related_products_statistics_-_NACE_Rev._2

[101] This analysis includes the category related to the parts of footwear (category 15.20.40), because detailed data was not available. However, this sub-category is not expected to be important compared to the others.

Table 17: Key indicators of the footwear structural business[102]

Indicators	Total Manufacturing	Manufacture of footwear
Number of enterprises	2 130 000	21 100
Turnover (EUR million)	6 410 000	24 000
Production value (EUR million)	:	:
Value added at factor cost (EUR million)	1 590 000	6 473
Gross operating surplus (EUR million)	580 000	2 200
Total purchases of goods and services (EUR million)	4 810 000	18 000
Personnel costs (EUR million)	1 010 000	4 200
Number of employees (thousands)	282 000	260
Apparent labour productivity (Gross value added per person employed – EUR 1000 per head)	52.8	23
Wage-adjusted labour productivity (Apparent labour productivity by average personnel costs) (%)	148	142
Average personnel costs (personnel costs per employee) (EUR 1000)	35.8	16
Gross operating surplus/turnover (gross operating rate) (%)	9.01	not available

Small and Medium Enterprises (SME) represent the majority of the enterprises in the footwear industrial sector; 75% of the companies in this sector employ less than 9 persons and represent approximately 13% of the value added, as shown in the Table 18.

Table 18: Market segmentation by industry size for footwear manufacture[102]

Size of companies	Total	From 0 to 9 persons employed	From 10 to 19 persons employed	From 20 to 49 persons employed	From 50 to 249 persons employed	250 persons employed or more
Number of enterprises	21 000 (estimated)	15 692	2 459	1 804	964	confidential
Turnover or gross premiums written (EUR million)	confidential	confidential	2 720	4 468	8 616	5 204
Value added at factor cost (%)	6 473	826	765	1 231	2 190	1 451

102 (Eurostat), 2010

II. Footwear distribution structure

According to CBI (CBI, 2010), the footwear sales/purchase system across Europe is mainly organized through specialised channels (about 65 % of the market) that include chain stores, buying groups and independent shops situated on the main streets or in town shopping centres. In most EU countries, footwear is supplied through the dedicated distribution routes, from manufacturer to importer/wholesaler to retailer (see Figure 12). These channels are most relevant for exporters from developing countries such as: China, Vietnam, India, Indonesia, Brazil and Thailand. Within recent years, the footwear sales chain has suffered from competition by (footwear) discounters, sports retailers, clothing retailers and hypermarkets.

In many cases wholesalers are bypassed: this is especially relevant to larger manufacturers that have their own retail outlets and tend to distribute items directly to their stores (IBISWorld, 2010). The footwear branch headquarter is not relevant anymore to the country where the footwear is produced, showing high level of companies merging and consolidation of industry participants. Moreover, the big brands have changed the business model, so that the product is often designed in the developed country or company headquarter, but its production is outsourced to the lower labour cost destination.

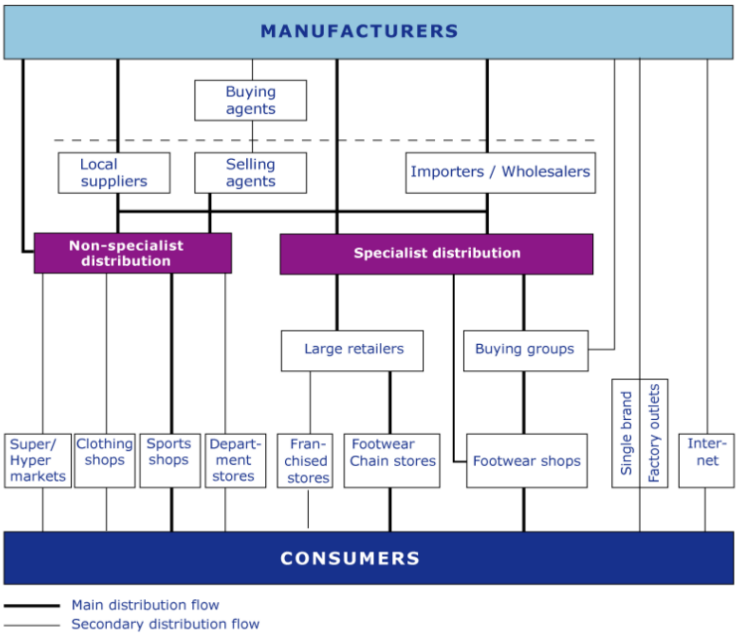

Figure 12: Typical distribution structure for footwear in EU markets[103]

[103] (CBI, 2010)

2.2.2. Global market overview

Industry revenue for the Global Footwear Manufacturing has increased 2.2% in 2012 to total USD 122.9 billion, up from USD 107.4 billion in 2011: this represents a representing annual growth of 2.7% over the last 5 years (IBISWorld, 2012)[104].

According to APPICAPS estimates (APICCAPS, 2012), world-wide production of footwear reached 21 billion pairs in 2011. When referring to the quantity of shoes produced, about 87% of the manufacturing takes place in Asia, mainly China (60.5%), followed by India (10.4%), Vietnam (3.8%), Pakistan (1.4%), and Bangladesh (1.3%)[105]. The Indian footwear industry has grown considerably over recent years due to overseas investment from US, Europe, and Taiwan, which focussed on concentrating production of mid-priced shoes in the country (IBISWorld, 2010).

South America accounts for 5% of global production, 3.8% of which comes from Brazil. The European footwear production accounts for approx. 3 % of the world total, followed by the North America (2%). Africa shows a slight increase in the production (currently 3%) with respect to previous years. The only European country included on the top-ten list is Italy, with an overall share of 1% of world production. Figure 13 shows the production distribution of the top-ten list countries

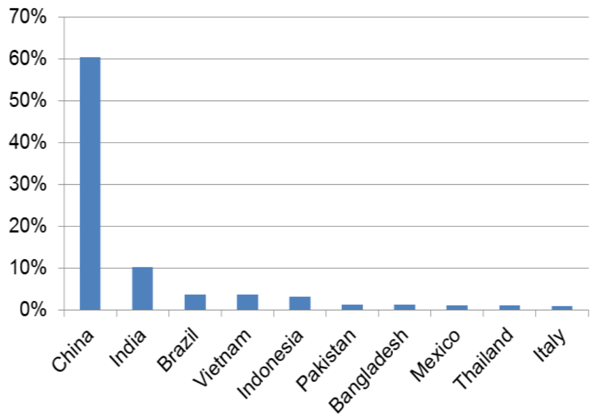

Figure 13: Top 10 of 2011 world footwear producers (volume)

In 2011 Asia was also the biggest consumer of footwear volume accounting, for 47% of world total, followed by Europe (21%), North America (17%), South America (8%), Africa (6%), and Oceania (1%). China accounts for 15.9% of global footwear apparent consumption (in volume), followed by the United States (12.9%), and India (12.7%). As is evident on the Figure 14, apparent consumption of footwear in Germany is the highest in Europe, representing 2.5% of global consumption.

[104] http://www.ibisworld.com/industry/global/global-footwear-manufacturing.html

[105] Data refer to the number of pairs

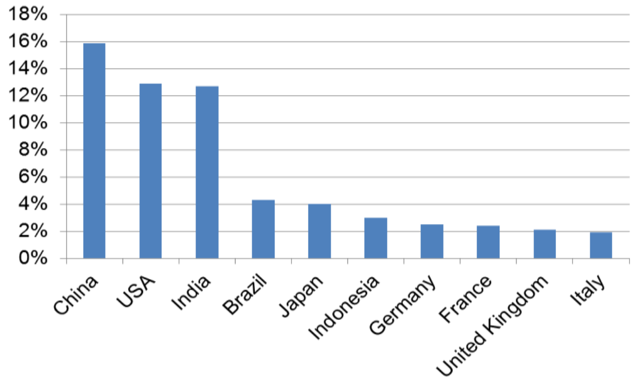

Figure 14: Top 10 of 2011 world footwear consumers (volume)

Footwear is an active product on the international markets, being one of the most widely traded and universally used commodities in the world. The level of international trade has risen steadily from 63.5% of industry revenue in 2006 at $75.2 billion, to $83.7 billion in 2010: this represents an annual average rise of 3.3% (IBISWorld, 2010). The intra-European value of footwear trade corresponds to 35% of world total value, and 83% of overall European export. This is followed by Asian exports to North America and Europe, which represent respectively 19% and 17% of the world total. Intra-Asian exports, at 13%, are also very significant. On the other hand, European exports to Asia and North America represent only 3% and 2% respectively, of the world total. At 2% of world total, Asian exports to Africa is the only other flow exceeding 1% (APICCAPS, 2012). Figure 15 illustrates the geographic patterns for the recent world footwear trade.

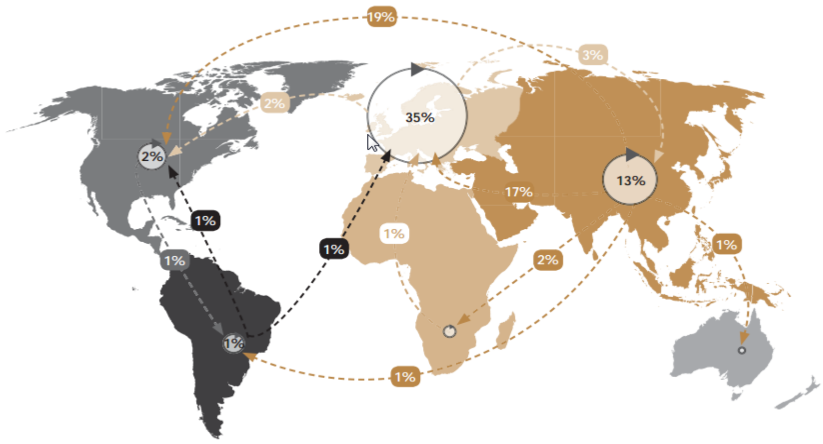

Figure 15: Geographic patterns of footwear trade (value) (2007-2011)[106]

Exports from China have increased as the major international footwear companies have outsourced their production to take advantage of the lower labour and production costs. Asia dwarfs all other continents as a footwear exporter, with 84% of the world total volume. Europe is a distant second, with 11% of global export share.

[106] (APICCAPS, 2012)

Europe leads the ranking of world importers. However, after reaching a maximum of 44% in 2008, its share of the world total volume has been declining for the last three years to 40%. At the other end of the table, Africa's imports have been growing steadily over the last decade, currently representing approximately 7% of the world footwear trade volume.

2.2.3. European market analysis

This section provides a statistical analysis of the market performance of the product group under study. The data presented have been extracted from the Statistical Office of the European Union Database (Eurostat). The main indicators discussed in this section are related to the production and trade in the EU27 and in several single Member States of major statistical relevance (top European producers). The analysis focuses on the period 2007-2011 and addresses footwear related categories according to the methodology provided in chapter 2.1.2. References to data from the most recent available period (2012) and other relevant sources are also incorporated into the analysis. Furthermore, the data presented refer to product volume (pairs of footwear) and value (in Euros)[107], reflecting considerable fluctuation between both market indicators (Table 19 and Table 20).

I. European Production

Table 19: Top-12 of European producers (EUR millions) [108]

	2007	2008	2009	2010	2011	Production share of 2011	Growth 2007-2011
EU27	***13 838***	***12 898***	***11 218***	***11 772***	***12 951***	***100%***	***-6%***
Italy	6 364	6 196	5 304	5 426	6 262	48%	-2%
Spain	1 836	1 707	1 454	1 476	1 563	12%	-15%
Portugal	1 137	1 117	1 094	1 204	1 270	10%	12%
Romania	1 017	877	716	756	793	6%	-22%
Germany	603	602	547	595	643	*5%*	7%
France	807	257	429	412	421	3%	-48%
Poland	351	354	269	298	307	2%	-13%
Slovakia	276	217	178	206	254	2%	-8%
Austria	187	209	224	252	248	2%	33%
United Kingdom	209	212	140	219	207	2%	-1%
Hungary	133	133	127	133	158	1%	19%
Finland	124	126	103	129	134	1%	8%
Others	793	892	633	665	690	5%	-13%

[107] Some data provided by Eurostat are confidential or estimated, therefore, they have to be interpreted with caution, e.g., changes in French data confidentiality induce artificial growths and declines, thus decreasing its reliability.

[108] Eurostat

Table 20: Top-12 of European producers (millions of pairs)[108]

	2007	2008	2009	2010	2011	Production share of 2011	Growth 2007-2011
EU27	***647***	***560***	***471***	***491***	***505***	***100%***	***-22%***
Italy	235	201	154	156	170	34%	-28%
Spain	116	105	90	88	90	18%	-23%
Portugal	59	54	51	56	54	11%	-7%
Romania	63	51	40	44	46	9%	-27%
Germany	22	21	21	24	22	4%	2%
France	39	9	20	19	19	4%	-52%
Poland	26	24	23	24	24	5%	-7%
Slovakia	14	10	8	9	10	2%	-31%
Austria	4	5	5	7	5	1%	16%
United Kingdom	4	4	3	4	4	1%	-7%
Hungary	10	9	9	9	10	2%	-5%
Finland	3	3	3	3	3	1%	6%
Others	50	65	43	50	48	9%	-5%

Southern Europe, especially the Mediterranean region, is the main European footwear manufacturing area. Italy, Spain, Portugal and Romania together represent approximately 76% of the overall European production value, and 72% of production volume.

The European footwear industry dominates production of high quality products in the medium to elevated price category. The average European production price has increased from 21.39 EUR in 2007 to 25.65 EUR in 2012. Because its highest share of the European market value (48 %) and volume (34 %),[13] Italy leads the EU27 in manufacturing medium to highly-priced shoes from prestigious designers and brands designed to suit current trends and satisfy customer demands; the "Made in Italy" label is a significant value-added component of the end product (IBISWorld, 2010). Nonetheless, when examining the previous decade (2002-2011)[109], the drop in production volume reached 44%, falling from 900 to 505 million pairs. This is partly due to manufacturing outsourcing and drastic growth in imports of medium-low to low priced domestic footwear, especially from Asian countries, which satisfies some of the European market demand.

Romania, Bulgaria, Hungary, Slovakia have also recorded a decrease in production. Despite benefiting from increased market demand due to the market extension after the EU entrance, they competed poorly against Asian suppliers, many of whom have both lower cost bases and are technologically well developed (CBI, 2010). In general terms, in accordance with the information subtracted from Eurostat database (period 2007-2011), European footwear production experienced an overall decrease of 22 % volume and 6 % value within the last 5 years, particularly in Italy, Spain, and Portugal, due to the economic recession and intense competition within the footwear industry. Notwithstanding the global footwear market redistribution, the top European producers have not changed much since 2002.

[109] In reference to the European Commission, Study for the Footwear Criteria Revision, Preliminary Report, 2008

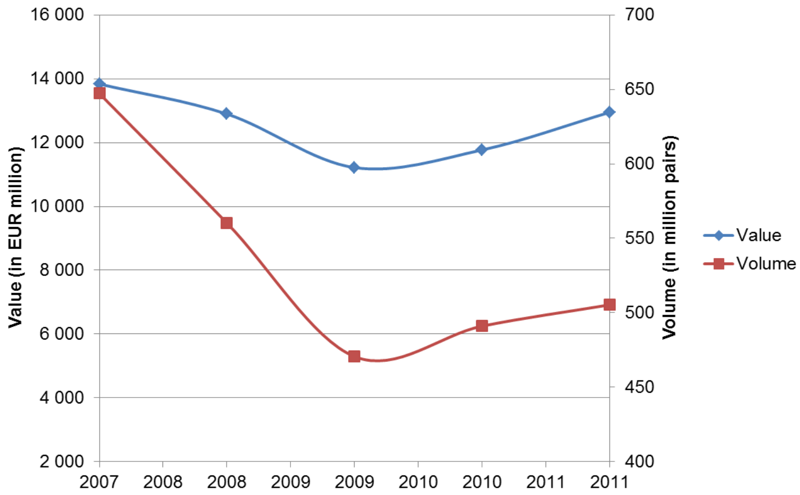

Figure 16: Production trends in EU27

The volume trend does not decrease proportionally to the unit value. This means that the product prices are higher, most probably due to increase of production costs. These might partially also be justified by the increase in materials price, especially related to the leather or natural rubber shortage. The general drop in production in 2009 reflects the European recession, as shown on the Figure 16. According to the trends projections for the upcoming years, the production volume and value are expected to grow, eventually achieving the levels recorded in 2007. However, since the current economic crisis is currently still affecting the Southern European countries, this growth projection may be diminished. Additionally, considering that the intensity of shoe consumption is dependent on household income, confronted with economic crises, it is plausible to expect that the demand for medium-low to low-priced products will continue to grow, whereas, demand for highly priced similar products will decrease.

II. Footwear trades

Comparing intra- and extra- European trade shows that more than half of the imports and exports of European production are destined to another European country. Consequently, according to the data set in the Table 21, most of the European-manufactured footwear remains in Europe[110].

Table 21: Intra and extra European trade (EUR millions)[111]

	Imports 2011 into EU27 countries	Exports 2011 from EU27 countries
With non-EU27 countries	14037	5944
With EU27 countries	18134	21308
Percentage of internal trade	**56%**	**78%**

[110] In theory, the values of imports and exports within EU27 countries should be balanced. However, this is not the case in practice, due to loans and changing stocks.

[111] Eurostat

The Table 22 shows China as the main non-EU27 country supplier, accounting for 50 % of the overall European import value in 2012. Between 2007 and 2012, the import value of Europe increased by about 22% with a decrease in 2009 due to the economic recession. As shown in Table 23, the share of import volume from China is much higher than the share of import value, suggesting a lower product cost. On the other hand, unit cost actually increased 44% between 2007 and 2012 regarding China (from 3.14 to 4.52 EUR/pair), and increased 34 % for all non EU27 countries (from 5.06 to 6.78 EUR/pair).

Cambodia and Indonesia represent fast-emerging European suppliers; between 2007 and 2012 the import value from these countries grew 183% and 90%, respectively. With respect to the period 2002-2006[112], the main suppliers for Europe did not change considerably, except for Romania which became a European Union Member State in 2007.

Table 22: Top-10 EU27 suppliers (EUR millions)[111]

Geographical Area	2007	2008	2009	2010	2011	2012	Share of 2012 imports	Growth rate 2007-2012
Total non EU27	***12 757***	***13 055***	***12 633***	***14 781***	***15 257***	***15 570***	***100%***	***22%***
China	5 797	5 924	6 051	7 294	7 584	7 788	50%	34%
Vietnam	2 101	2 287	1 901	2 088	1 828	2 105	14%	0%
Indonesia	645	702	788	932	1 035	1 227	8%	90%
India	960	971	952	1 159	1 258	1 110	7%	16%
Tunisia	434	459	416	487	477	427	3%	-2%
Cambodia	106	113	144	217	272	300	2%	183%
Morocco	240	241	247	281	303	277	2%	15%
Switzerland[113]	173	191	178	173	208	261	2%	51%
Bosnia and Herzegovina	188	202	195	227	250	250	2%	33%
Brazil	468	507	411	428	306	235	2%	-50%
Others	1 646	1 458	1 350	1 497	1 736	1 589	10%	-3%

[112] (Life Cycle Engineering, 2008)

[113] Including Liechtenstein

Table 23: Top-10 of EU27 suppliers (millions of pairs) 111

Geographical Area	2007	2008	2009	2010	2011	2012	Share of 2012 imports	Growth rate 2007-2012
Total non EU27	**2521**	**2438**	**2251**	**2523**	**2564**	**2296**	***100%***	***-9%***
China	1846	1761	1668	1885	1950	1720	75%	-7%
Vietnam	278	292	220	227	195	195	8%	-30%
Indonesia	64	76	79	89	92	101	4%	58%
India	67	67	72	83	81	69	3%	3%
Cambodia	14	14	16	23	28	29	1%	109%
Tunisia	23	24	22	26	24	21	1%	-9%
Turkey	31	24	19	20	22	19	1%	-37%
Brazil	38	38	30	32	23	17	1%	-54%
Morocco	18	17	15	17	18	16	1%	-10%
Bangladesh	10	11	12	14	17	15	1%	49%
Others	133	115	99	109	115	93	4%	-30%

The Table 22 and Table 23 above showing the import trends in EU27, indicate that the value of footwear imported into EU27 from outside Europe has increased within last 5 years, despite a net decrease in the import volume. This highlights a trend of increasing footwear production costs outside Europe.

The Table 24 and Table 25 highlight the United States, Russian Federation, and Switzerland as the main extra-EU destination of footwear made in EU27. On one hand, export to the United States has decreased during this period, but there has been a substantial increase in exports to the Russian Federation and Switzerland.

Trade statistics for the period 2007-2012 show little change compared to 2002-2006[114] in the distribution of EU27 export destinations.

[114] In reference to the European Commission, Study for the Footwear Criteria Revision, Preliminary Report, 2008

Table 24: Top-10 EU27 markets (EUR millions)[111]

Geographical Area	2007	2008	2009	2010	2011	2012	Share of 2012 imports	Growth rate 2007-2012
Total non EU27	***5722***	***5813***	***4853***	***5513***	***6580***	***7460***	***100%***	***30%***
United States	1256	1024	773	943	1078	1194	16%	-5%
Russian Federation	878	1016	673	761	930	1130	15%	29%
Switzerland	700	767	725	809	933	1064	14%	52%
Japan	332	300	278	299	356	415	6%	25%
Hong Kong	162	190	173	236	335	400	5%	147%
Turkey	134	230	262	262	338	361	5%	169%
China	62	76	80	113	192	255	3%	310%
Ukraine	219	209	136	155	190	193	3%	-12%
Canada	161	152	119	146	178	175	2%	8%
United Arab Emirates	108	131	112	109	140	170	2%	57%
Others	1709	1719	1521	1679	1910	2105	28%	23%

Table 25: Top-10 EU27 markets (millions of pairs)[111]

Geographical Area	2007	2008	2009	2010	2011	2012	Share of 2012 imports	Growth rate 2007-2012
Total non EU27	***176***	***175***	***155***	***171***	***195***	***218***	***100%***	***23%***
Russian Federation	18	21	16	19	22	27	12%	47%
Switzerland (Incl. Li)	22	23	21	24	26	26	12%	16%
United States	33	25	18	20	22	23	11%	-29%
Turkey	7	9	9	12	16	17	8%	130%
Croatia	6	6	6	6	6	11	5%	70%
Japan	7	6	6	6	7	8	4%	22%
Algeria	1	3	5	2	3	7	3%	375%
Cyprus	3	4	4	4	5	7	3%	96%
Ukraine	8	7	6	6	7	6	3%	-25%
Canada	6	5	4	4	5	5	2%	-13%
Others	64	66	61	67	75	81	37%	27%

III. European apparent consumption

The apparent consumption is calculated by using Eurostat data, as follows: production + imports – exports. It is the best figure available to represent what quantity the consumers actually use in the different countries.

According to data presented in Table 26 and Table 27, Germany, France, Italy, Spain and the UK are the top-5 European footwear consumers, supporting the observation that population intensity is one of the main driving factors of the footwear market.

Overall European footwear consumption has been stable except for 2009, which is characterized by a small decrease due to the global recession. However, this general conclusion should not be extrapolated to individual countries, and each country should be assessed separately.

Table 26: Top European footwear consumers (EUR millions)[115]

	2007	2008	2009	2010	2011	Share 2011	Growth 2007-2011
Total EU27	***20 537***	***19 788***	***18 705***	***20 731***	***21 145***		***3%***
Germany	2 829	2 676	2 734	3 263	3 616	17%	28%
France	3 477	2 830	3 039	3 321	3 367	16%	-3%
Italy	2 685	2 601	2 725	2 659	2 987	14%	11%
United Kingdom	3 190	2 883	2 698	3 061	2 910	14%	-9%
Spain	1 783	1 861	1 428	1 753	1 628	8%	-9%
Austria	538	606	601	699	715	3%	33%
Poland	551	679	574	651	698	3%	27%
Sweden	390	356	321	414	480	2%	23%
Greece	605	679	601	509	423	2%	-30%
Finland	261	283	250	270	293	1%	12%
Ireland	342	319	277	292	270	1%	-21%
Denmark	292	271	204	204	226	1%	-23%
Netherlands	185	200	160	249	209	1%	13%
Czech Republic	182	264	221	204	201	1%	10%
Portugal	242	210	274	312	192	1%	-21%
Hungary	114	169	125	117	137	1%	21%
Romania	314	306	254	202	127	1%	-60%

115 Eurostat

Table 27: Top European footwear consumers (millions of pairs)[115]

	2007	2008	2009	2010	2011	Share 2011	Growth 2007-2011
Total EU27	***2 986***	***2 816***	***2 559***	***2 835***	***2 864***		***-4%***
France	416	355	360	406	419	15%	1%
Germany	381	370	356	383	415	14%	9%
United Kingdom	437	405	410	413	372	13%	-15%
Spain	344	343	374	356	306	11%	-11%
Italy	377	327	272	295	301	10%	-20%
Czech Republic	121	99	83	99	139	5%	16%
Poland	99	87	93	94	103	4%	4%
Netherlands	89	77	63	91	89	3%	1%
Romania	97	93	69	71	64	2%	-34%
Greece	69	102	62	57	56	2%	-18%
Austria	43	48	44	52	52	2%	19%
Sweden	41	37	33	37	40	1%	-4%
Portugal	42	41	42	52	36	1%	-13%
Ireland	30	30	33	31	31	1%	3%
Denmark	37	32	47	29	27	1%	-27%
Finland	20	24	18	19	21	1%	5%
Slovakia	9	6	13	1	14	1%	56%
Bulgaria	14	16	11	12	12	0%	-18%
Hungary	13	16	14	10	11	0%	-18%

Figure 17 contrasts the volume of apparent consumption with production in the top-10 European footwear consumers in 2011. From Figure 17, it is apparent that the national consumption volume dwarfs production mainly due to intensive intra-European trade and massive import of cost competitive products from outside Europe. Following the same line of reasoning, the EU 27 apparent consumption is almost 5 times higher than production volume.

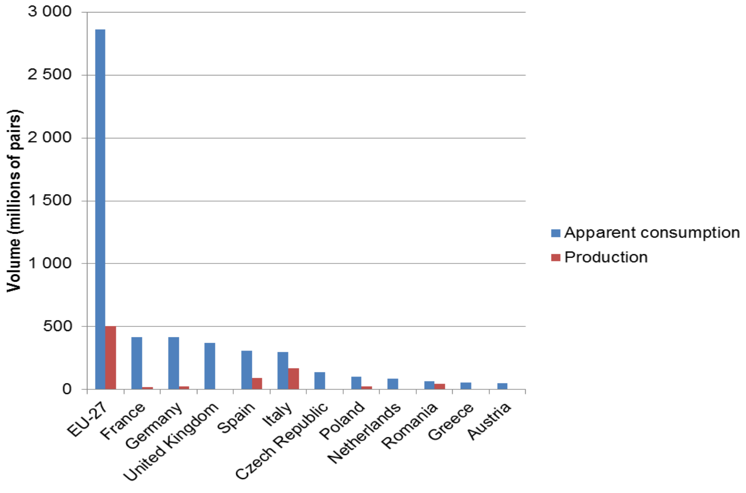

Figure 17: European production vs. apparent consumption [115]

IV. European market forecast

Market performance, drivers, and prospects

Population growth is the key driver in the footwear industry that leads toward greater demand for consumer products, particularly for basic necessities such as discretionary footwear. A projected overall European population increase of around 3%[116] within the upcoming decade should therefore act as a future stimulus to the footwear market.

On the other hand, household income level is another important factor that shapes the intensity of footwear demand, influencing quantity, quality, design, and frequency of footwear purchases (APICCAPS, 2012). Fall in consumer purchasing power, coupled with rise in EU unemployment rates, will most probably shifts market preference towards basic, frequent-use, casual shoes.

The style of female footwear changes seasonally, allowing intense competition among companies, whereas, men's footwear remains more generic, permitting market durability for design patterns. The level of fitness awareness and the age of the population are the dominant social factors that affect demand for particular types of shoes. For example, with an incremental increase in the average age of population in some developed countries, the demand for walking shoes may gradually increase compared to sport and school shoes.

Seasonal factors and weather conditions should also be considered as one of the market drivers, because the sales intensity of different type of footwear types fluctuates based on the seasons and prevailing weather conditions. For example, during the cold winter months, sales of sandals will decrease and sales of boots will increase.

The quality of locally made shoes can also create changes in demand and consumer perceptions, especially for shoes categorized as discretionary purchases. To some extent, domestic consumers

[116] EUROSTAT

might to a certain extent prefer local products out of a sense of loyalty towards native companies. Customers might also be motivated to pay more for footwear from certain branches or countries well-known for their footwear quality and creation of fashion trends. Additionally, intense competition within the footwear industry creates potential niche for added-value products, e.g., vegan or eco-footwear. Even if the EU market is not expected to grow significantly in the coming years, there will be contrary movement towards price competitive footwear imported from Asia.

According to (CBI, 2010), the future market tendencies imply upgrading up to higher value Are likely to lead people to footwear in terms of:

- Comfort: in casual footwear for the growing group of older people. Comfort upgrade my be related to softer leathers, more perfect fit, warmth, inner soles with linings made from a single piece of leather, fabrics that wick moisture, membranes, breathable footwear or rubber soles. Also, evening footwear comfort may improve by developing different forms of high heels that allow easier walking.
- Design: in terms of footwear shapes that are rounded, refined and sometimes very feminine. Sneaker designs are fusions of a sporty urban or solid technical look with refined shapes.
- Technology: with innovative footwear development mixing different materials in soles, such as leather, Gore-Tex, nubuck and canvas developed by the new brand MBT. Computer aided design will continue to generate demand for new types of footwear.
- Niches: for example, more variety in evening footwear, recycled footwear, ethical footwear, eco-friendly, urban footwear or in outsized or specialised shoes.

Forecast

Figure 18 and Figure 19 present the overall view on the European market reality and forecast for the period 2006-2014 for trends in production, imports, exports and apparent consumption.

The graphs present the forecasts for the years 2013 and 2014 based on mathematical extrapolations which should be interpreted with caution considering that contextual changes occurring during the forecasted years are not taken into account.

As previously stated, imported footwear is the main source of product supply in Europe, therefore, it is the variable that has the greatest influence on the apparent consumption volume, which is expected to grow. Being a factor[117] that displays a high degree of fluctuation, it is complicated to derive a related forecast. Nevertheless, considering the previous market analysis, it is anticipated that the import value will be stable over the upcoming years.

[117] Imports volume is characterized by lack of stability thus having no stable increase or decrease

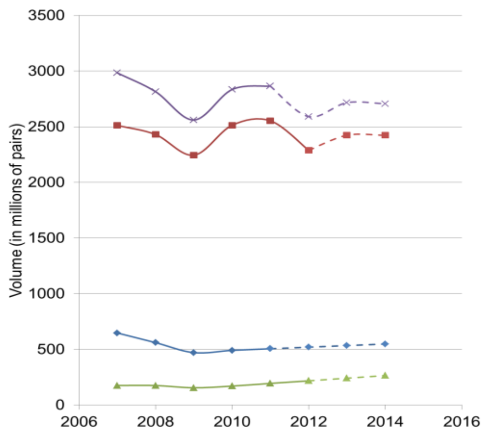

Figure 18: Market overview in EU27 – volume[118]

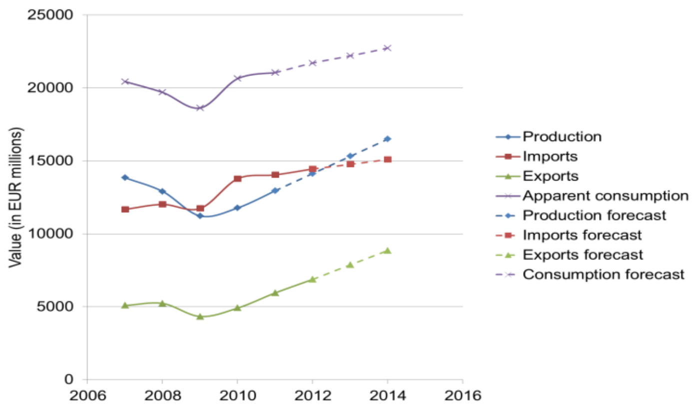

Figure 19: Market overview in EU27 – value[118]

2.2.4. Market segmentation

There are several ways in which footwear market can be categorized. In this report two basic types of segmentation have been considered based on the available statistical information from Eurostat:

- Main materials used
  - Rubber or plastics for uppers;
  - Leather for uppers;
  - Textiles for uppers;
  - Wood for soles.
- Use
  - Waterproof;
  - Slippers;
  - Sandals;
  - Town footwear;
  - Sports footwear;
  - Protective footwear.

The detailed matching between the segmentations and NACE nomenclature is given in Annex I. Other sources referenced[119] use apparently similar segmentation, nonetheless some of them analyse the

[118] Eurostat

[119] (APICCAPS, 2012), (CBI, 2010), (IBISWorld, 2010)

market according to gender or mix materials/use segmentation types listed above, hindering the reliability of direct comparison.

It is also possible to analyse footwear segmentation according to geographical area of production; this issue has been already addressed in the chapter 2.2.3.

I. Global market segmentation

Using the World Footwear 2012 Yearbook Data (APICCAPS, 2012) as the basis for the global shoe market segmentation overview, leather footwear represents approximately half of the world exports value (16% in terms of volume). The noticeable decrease in leather trading has been accommodated by gains in other footwear types (except the residual category “others”, if measured in volume) (refer to Figure 20). Special attention is warranted for the notable increase in rubber and plastic footwear export, representing the main volume share (56%).

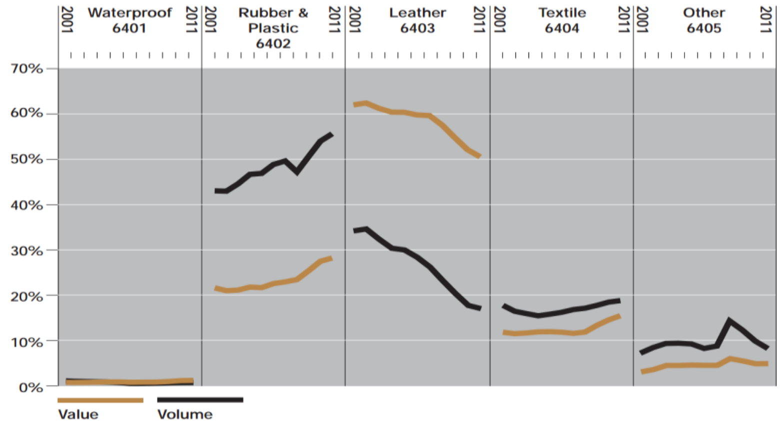

Figure 20: Global share of exports by type of footwear 2001-2011[119]

According to IBISWorld, 2010, women’s footwear is the most important type of footwear on the market (31.2%). Figure 21 summarises the global footwear value market segmentation considering both intended use and materials. Different sourcing and data aggregation methods limit the feasibility of comparing data from (APICCAPS, 2012) and Eurostat with the segmentation presented on Figure 21 and, therefore, this information should be treated independently.

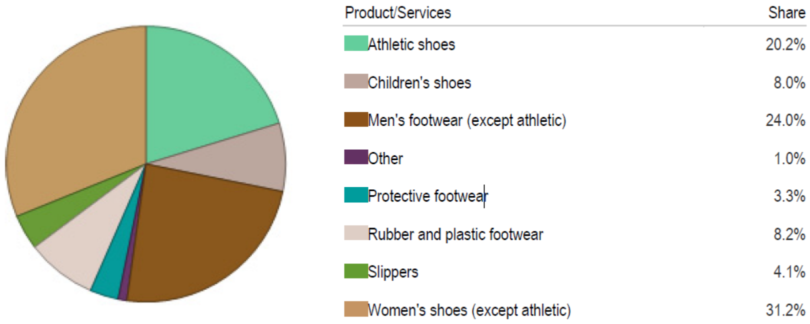

Figure 21: Global market segmentation - value[120]

II. European footwear production segmentation

Regarding the material oriented segmentation, production of footwear with leather uppers in 2011 represented 66 % of the European sector in terms of volume, and 84% in terms of value. These data confirm the European production focus on manufacturing traditional "made of leather" high-quality footwear.

Between 2007 and 2011, the total production value of footwear with rubber and plastic uppers grew by 6 %, whereas, the remaining footwear types declined by about 4 to 7%.This decline is more significant in terms of volume, with declines of about 15-20 % for wooden soles and leather uppers footwear, and about 40 % for textiles uppers. However, the texture upper decline appeared between 2007 and 2008, with subsequent production stabilization.

Figure 22, presenting the intended use segmentation for the EU27, highlights town footwear as the major type; it represents 61% of total European sector production in terms of volume and 78% in terms of value.

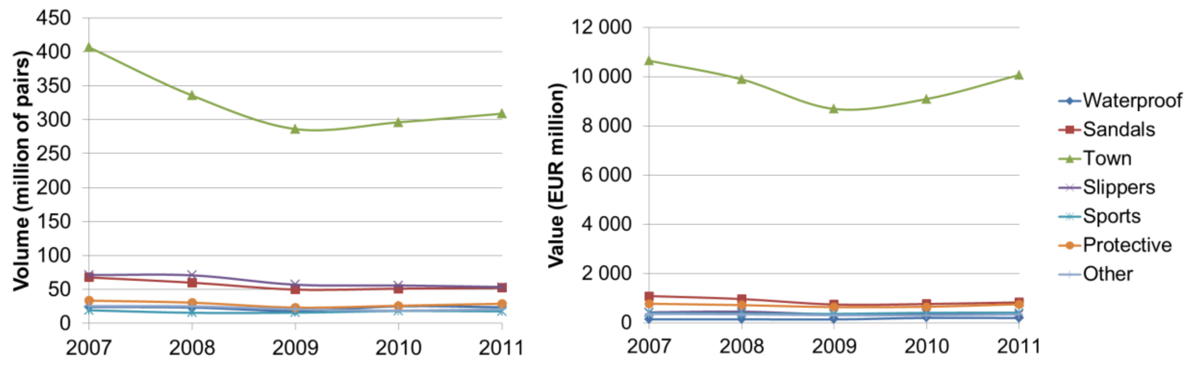

Figure 22: Footwear intended use segmentation in EU27 (production volume and value)[118]

[120] (IBISWorld, 2010)

Based on the referenced segmentation classification, between 2007 and 2011, the production of all footwear types decreased on a volume basis (from 1 % for waterproof footwear to 25 % for slippers).

III. European footwear consumption segmentation

Based on the previous EU Ecolabel criteria revision for footwear presented in the Technical document that covered the period of time between 2002 and 2006 (Life Cycle Engineering, 2008), there is no noticeable change in market segmentation for intended use. Indeed, the main group of intended use was already town footwear, with 65 % of the market share.

Regarding the material segmentation, the Figure 22 below highlights footwear with leather uppers as the major type in terms of value, representing 60% of the 2011 European consumption; footwear with rubber or plastic uppers was the type most purchased based on volume, accounting for 43 % of the European consumption. Between 2007 and 2011, the total consumption (value based) of footwear with rubber, plastics and textiles uppers grew by 32 %, whereas, consumption of other types declined by about 7-8 %.

Volume-based consumption of footwear with leather uppers or wooden soles declined by 20%, whereas, footwear with plastic, or rubber and textiles uppers increased by 6-7%.This highlights the current tendency towards purchasing cost-competitive products made of synthetic materials and textiles rather than high-quality, more expensive leather footwear.

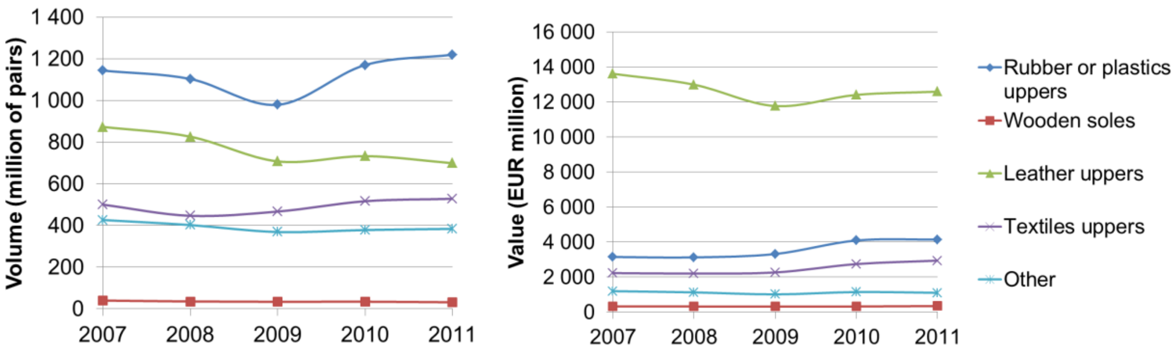

Figure 23: Materials segmentation in EU27 (consumption value and volume)[118]

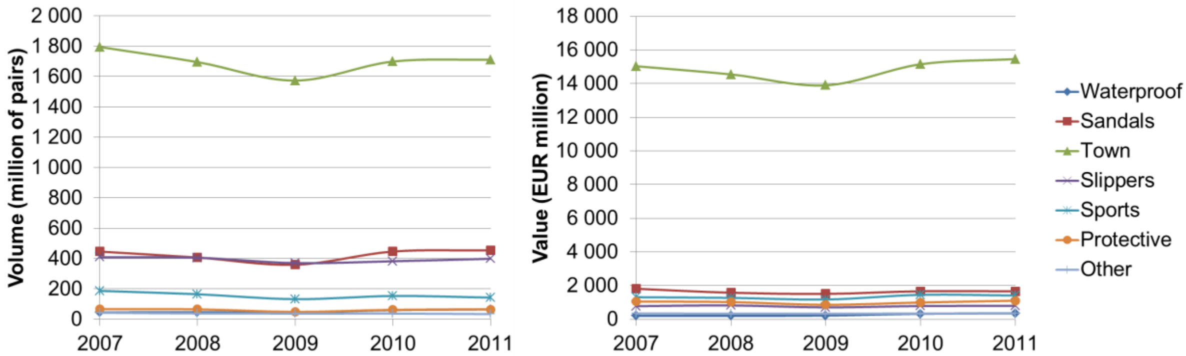

Figure 24: Use segmentation in EU27 (consumption volume and value)[118]

Figure 24 summarizes the intended use segmentation data; it shows town footwear as the major footwear type consumed, representing 60% of total European volume-based consumption, and 73% of value-based consumption.

Between 2007 and 2011, volume-based consumption of different types of footwear showed a general decrease (e.g., 3 % for protective footwear to 24 % for sports footwear); the exceptions were sandals for which consumption remained stable, and waterproof footwear for which consumption increased 46%.

The value-based consumption for footwear types increased between 2 to 76 %, except for sandals which decreased by 9 %. The 76 % increase in waterproof footwear consumption is of relatively insignificant considering the total sales value between 2007 and 2011.

IV. Footwear import segmentation

As previously stated, according to the Eurostat data, extra-EU import is the main source of footwear on the European market, and footwear with leather uppers is the main value-based import category, representing 45% of the market share; rubber and plastics uppers represent 47% of the volume-based market share. Considering the relatively low impact of exports compared to the importance of footwear production and imports, no detailed analysis of the data extracted from Eurostat has been performed for exports.

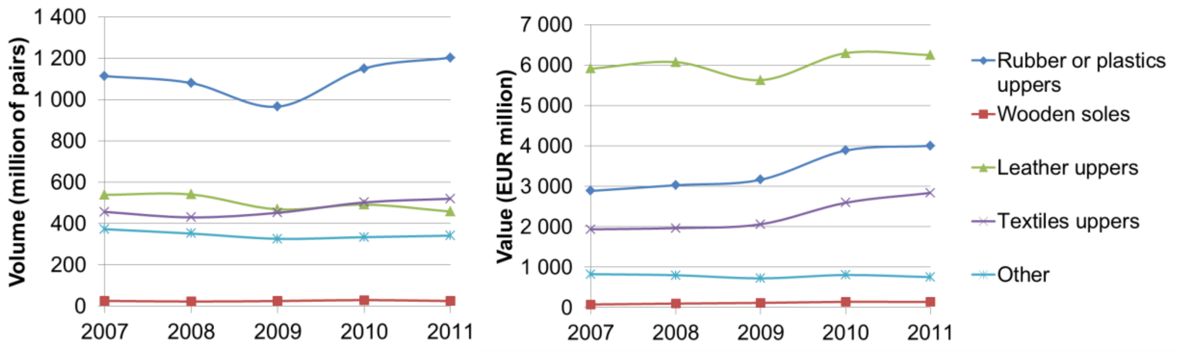

Figure 25: Material segmentation in EU27 (Imports value and volume) [118]

Figure 25 presents the segmentation for the main intra-European importers. Data sources are as follows: Spain, from FICE (2008); France from Fédération Française de la Chaussure (2011); Italy from ANCI (2011); and the other EU countries come from APICCAPS(2012).

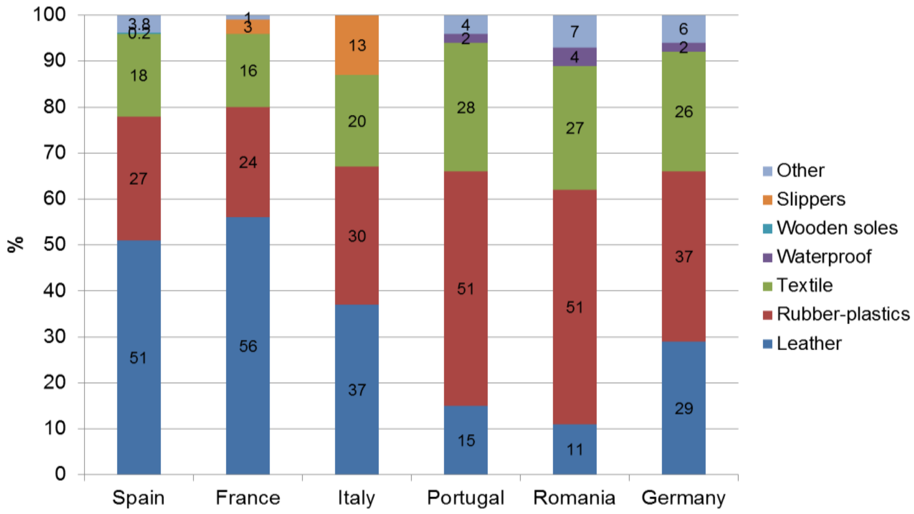

Figure 26: Imports segmentation for the main European producers[121]

2.3 Leather market overview

2.3.1. Introduction

This chapter focuses specifically on the leather market. The purpose of this approach is to evaluate which of the product types are the key drivers in the leather market. This is particularly important considering that that possible footwear product group scope extension may eventually incorporate other leather goods[122].

Leather is the major material used in footwear production, despite its decline in recent years in favour of rubber and plastics, as analysed in chapter 2.2.4. On the other hand, leather is commonly used for a vast quantity of non- shoe manufacturing applications, such as furniture, automobiles and garments.

There are many ways in which leather market can be segmented. In this report, three basic types of segmentation are considered:

- Segmentation by animal origin;
- Segmentation by final product destination;
- Segmentation by geographical area.

2.3.2. Animal origin segmentation

FAO publishes the annual "World statistical compendium for raw hides and skins, leather and leather footwear" with estimates on worldwide production of raw hides and skins. In 2011, over 6.7 million tons (that amounts to about 215 million pieces) skins were produced; the majority of these

[121] Source: Italy: ANCI – France: FFC – rest: (APPICAPS, 2012)

[122] Detailed analysis is presented in Chapter 1 of the present document

originated from bovine hides (71% of total), followed by sheepskin (14%), goat skins (8%) and calfskins (6%).

Table 28: Global leather production - Average 2008-2010[123]

	Heavy leather from bovine animals		Light leather from bovine animals		Light leather from sheep and goats	
	Million sq. meters	Growth (%)	Million sq. meters	Growth (%)	Million sq. meters	Growth (%)
World	50	2.2	1314	2.6	487	1.9
Developing countries	37	3.8	836	3.6	383	3.3
Developed countries	14	-0.8	478	1.1	103	-1.6

The remaining animal skins processing (principally reptiles, deer) covers a small part of the industry (less than 1 %) and could be considered as a niche market (COTANCE, 2012). The stakeholders responding to the first questionnaire confirmed this segmentation, pointing out that bovine leather is the most commonly used, followed by goat, sheep, kid and pig leather. One stakeholder also mentioned crocodile leather as niche.

Figure 27 present the production of leather in European countries per animal typology. The percentage values represent the share of each type of leather in the European production and per country. Most of European bovines and calves leather is produced in Italy, with 70.3 % of European share. The other types of leather are also in most part produced in Italy (68.6 % for sheeps and goats, and 49.3 % for other animals). Spain is the second European country producing leather.

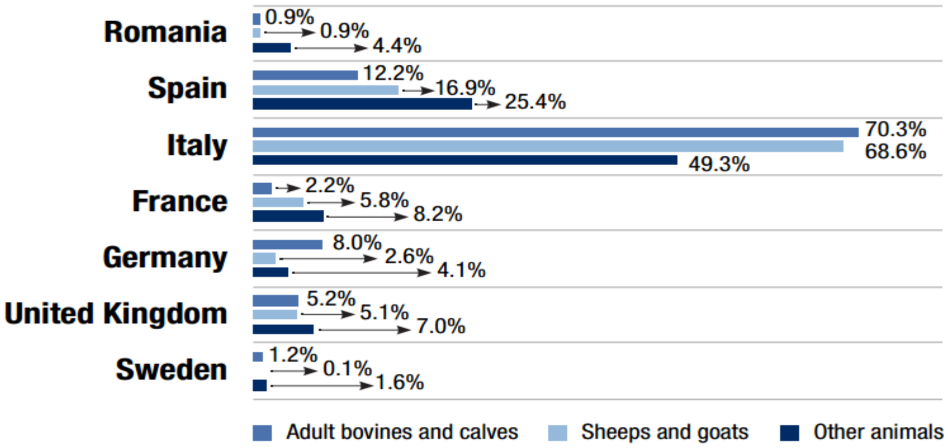

Figure 27: Production per animal typology in main European countries[125]

[123] (FAO, 2011)

Based on documents consulted, more than 99% of the world[124] and European leather[125] production is derived from raw hides and skins that originate from animals raised mainly for milk and/or meat production.

2.3.3. Geographical area segmentation

European turnover accounts for 26.7% of the world leather production. China is the leader with approximately 29.5% of the leather production (COTANCE, 2012).

According to the EUROSTAT statistical data for 2011, Italy accounted for approximately 67% of the European leather production value. Spain is a distant second with 6%; France and Germany each account for 5%. Table 29 present the Top-10 EU27 leather producing countries in 2011 along with each country's annual production value (EUR millions).

Table 29: Top-10 EU27 producers of leather in 2011 (EUR millions)[126]

	Export	Import	Production	Consumption	Share of production
Total EU27	2788	2668	6730	6610	
Italy	3623	2108	4483	2968	67%
Spain	427	511	392	476	6%
France	293	412	353	472	5%
Germany	671	702	332	363	5%
United Kingdom	196	149	256	208	4%
Austria	327	195	189	57	3%
Portugal	59	373	168	482	3%
Poland	114	386	107	379	2%
Netherlands	164	101	97	35	1%
Denmark	47	25	30	8	0.5%

NB: Data are not provided in volume quantity because the unit is not homogenous depending on the category (m^2 or kg).

2.3.4. End product segmentation

The official EU leather production statistics referenced (PRODCOM, COMEXT) do not consider detailed leather market segmentation. Aggregation of leather with other materials within specific product groups severely limits the reliability of these data for making estimates about market segmentation. Indeed, the leather category includes products that extensively use of a variety of

[124] Brugnoli, F., Life Cycle Assessment, Carbon Footprint in Leather Processing (Review of methodologies and recommendations for harmonization) Eighteenth Session of the leather and leather products industry panel Shanghai, China, 01 – 05 September 2012, November 2012, UNIDO Report

[125] COTANCE (2012) Social and Environmental Report the European leather industry

[126] Eurostat

materials in addition to leather, such as synthetic materials (plastic, nylon, vulcanised fibre, PVC, PP, etc.), textiles, paperboard or a combination of all.

Table 30 presents statistical estimates of the International Council of Tanners, regarding the world leather use by end product in 2007. The market analysis shows a very broad range of articles made of leather pointing out footwear as the major product of interest for the EU Ecolabel, sharing as much as 52% of global leather destination. Other leather products of possible interests (belts, bags) correspond to as little as 9.4% of global market share (13.8% if gloves are included).

Table 30: World leather use by end-product[127]

Leather use-million square feet	
	2007 Estimates
Footwear	11 925
Furniture	3 210
Auto	2 340
Garments	2 290
Gloves	1 010
Other leather products	2 155
Total	22 930
Leather use-% of total production	
Footwear	52
Furniture	14
Auto	10.2
Garments	10
Gloves	4.4
Other leather products	9.4
Total	100

The Figure 28 presents the typical European segmentation: footwear sector is the main destination of leather (41%), followed by furniture (17%) and car upholstery industry (13%), The broad category of leather goods take up 20% of Europe's leather production and garments 8%, the rest 3% are considered niche products (COTANCE, 2012).

[127] (International Council of Tanners) estimates 2007

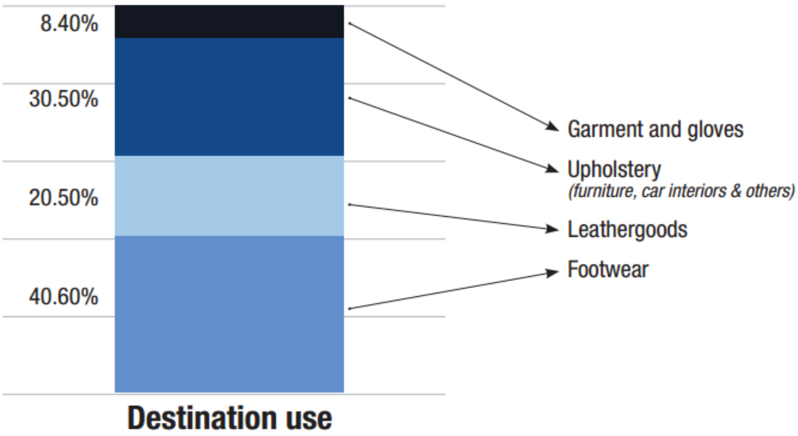

Figure 28: Estimated production share of the key leather segment [128]

Considering the scope definition proposed in Chapter 1, a specific focus of this study is directed at understanding the overall market significance of leather goods. Table 31 shows the different market aspects as follows:

- Production of leather goods and trade with non-EU countries (imports and exports)
- The figures are displayed with respect to the quantity (amount of products) and the value (amount of euros corresponding to the leather goods).

The Table 31 indicates that the clear footwear sector dominance on the European level with about 55 to 80 % share depending on the indicator (value or volume), followed by handbags, whereas the other leather goods are of less importance from the market perspective.

[128] (COTANCE, 2012)

Table 31: Market figures for the different leather goods (millions)[129]

	Export		Import		Production		Apparent consumption	
Sector	**#**[130]	**EUR**	**#**	**EUR**	**#**	**EUR**	**#**	**EUR**
Articles of apparel[131]	:	446	:	11	1572	1047	11	1572
Gloves, mittens and mitts[132]	2	34	40	43	199	77	43	199
Belts and bandoliers	:	351	:	54	544	723	54	544
Trunks, suitcases, vanity-cases, briefcases, school satchels and similar containers	:	522	:	10	1311	520	10	1311
Handbags	42	3559	565	581	3453	4612	581	3453
Footwear	191	5798	2551	2865	21145	12951	2865	21145
Footwear share	***81%***	***54%***	***81%***	***80%***	***75%***	***65%***	***80%***	***75%***

NB: the apparent higher footwear shares in Table 31 compared to Figure 28 arise because Table 31 does not consider upholstery leather which represents over 30% of the leather market.

In their responses to the first questionnaire, stakeholders provided data that show dynamic market segmentation. For the countries for which no additional, or insufficient, data were provided, figures were derived based on the information presented in the Social and Environmental Reports published by the COTANCE(2010), the European Leather Industry Association. Data for Sweden, United Kingdom, Portugal and Germany come from the stakeholder feedback, while the data for Italy (UNIC, 2010), Bulgaria (BULFFHI, 2010) and Romania (APPBR, 2010) come from the COTANCE Social and Environmental reports.

As shown in the Figure 29, the leather segmentation per destination is not homogenous for all European countries. Northern European countries specialize in upholstery leather production (i.e., furniture and automotive) and Southern European countries dedicated to footwear and apparel industry. This conclusion corroborates information present in the revised Tannery BREF (EC, BREF, 2013).

[129] Eurostat

[130] Amount of products

[131] including coats and overcoats - excluding clothing accessories, headgear, footwear

[132] excluding for sport, protective use for all trades

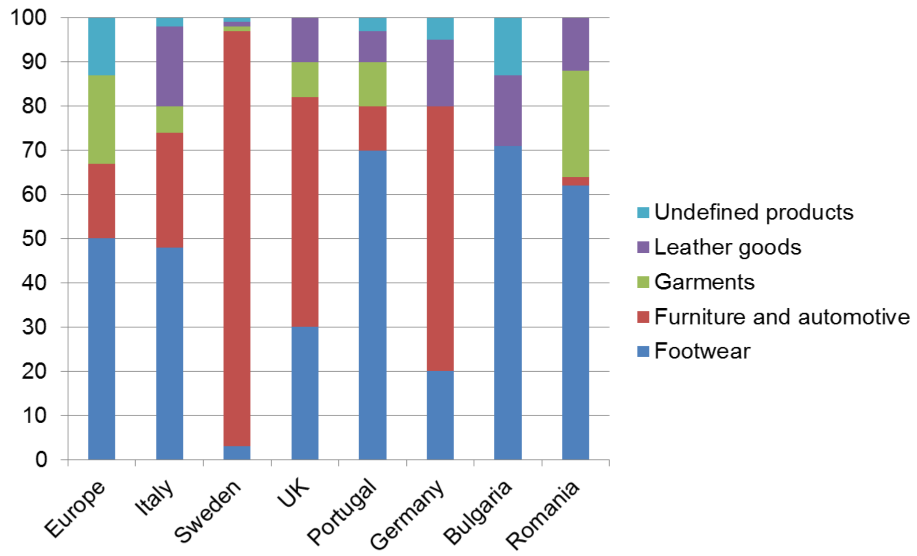

Figure 29: Destination of leather per country[133]

2.4 Market penetration of the EU Ecolabel

Currently there are eight Ecolabel licences that cover 65 products (ECAT)[134]:

- 1 licence in Sweden;
- 2 licences in Spain;
- 1 licence in Finland;
- 4 licences in Italy.

The number of licences has not changed much since the last product group revision in 2008 accounted for nine licence holders (7 in Italy, 1 in Sweden, and 1 in Spain)[135].

The statistical analysis shows limited market penetration of the EU Ecolabel for the product group under revision (the number of EU Ecolabel awards to footwear represents 0.4 % of the overall number of the EU Ecolabelled products), especially with regard to the information presented in Figure 30. The purpose of the first questionnaire presented in conjunction with the on-going Ecolabel

[133] Sources: Europe: (EC, BREF, 2013); Italy, Bulgaria, Romania : (COTANCE, 2012) – Sweden, UK, Portugal, Germany: stakeholders’ feedback

[134] http://ec.europa.eu/ecat/#

[135] (Study for the Footwear Criteria Revision, Preliminary Report, 2008)

revision process is to identify the crucial factors that could potentially limit large-scale adoption of the Ecolabel scheme.

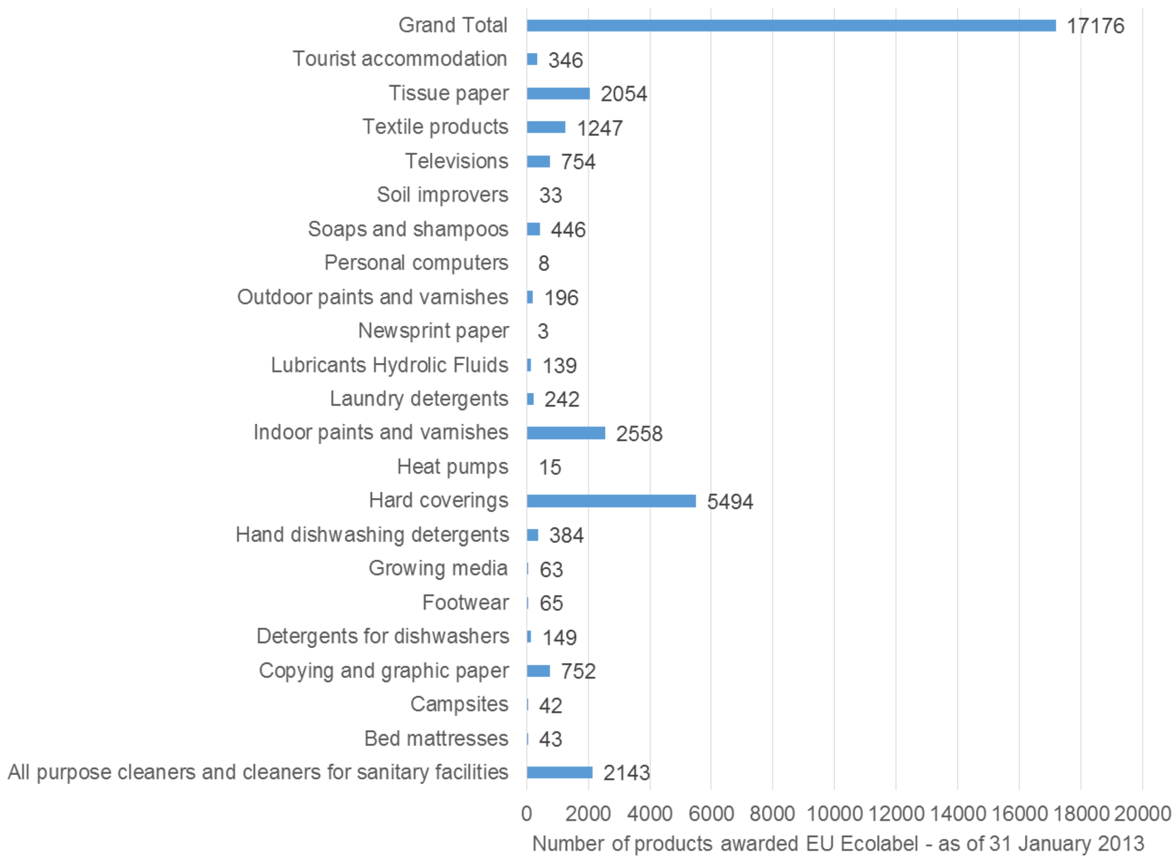

Figure 30: Number of products awarded EU Ecolabel – January 2013[136]

According to consultations with stakeholders, one of the main constraints that appears to hinder industry application for the EU Ecolabel for footwear is quick and seasonal evolution of fashion industry in general and the broad range of other factors (weather, demographic changes, social events, advertisements, fashion, etc.) that influence customer preferences during specific periods. Other less frequently mentioned reasons are: timing, the stringency of Ecolabel criteria, application cost, existence of internal/branch labels, and the fact that the label is perceived as not providing a significant economic competitive advantage. However, textiles appear to confront the same constraints as footwear, but yet still show a significantly higher amount of licenced products: 1247 products were awarded the Ecolabel in 2013[137]. Even if European footwear consumption is about one-sixth that of textiles[138], there are 20 times more EU Ecolabelled textile products than footwear.

[136] Statistics from ECAT database

[137] In 2010, there were 89 licences

[138] Comparison of this market analysis with the one performed for the revision of EU Ecolabel for textiles

Moreover the geographical segmentation of the EU Ecolabelled footwear is quite representative for the specificity of European shoe sector, stating that Italy and Spain are listed between the main EU-27 producers.

Further consultation with stakeholders within the on-going revision framework is necessary to uncover possible solutions that may help increase in number of the EU Ecolabel licences for the footwear product group.

2.5 Other Ecolabel schemes

The identification of the most important schemes related to the footwear sector has been conducted within the framework of chapter 1.4. "European and non-European Ecolabels" of the present report.

For the label Nordic Swan, the criteria document of product group "Textiles, hides/skins and leather"[139] indicates that shoes are included in the EU Ecolabel criteria for footwear; therefore, no footwear product is ecolabelled by the Nordic Swan.

For the label Blue Angel, there are two products labelled which consist of soles containing bamboo fibres.

For Environmental Choice New Zealand, only one company provides ecolabelled products related to textiles and leather, but not to footwear products.

For Japanese Eco Mark, there are eight products certified under the criteria "143 Shoes and Footwear"140.

Other ecolabels do not focus on footwear, but, rather, on component materials (such as textiles or leather); or, no information on the number of ecolabelled products was available.

Table 32 summarizes the penetration of other ecolabel schemes on the market.

Table 32: Penetration of other ecolabels in the footwear sector

ecolabel	Number of licences for footwear
Nordic Swan	None for footwear 11 licences (expiry date 2013-12-31) for textiles and leather products[140]
Blue Angel	2 for soles with bamboo fibres only
Environmental Choice New Zealand	1 for textiles and leather
Japan Eco Mark – criteria "143 Shoes and Footwear"	8 products[140]
Other ecolabels	Information not available

[139] http://www.nordic-ecolabel.org/criteria/product-groups/

[140] Personal communication with a person from the Japanese Eco Mark in July 2013

2.6 Identified best practices in the footwear market

2.6.1. Introduction

The footwear market shows a wide range of possible eco-innovations identified with the support of information contained in following sources:

- Brands websites (cf. chapter 2.6.5 for the list):
- BREF for the Tanning of hides and skins (2013);
- BREF for Textile (2003);
- Textile Eco-label preliminary report (2012);
- IMPRO Report (2010);
- Stakeholder questionnaires conducted in conjunction with the revision process;
- Direct contact with industry representative stakeholders (9 contacts, 5 responses),
- Environmental reports, technical and scientific papers, and innovative projects, among others, that reflect the current sectorial state-of-the art.

2.6.2. Global overview

Application of best practices can take the form of improved products and processes that reduce environmental impact, new technologies and services, and new work strategies, but key to transitioning toward more eco-friendly products is the combination of cleaner technologies, new business models and sustainable behaviours[141]. In general manner, mechanisms applied by retailers to drive environmental improvement across product supply chains include: product certification; environmental criteria for suppliers; dissemination of better management practices across the supply chain; promoting ecolabelled products; eco design; application or subsidization of clean technologies; local or regional sourcing; optimization of logistics[142].

Considering the current state of market knowledge about ecolabels and eco-innovation, it is not feasible to obtain substantial data on the scale of ecolabelled footwear market penetration, i.e., regarding the proportion of footwear and related products that carry eco-innovations and their overall market impact; however, it is still possible to address common strategies that have been introduced to the market:

- Improvement of the supply chain control by imposing material and process requirements to master the multi-supply chain;
- Use of more sustainable materials;

[141] EIO (2013). Europe in transition. Paving the way to a green economy through eco-innovation. Annual Report 2012. European Commission Report.

[142] Styles, D. Schoenberger H., Galvez-Martos, J.L. (2012) Environmental improvement of product supply chain: Proposed best practice techniques, quantitative indicators and benchmarks of excellence for retailers. Journal of Environmental Management 110, pp. 135-150

- Minimisation of the use of adhesives, leather coatings and solvents;, or using solvent-free products to reduce net VOC emissions;
- Optimisation of material cutting and assembly to minimize the quantity of material used and reduce the quantity of waste generated;
- Establishment of waste management programmes;
- Minimisation of hazardous substance use.
- Establishment of end-of-life programs for used footwear

Other eco-innovations that may be applied include: use of green energy or more eco-friendly transportation and packaging systems. We anticipate that additional investigation of best-practices and their market relevance will be conducted with input from industry stakeholders.

Management of the materials supply chain is one of the emerging strategies being used to master environmental performance of products and improve material traceability, mainly by introducing clear management rules such as specific guidelines of environmental product performance requirements. Therefore, the footwear sector needs to improve its capacity for controlling the entire product and process along life cycle. Facing this challenge, globally leading shoe manufacturers – including Adidas, Inditex Group, PUMA, Nike, Timberland, Mark and Spencer, or UVEX, among others –have committed themselves to bring forward environmentally friendly actions in their product lines. Following the information gathered as part of the on-going revision process, we have observed a similar tendency among footwear intermediate material producers to improve the environmental performance of production[143 ,144,145,146,147].

However, it is noteworthy that according to the information gather from the registered stakeholders, effective control along the supply chain is more feasible for the globally recognized footwear and apparel companies; whereas, this is very difficult to achieve for SMEs, which constitute the majority of European footwear industry - with average production rates of 100.000 -150.000 pair of footwear per year[148]. Similar observations have been reported for tanneries, where many of chemical products purchased are preparations (mixture or solution composed of two or more substances).

Our review of the list of different ecolabels and strategies towards more sustainable production, both private and independent, indicates that an industry needs to promote and document the environmental profile of its products in order to be effective in the marketplace. Consequently, a

[143] Rydin, S. (2011) Risk Management of Chemicals in the Leather. Sector: A Case Study from Sweden. In: B. Bilitewski et al. (eds.), Global Risk-Based Management of Chemical Additives I:Production, Usage and Environmental Occurrence, Hdb Env Chem, Springer-Verlag Berlin Heidelberg 2011

[144] BREF Tanning (2013)

[145] BREF Textile

[146] (COTANCE, 2012)

[147] BREF Polymers

[148] Personal communication with stakeholders

number of independent, government and industry-led labelling and auditing initiatives have emerged in order drive performance improvement, provide market differentiation and enable verification of best-practices. The focus varies among labels or certification schemes, with some placing the emphasis on the material origin and processing (e.g., organic cotton, Leather Working Group certificate), chemical performance (Restricted Substances Lists, Schadstoffgeprüft), whereas, others place more emphasis on ethical aspects (e.g., Global impact, CSR). Limited information is currently available about the market penetration of these initiatives, although clearly some appear to be more significant than others, particularly those with considerable industry engagement. The EU Ecolabel and national ecolabels coexist well and are developing a policy of cooperation and coordination. Article 11 of the EU Ecolabel Regulation (EC) 66/2010 introduces measures to encourage harmonisation between ecolabel schemes, particularly in selection of product groups and development and revision of the criteria. Within the process of criteria development, existing requirements developed by other national ecolabelling schemes (EN ISO 14024 type I) in the Member States should also be analysed.

The following chapters present different environmental initiatives and innovations classified according to

- Life cycle phases
- Eco-innovative brands.

2.6.3. Corporate Social Responsibility

Responding to the new challenges and legal requirements within the recent years, footwear and apparel manufacturers and brands have received increasing attention from Government’s, NGOs and consumers in relation to their environmental performance. The common trends of outsourcing practices have also raised the importance of Corporate Social Responsibility (CSR) for overseas suppliers.

Corporate Social Responsibility (CSR) is a general term related to public reporting on the adherence of companies’ suppliers, and manufacturing sites to national and internationally recognised social and environmental standards. CSR has been identified as a separate overarching issue for analysis of best practices and labelling initiatives and for dealing with social and ethical issues, but it also often addresses the environmental management practices of production plants.

CSR programs are bound to follow certain principles such these proposed by the Global Compact program of the United Nation:

- Human Rights
    - Principle 1: Businesses should support and respect the protection of internationally proclaimed human rights.
    - Principle 2: Businesses should make sure that they are not complicit in human rights abuses.
- Labour
    - Principle 3: Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining.

  - Principle 4: Business should eliminate all forms of forced and compulsory labour.
  - Principle 5: Businesses should effectively abolish child labour.
  - Principle 6: Businesses should eliminate discrimination with respect to employment and occupation.
- Environment
  - Principle 7: Businesses should support a precautionary approach to environmental challenges.
  - Principle 8: Businesses should undertake initiatives to promote greater environmental responsibility; and
  - Principle 9: Businesses should encourage development and diffusion of environmentally friendly technologies.
- Anti-Corruption
  - Principle 10: Businesses should work against corruption in all its forms, including extortion and bribery.

Among the surveyed stakeholders, less than half (30-40%) have signed a declaration such as "Global Compact", or equivalent, or work within an international scheme (e.g., SA8000, ISO26000…); and, few hold CSR certification, and/or are certified to an industry or third-party CSR scheme.

2.6.4. Identified best practices per life cycle phases

I. Raw material

Leather

Sustainable cattle raising

The Rainforest Alliance offers third-party certification and ecolabelling services to forests and farms managed in ways that reduce environmental impacts and increase social benefits. The RA-Cert Division evaluates and certifies sustainable forestry operations under the standards of the Forest Stewardship Council (FSC) using the Rainforest Alliance CertifiedTM Seal and FSC labels. Likewise, this unit evaluates sustainable agriculture using the Sustainable Agriculture Standards and certifies compliance using the Rainforest Alliance CertifiedTM Seal[149].

The Rainforest Alliance reported that in 20101 in the United Kingdom and Ireland in 2010 consumer awareness of Rainforest Alliance certification was as high as 54%. In 2011, 39% of consumers in Germany recognized the Rainforest Alliance Certified green frog seal. In Sweden, Denmark, Norway and Finland, the Rainforest Alliance has reached 44% awareness. In Australia in 2009, 42% of consumers reported awareness of the Rainforest Alliance Certified seal[150]. The Italian luxury house Gucci launched a collection of handbags using sustainably produced leather sourced from Brazilian

[149] http://www.rainforest-alliance.org

[150] http://www.rainforest-alliance.org/branding/documents/sustainable_australia_markets_study.pdf

cattle ranches that have achieved the Rainforest Alliance Certified seal. Each "Gucci for the Green Carpet Challenge" bag carries a "passport" that details the precise history of the product's supply chain[151].

On the other hand, according to Veja[152], it is difficult to work directly with leather producers and nearly impossible to ascertain the origin of leather or the manner in which the cattle have been treated. Therefore, a major goal of the brand Veja is to ensure that the cattle do not originate from the Amazon region where a cattle breeding is one of the main factors affecting deforestation[153].

Leather Processing

Table 33 summarizes the emerging techniques thoroughly analysed in the Best Available Technique Reference document of the European Commission for tanning hides and skins (EC, BREF - Tanning, 2013). Techniques considered to be 'emerging' are those currently under development which might form the basis for BAT in the future, even if they have not yet been applied in full-scale operations.

Table 33: Emerging technique identified by the BREF document for tanning hides and skins[154]

Process steps	Specific processes	Status of development		
		Description	Exploited	Pilot
Curing	Use of recovered salt	Factory of Vergnet, Viterbe, France is an example of an industrial unit applying this technique (as a dealer in leather and hides) in 2008.	X	
Degreasing	Solvent degreasing using dimethyl ether	A pilot plant of 120 litres capacity with a complete recovery unit has been built in Avinyó, Spain. It is able to treat up to 25 kg of material per batch. Trials and semi-industrial production trials have been carried out since 2005 in this plant. Different sheepskin, leather, and other fatty hides/skins have been treated specifically for some of the major tanneries in Spain, France, Italy, UK, Holland, Norway, Turkey, and South Africa. Performance of the process has been extensively evaluated by external leather institutes, such as LGR-Germany, CTC-France and AIICA-Spain.		X
Tanning	Extraction of vegetable tannins from grape pips	The extraction and concentration have been conducted at pilot plant scale. The material produced has been tested for leather production.		X
	Use of a cross-linking agent derived from olive waste	Laboratory and pilot scale trials have been conducted.		X
Post-tanning	Continuous retanning and dyeing	A prototype was built and used in 2008 for pilot trials to evaluate the emerging technique. The results were promising.		X

[151] http://www.vogue.co.uk/accessories/news/2013/03/05/gucci-creates-first-zero-deforestation-ethical-handbag-collection---green-carpet-challenge

[152] http://www.veja.fr

[153] http://www.greenpeace.org/international/Global/international/planet-2/report/2009/1/amazon-cattle-footprint-mato.pdf

[154] (BREF - Tanning, 2013)

Process steps	Specific processes	Status of development		
		Description	Exploited	Pilot
	Use of fat recycled from sheepskin degreasing in fat liquors	A demonstration project has been completed.		X
Finishing	Organic solvent-free finishing	Several formulations are already available on the market. New materials are under development.	X	X
	Dry abatement of volatile compounds from tanneries	The technique has been tested at the pilot scale in various Italian tanneries with different types of leather production (shoe upper, upholstery and clothing). Therefore, many substances have been tested (such as acetone, alcohols, esters, ethers and aromatic substances (toluene)) both as single substrates and as complex mixtures (more than five solvent components).		X
Membrane techniques	Application of membrane techniques in processes	Research was in progress at the pilot-plant- and a full-scale in several countries in Europe in 2008.		X
	Use of membrane bioreactor (MBR) for enhanced biological effluent treatment	The technique has been used at full-scale with success.	X	
Waste water treatment	Use of biofilm waste water abatement technique	No example plants with full scale implementation of this technology exist within the leather industry. However, the technique is used for effluent treatment in the food industry, the pulp and paper industry and the pharmaceutical industry.		
Use of enzymes	Use of enzymes in various process steps	The main problems associated with the application of enzymes in various process steps are: • lack of product knowledge on specific enzymes and innovative applications • lack of sufficiently pure preparations of enzymes • limitation in the activity range of currently used enzymes, especially with regard to the pH • risk of damaging the valuable grain surface enamel • enzymes are expensive and their benefits can be difficult to quantify.		
Waste treatment	Gasification of leather waste	A plant has been constructed and put into operation.	X	
	Biodiesel production from tallow from the leather industry	The technique has been tested in a pilot plant.		X

Leather Working Group Certification

The Leather Working Group (LWG)[155] was formed in April 2005 to promote sustainable and appropriate environmental stewardship practices within the leather industry. As part of this process, the LWG created a protocol to accurately assess the compliance and environmental stewardship practices of leather manufacturers. The group endeavours to promote improvement in the tanning industry by creating alignment on environmental priorities by bringing visibility to best practices and providing guidelines for continual improvement. It is the group’s objective to work transparently, involve tanners, brands, retailers and other relevant supply chain representatives, solicit input from leading centres of excellence within the leather industry, and utilize peer reviews from NGO bodies, academic institutions and other stakeholder organisations.

The number of LWG-certified tanneries is presented in the Table 34.

Table 34 : Number of awarded tanneries, by level and countries[156]

Country	*Gold*	*Silver*	*Bronze*	*Audited*
Argentina	2			
Australia	3	1		
Brazil	11	9	5	1
China	17	9	2	1
Dominican Republic	2			
Germany	3			
India	7	1	1	
Indonesia	2	1	1	
Italy	2	3		
Mexico	2		1	
Paraguay		1		
Saudi Arabia		1		
Slovakia	1			
South Korea	1	1	1	
Taiwan	1	12	6	
Thailand	2	2		
United Kingdom			2	1
Total	**56**	**41**	**19**	**3**

[155] http://www.leatherworkinggroup.com/

[156] http://www.leatherworkinggroup.com/ - LWG Rated Suppliers

Some stakeholders within the reference questionnaire mentioned the use of leather certified by "Leather Working Group" in their products. This certificate rewards tanneries with good environmental practices, according to three levels: Gold, Silver and Bronze. The main environmental areas audited are: restricted substances, energy consumption, air emissions, waste management, environmental management systems, water usage, processes (e.g., beamhouse, tanyard, post tanning finishing), and effluent treatment. One of three levels (golden (highest), silver, and bronze (lowest)) is awarded depending on score achieved for each criterion and the weighting procedure. Some tanneries are simply given the status "Audited" which means that the tanneries do not obtain a sufficient score to quality for a bronze medal rating.

In the last six years, the LWG has audited over 20% of the supply chain of footwear leather, representing over 2 billion square feet of material, which corresponds to slightly over 10% of global leather production. For auditing purposes, leather is split into seven categories. The main category is wet blue to finished leather, and in this category Europe has approximately 3.65% of the total leather audited against the LWG Environmental Stewardship Protocol[157].

Currently, there are over 140 member companies from 21 countries participating in the certification program, including 12 in Europe.

According to information presented by Adidas Group, approximately 79% of the leather used by the company originated from outside Europe from tanneries certified to Gold standard, around 20% was from Silver-certified tanneries, and about 1% was from Bronze-certified tanneries[158].

The Adidas report bases the environmental burdens of the products on percentage of turnover but not based on emissions levels. They provide data for the main environment stresses of the tannery industry:

- Waste Water
- Waste
- Energy
- Air Emissions
- Hazardous
- Certification

Chrome-free tanning

The chromium tanning process is the most commonly used worldwide, accounting for approximately 80-90% of the global leather production (BREF, 2013). The remaining leather is usually treated in vegetable, aldehyde or mineral tanning process. Because of its properties, vegetable leather is usually destined for the sole and hard leather production. It is important to mention that according

[157] Personal communication with a person from LWG in July 2013

[158] http://www.adidas-group.com/en/sustainability/Environment/Product_creation/Leather/

to the Leather Technology Centre (BLC)[159], vegetable leather production is not necessarily more sustainable than chrome-tanning, as specified in Task 3: Technical Analysis of the present document[160]. This is consistent with the BREF[161] findings which point out that vegetable tannins have the potential to degrade surface waters. Problems arise due to the low biodegradability of the vegetable tannins and their toxicity to aquatic life.

It is relevant to mention that an innovative pilot project involving chromium-free aldehyde tanning with oxazolidine[162] was conducted at a semi-industrial level; it showed that the resulting leather product is comparable in quality to that produced in a traditional chromium tanning process, but with some notable environmental benefits[163] :

- Increased biodegradability of waste water from the tanning process
- Prevention of harmful Cr VI emission. The sludge derived from waste water treatment may be used for agricultural applications
- Better biodegradability. Oxazolidine tanned leather is 43% more biodegradable than chrome-tanned, reducing the environmental impact of waste generated.

The European project "TiLEATHER, Eco-friendly Leather Tanned with Titanium" has been focussed on producing a titanium-tanned Sanotan® Leather characterized by a production process that reduces wastewater contamination and decreases energy and natural gas consumption by about 8%. The quality control tests on leather were designed to check certain properties requirements to meet the ecological criteria for the EU Ecolabel for footwear according to the Decision 2009/563/EC [164].This technology is used for 25% of INCUSA (Industrias del Curtido S.A.) production[165]. Two-hundred thousand m^2 of leather[166] has been produced using this technology, and this leather has been used to manufacture 1 million pair of footwear. The "Snipe 100", also made of Sanotan® Leather, is 100% compostable leather shoe[167].

It is important to stress that the experience of some other footwear brands such as Mandala Shoes[168], El Naturalista, Veja [169] and Legero group, among others, has also proven the feasibility of using chrome-free leather for footwear manufacturing.

[159] http://www.blcleathertech.com/

[160] According to (BLC - Leather Technology Centre): among others, vegetable leather requires twice as much water consumption but generates half as much waste. For other impact categories, results differ depending on the category. For more details, consult Task 3.

[161] (BREF - Tanning, 2013)

[162] LIFE08 ENV/E/140

[163] www.oxatan.eu

[164] www.tileather.eu

[165] http://www.euronews.com/2012/02/03/ti-my-shoes/

[166] 2.2 million square feet, according to the source

[167] http://www.snipe.com

[168] http://www.mandalashoes.com

Synthetic materials and rubber

Currently, conventional plastics and synthetic rubbers used in the shoe industry are almost entirely based on fossil raw materials. Worldwide, around 500,000 tons of polyurethane (PUR) are used annually for shoe soles production[170].

Bioplastics

Development of bio-based, high-quality polymers and material recycling are the main areas of research in this arena. There is also an observable trend toward returning to use of natural materials, such as cork and latex, for sole production.

Bioplastics are used in an increasing number of markets – from packaging, catering products, consumer electronics, automotive, agriculture/horticulture and toys to textiles and a number of other segments. Growing demand for more sustainable solutions is evident in the growing production capacities for bioplastics; worldwide production capacities in 2011 were approximately 1.2 million.

The main sector of bioplastics use is packaging (68%). Consumer products (including textiles and footwear) represent 5% of the global production. The production capacity of bioplastics in Europe in 2011 represented 18.5% of the global production[171].

Following this bioplastics trend, Bayer researchers have developed the "EcoTrekker" concept shoe, consisting of up to 90% of sustainable materials[170]. Oil-based raw materials have been replaced with renewables such as corn starch or by-products from the sugar industry. The production is done with the solvent-free coatings and adhesives as well as with materials made of thermoplastic polyurethane (TPU). In addition, the polyurethane soles contain no heavy metals to contaminate the waste residue after disposal.

The bio plastic bio-TPU (thermoplastic polyurethane) produced within the European Eco-Innovation Project is partially made of polyols synthesised from renewable sources, thus the bio-based content in the final product is between 45 and 75%. Taking into account the estimated production capacity at the end of the project (5,000 tons/year), the expected environmental benefits are the reduction of non-renewable energy demand by about 480 tons per year and the reduction of the global warming impact by about 25,000 tons CO_2 per year. This new bio-based family of plastics, with similar properties to those obtained using fossil resources, is already available on the market and it has been successfully used by some European footwear and footwear components manufacturers[172].

Despite efforts to use bio-based products and reduce wastes, recalcitrant plastic residue will continue to be deposited in landfills. To promote enhanced degradation of bio-plastics, EcoPure[173] --

[169] http://www.veja.fr

[170] http://www.research.bayer.com/en/23-green-shoe.pdfx

[171] http://en.european-bioplastics.org/press/press-pictures/labelling-logos-charts/

[172] http://www.ecotpu.eu

[173] http://www.goecopure.com/EcoPure/

a pellet mixture containing millions of tiny microbes -- is added to the plastic, rubber, and EVA[174] mixtures used for the midsoles and outsoles of the BIO-D collection of Simple Shoes. Under the temperature and moisture conditions common to landfills and compost bins, the biodegradation process takes on the order of twenty years and works in both anaerobic and aerobic conditions. Brooks use a similar innovation and sells shoes which contains Biomogo, a non-toxic, natural additive which accelerate microbial degradation of plastic in landfills. Biomongo incorporated into Brooks' EVA foam is projected to enhance degradation rates on the order of 50 times, which means complete degradation within 20-25 years instead of the current 1000-year projection.

Recycled materials

There are several examples of brands that integrate recycled materials (plastics or rubber) in their shoe production, especially for soles[175,176]. Nonetheless, exact data on the percentage of recycled plastics and rubber used in footwear present on the European market is not known. Some examples of common footwear retailers that sell footwear with recycled content are listed below:

- Blackspot (unknown %);
- Chaco (25% of recycled rubber);
- The North Face (40% of recycled rubber);
- Patagonia (up to 20% of recycled rubber);
- Teva (50% of recycled rubber).
- El Naturalista (unknown %)
- Ocean Minded (unknown % of recycled rubber for soles - 25% of post-industrial recycled foam for sandals)
- Soul Seekers Recycled (20% of recycled plastic and 10% of recycled rubber for the flip-flops)
- TerraPlana (70% of recycled PU)

One particular technique for incorporating recycled content into shoes involves producing soles from recycled tyres. This technique is used by the following brands:

- Noshu (60% of motorcycle tire rubber is mixed with natural rubber, made in Bali),
- Ocean Minded (uses automobile tire rubber, made in USA),
- Simple Shoes (uses automobile tire rubber, made in USA)

[174] Ethylene Vinyl Acetate

[175] The rate of recycled rubber varies depending on the brands and is indicated in brackets

[176] http://recycledreused.wordpress.com/2011/04/19/top-5-recycled-shoe-companies/

In their study comparing the economic benefits of using recycled tyres in their shoes versus using natural rubber (cf. Figure 31), Simple Shoes projected a 93% cost benefit on the purchase price of scrap tire compared to rubber sheet on a per pound basis [177].

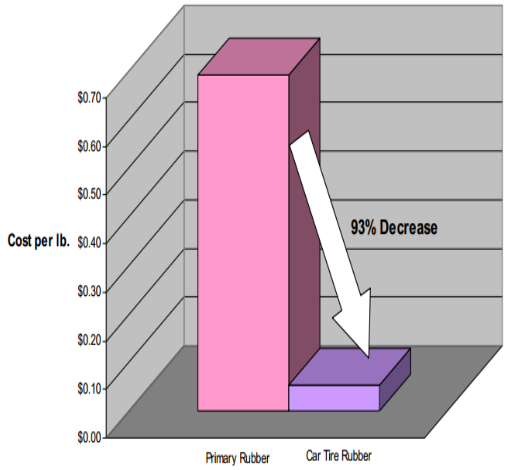

Figure 31: Economic costs reduction of using car tire rubber[178]

According to reRUBBER[179], using 1 kg of recycled rubber can save 1 kg of CO2 emissions compared to using 1 kg of synthetic rubber.

<u>Natural rubber</u>

Another practice is the use of more sustainable materials. According to Lafuma[180], replacement of a synthetic soles with a natural rubber sole and use of hemp instead of nubuck for the model Djebel Hemp (open shoes) reduces the environmental impact by 10% (based on environmental categories of eco-indicator 99).

Nike has designated the following as Environmentally Preferred Materials: Organic cotton, Recycled Polyester, and Environmentally Preferred Rubber. Table 35 presents Nike’s statistics for shoe pairs that contain some Environmentally Preferred Rubber (EPR), but the actual percentage of EPR used in the shoe compared to the other component materials is unknown.

177 See task 3 for more detailed on this LCA study

178 Simple Shoes, 2008

179 http://www.rerubber.com/environmental-impact/

180 http://ecoconception.files.wordpress.com/2008/06/lafumacas.pdf

Table 35: % of Nike Shoe Pairs containing some Environmentally Preferred Rubber [181]

Year	%
2006	50
2007	72
2008	66
2009	76

Nike also produces the Greenspeed football shoe, its best technical eco-innovation, which reduces CO_2 emissions by 35% compared to the standard football shoe. Below are some eco-innovations that contribute to this:

- use of eco-TPU (15% lighter than TPU);
- use 95% recycled polyester;
- use cutting optimization technology (less waste);
- use better chemicals management, thanks to a partnership with Bluesign[182].

Textiles

The main areas of eco-innovations related to the fabrics used in footwear manufacturing focus on use of more sustainable raw materials (mainly of natural origin) or recycled fibres (mainly polyester).

Organic labelling schemes

The Global Organic Textile Standard (GOTS) is the leading worldwide textile processing standard (also includes ecological and social criteria) for organic fibres and it is backed up by independent certification of the entire textile supply chain. GOTS was developed in 2002 by the Certifying Body consisting of The Soil Association (GB), the IVN- International Association Natural Textile Industry (Germany), the US Organic Trade Association and the Japanese Organic Cotton Association (JOCA)[183]. In May 2011, the US Department of Agriculture (USDA) released a Policy Memorandum confirming that textiles produced according to GOTS criteria may be sold as "organic" in the US.

In 2011, the GOTS logo was a registered trademark in approximately 80 countries, accounting for 2714 GOTS certified facilities. The standard covers processing, manufacturing, packaging, labelling, trading and distribution of all textiles made from at least 70% certified organic natural fibres. The final products may include, but are not limited to, fibre products, yarns, fabrics, clothes and home

[181] Nike, http://www.nikebiz.com/crreport/content/environment/

[182] http://nikeinc.com/news/nike-partners-with-bluesign-technologies-to-scale-sustainable-textiles

[183] http://www.global-standard.org

textiles. The standard does not set criteria for leather products. The key certification criteria for fibre *production* according to version 3 published in March 2011 can be identified as[184]:

- Organic certification of fibres is made on basis of recognised international or national standards (e.g. EEC 834/2007, USDA NOP).
- Certification of fibres under current supervision of a standard is possible if the applicable farming standard permits such certification.
- A textile product carrying the GOTS label grade 'organic' must contain a minimum of 95% certified organic fibres, whereas; a product with the label grade 'made with organic' must contain a minimum of 70% certified organic fibres.

Other criteria cover *processing* and the *manufacturing*, such as:

- All chemical inputs (e.g., dyes, auxiliaries and process chemicals) must be evaluated and meet basic requirements on toxicity and biodegradability/persistence,
- Restrictions for accessories are set (e.g., no PVC, nickel or chrome permitted; polyester must be post-consumer recycled from beginning in 2014),
- Wet processing units must keep complete records for chemicals use, energy and water consumption, and waste water treatment, including the disposal of sludge. The waste water from all wet processing units must be treated in a functional waste water treatment plant.

The Better Cotton Initiative (BCI) objective is to minimise the social and environmental impacts of cotton production worldwide by developing four specific goals[185]:

- Reduce the environmental impact of cotton production
- Improve livelihoods and economic development in cotton producing areas
- Improve commitment to and flow of Better Cotton throughout the supply chain
- Ensure the credibility and sustainability of the Better Cotton Initiative

BCI's ongoing activities focus on increasing the number of farmers (and producer organisations) who commit to growing Better Cotton, collecting and processing the vast amount of information that flows up from the producers, managing the monitoring and evaluation process, ensuring adequate penetration through the supply chain, and promoting and facilitating adoption of Better Cotton practices wherever cotton is grown.

Some of the 2012 goals of the Better Cotton Initiative were[186]:

- Have at least 15% of global cotton production represented BCI brand/retailer members.
- Have 1.3% of global cotton production produced as Better Cotton.

[184] GOTS, version 3.0.

[185] http://bettercotton.org

[186] http://www.solidaridadnetwork.org/what-we-do/cases/better-cotton-initiative-benefits-sector

- Develop a Better Cotton system in China and Central Asia.
- Globally, have at least 100,000 farmers producing Better Cotton.
- Demonstrate enhanced financial profitability for farmers producing Better Cotton.

Adidas, H&M, Nike, and Mark and Spenser are notable brands/retailers that are members of the Better Cotton Initiative.

In response to the current market/sustainability trends, Nike established a goal that all products released will contain a minimum 5% organic cotton. The data in the Table 36 were extracted from the last available corporate responsibility report covering the period 2007--2009.

Table 36: Evolution of organic cotton use rate in Nike's products[187]

	1999	2004	2005	2006	2007	2008	2009	2011 (target)
% of cotton apparel containing min. 5% organic fibre	22	47	47	52	76	83	86	100
% of cotton fibre used that is organic		2	4	5	7	10	14	
Organic cotton (tons)		975	1 745	2 645	4 306	6 436	9 603	

The target for 2011 was fixed according to the "Fast Track Program" of Better Cotton Initiative (BCI)[188].

Besides organic cotton usage, some brands like Ethletic promote cotton from fair trade, taking into account social aspects (similar approach is applied to natural rubber).

For Veja, the social aspect is the main principle of the brand, but it is also committed to using 100% vegetable-tanned leather. They also use organic cotton and natural rubber[189]. Furthermore, Veja's production capacity has to be adapted to the market availability of organic cotton, which may vary; this means that the quantity of organic cotton ordered by retailers reflects the amount of cotton harvested.

<u>Hemp</u>

According to the EIHA[190], greenhouse gas emissions related to hemp-based composites is 45 to 90 % of those for to petrol-based composites (not including the carbon stored in the hemp) and between 25 and 70 % if carbon storage is accounted for[191], as displayed in Figure 32.

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[187] http://www.nikebiz.com/crreport/content/environment/4-2-2-environmentally-preferred-materials.php?cat=product-design

[188] http://nikeinc.com/news/nike-roadmap-toward-zero-discharge-of-hazardous-chemicals

[189] http://www.veja.fr/#/projets/

[190] European Industrial Hemp Association: http://www.eiha.org/

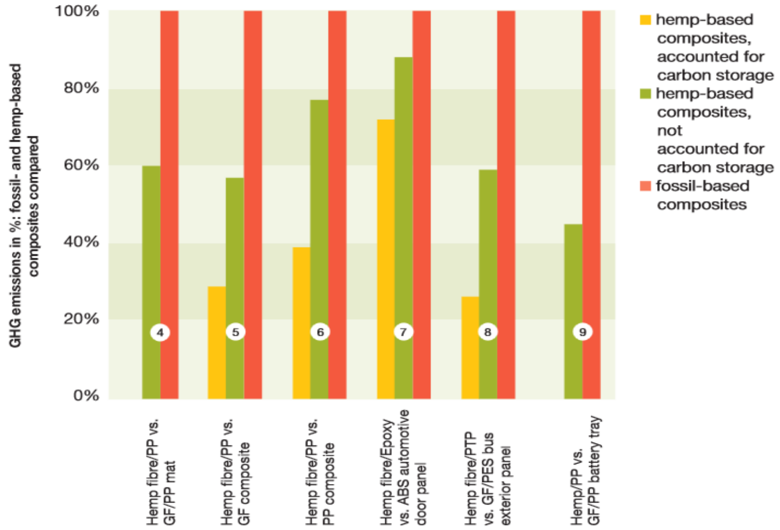

Figure 32: GHG emissions of hemp-based composite compared to fossil-based composites[190]

A significant number of brands (e.g., Blackspot Adidas; Lafuma; Reneu; Sole; Vans) use hemp instead of synthetic fibres to make their products more environmentally friendly. The percentage of hemp used in comparison with other types of fibres is difficult to evaluate. However, it is most probably a minor fibre on par with flax, which represents less than 1 % of the textile market[192].

Recycled Polyester

Use of recycled polyester in Nike's apparel has doubled between 2010 and 2011; in 2011, 31.5 million garments contained some recycled polyester. The material originated from more than 280 million of recycled PET plastic bottles[193].

The Table 37 presents the evolution of recycled polyester use by Nike.

Table 37: Evolution of recycled polyester use rate in Nike's products[194]

[191] Carbon storage refers to the carbon that has been captured by the hemp and is contained in it. This carbon may be released eventually (when the waste product is incinerated, or biodegraded)

[192] (Environmental Improvement Potential of Textiles (IMPRO-Textiles) , 2013)

[193] http://www.nikeresponsibility.com/report/content/chapter/materials

[194]http://www.nikebiz.com/crreport/content/environment/4-2-2-environmentally-preferred-materials.php?cat=product-design

	2004	2005	2006	2007	2008	2009
% of polyester apparel containing min. 5% recycled polyester	0	0.32	0.75	1.58	1.36	2.74
Recycled polyester as a % of total polyester	< 1	< 1	< 1	< 1	< 1	1.6
Recycled polyester (tons)		57.6	97.9	204.8	205.2	881

Since 2005, use of recycled polyester has steadily increased in Nike's production, increasing by a factor of 15 within the recent 5 years. In 2011, New Balance launched newSKY™ footwear, in part made from recycled PET bottles. This approach has also been implemented by Adidas, Patagonia, Terra Plana, H&M, Marks & Spencer, among others.

Adidas sponsored an LCA study by the University of Utrecht related to the possible environmental benefits that stem from usage of recycled polyester[195]. The results of the study indicate that recycled polyester fibres offer important environmental benefits over virgin polyester. Among other categories, achievement of natural resources and GHGs emissions savings by 40-85% and 25-75%, respectively. The study also shows that mechanically recycled polyester has a better environmental profile than its chemically recycled counterpart; however, the latter has a broader range of industrial applications. According to the GOTS criteria, version 3.0., beginning in 2014, any polyester used must be made from the recycled post-consumer waste[196].

Terra Plana and Worn Again[197] created footwear composed on 99% recycled materials coming from:

- Oxfam suits jackets,
- Prison Blankets,
- Military parachutes.

Textile EU Ecolabel

Key areas of best-practices related to textile processing which were identified in conjunction with the revision of the EU Ecolabel for textile are presented in Table 38 [198] [199] [200].

[195] http://www.adidas-group.com/en/sustainability/Environment/Archive/2010_recycled_polyester.aspx - (Utrecht University, 2010)

[196] GOTS, version 3.0.

[197] http://www.besportier.com/archives/terra-plana-jack-recycled-shoe.html

[198] (Revision of the European Ecolabel and Green Public Procurement (GPP) Criteria for Textile Products - Technical report and criteria proposals, 2013)

[199] (Environmental Improvement Potential of Textiles (IMPRO-Textiles) , 2013)

[200] (Revision of the European Ecolabel and Green Public Procurement Criteria for Textile Products - Preliminary report, 2012)

Table 38: Best practices specific to textiles

Life cycle phase	Innovation	Criteria proposed in the EU Ecolabel for textiles
Raw material use	Organic cotton	50 % of the cotton
	Cotton that is produced using less pesticides (for example, BCI) and less irrigation water	
	Polyester fibre with a recycled content, often at a very high % content	Staple fibres: 50 % Filament fibres: 20%
	Nylon fibre with a recycled content, although this is a relatively new area	20 %
Chemical use	Chemical management, often in the form of lists of restricted substances	RSL created for the EU Ecolabel
	A focus on substitutes for specific high profile chemicals and groups of substances	List of substitution and derogations
	A focus on residual chemicals in products and their potential effect of human health	-
Lifespan	Product repair and take-back initiatives in conjunction with remanufacturers	-
	Fabric treatments designed to reduce the need for washing and extend lifespan	8 fitness-for-use criteria (dimensional changes during washing and drying, colour fastness, fabric resistance to pilling and abrasion, durability of function)
Other	Supply chain auditing against environmental management standards	Two criteria are proposed in relation to CSR (ILO Core Labour Standards, restriction on sandblasting of denim)
	Auditing of sub-suppliers for non-compliance with social and ethical (CSR) codes of conduct.	

II. Management of chemicals and hazardous substances

Besides legal regulations on chemicals and hazardous substances (e.g., REACH, CLP), companies tend to use a specific Restricted Substances Lists (RSL) as internal policy addressing chemical risks reduction. According to the questionnaire results, most companies (~95%) use RSL, 55% of which use internally-derived RSLs. Some of the internal lists are confidential. The external list usually refers to REACH or national Regulation, CEN ISO TR 16178, or a third-party made-public RSL.

As a consequence of society’s rising environmental awareness, supported by legislative changes, there are existing global initiatives that promote better chemicals management, and elimination or limitation of the use of certain hazardous substances. In 2011, Adidas Group, C&A, G-Star, H&M, LiNing, NIKE, and PUMA made a shared commitment to help lead the industry towards zero discharge of hazardous chemicals (ZDHC) by 2020[201]. Called the ZDHC Group, they developed a joint roadmap that specifies the goals and timeframes of the initiative[202]. Important elements of the ZDHC Group’s commitment include the following:

- Conducting pilot projects at major, vertically integrated and materials suppliers between 2011 and 2013 to better understand scope of use and discharge of hazardous chemicals.
- Verifying that nine classes of hazardous or persistent chemicals are not currently used.
- Initiating an inventory of all chemicals used in apparel manufacturing by the end of 2012.
- Disclosing the results of all pilots and studies undertaken as part of this commitment.
- Reporting regularly and publicly on the group’s progress toward this commitment (quarterly in 2012, annually from 2013 to 2020).

According to the ZDHC website, there are currently a group of 13 major global apparel and footwear brands and retailers that committed to the ZDHC principles, mainly, Zero Discharge of Hazardous Chemicals. [203]

Apparel & Footwear International RSL Management Group (AFIRM)[204]

AFIRM is a global centre which provides resources for sustainable, self-governing RSL implementation across the apparel and footwear supply chain. All operators along the supply chain have knowledge about RSL and chemical safety, assuring that consumers and workers are safer from the impact of harmful substances and the environment is cleaner.

The group provides a forum to advance global management of restricted substances in apparel and footwear, communicates information about RSL to the supply chain, discusses concerns, and exchanges ideas for improving RSL management, to ultimately increase consumer satisfaction.

Nineteen groups and companies are members of AFIRM, including: Nike, Adidas, Puma, Hugo Boss, Levi Strauss & Co, American Apparel and Footwear Association, H&M, Inditex Group.

Sustainable Apparel Coalition[205]

The Sustainable Apparel Coalition is group of over 100 leading apparel and footwear brands, retailers, suppliers, non-profits, and NGOs working to reduce the environmental and social impacts of apparel and footwear products around the world.

The focus of the Sustainable Apparel Coalition is the Higg Index which measures the environmental performance of apparel products. The chemical performance of the product is checked by

[201] http://www.roadmaptozero.com

[202] http://about.hm.com/content/hm/aboutsection/en/About/Sustainability/Commitments/Use-Resources-Responsibly/Chemicals/Zero-Discharge/Action-Plan.html

[203] Last check, July 2013

[204] http://www.afirm-group.com/

[205] http://www.apparelcoalition.org/

application of the Higg Index 1.0, which is an indicator-based tool that enables companies to evaluate material types, products, facilities and processes based on a range of environmental and product design choices. The Index asks practice-based, qualitative questions to gauge environmental sustainability performance and drive behaviour for improvement. It is based largely on the Eco Index and Nike's Apparel Environmental Design Tool; however, it has been significantly enhanced through a pilot-testing period.

SG SchadstoffGeprüft" or "SG-label" Institutional

SG is a German label for low-pollutant leather products awarded only to those products that meet the stringent limit values and parameters for harmful substances set forth in the SG test criteria catalogue.

The limits for harmful substances such as carcinogenic dyes, formaldehyde, pesticides, PCP, heavy metals, etc., may not be exceeded by any certified product. These limits are often stricter than the legal requirements. Products may not emit strong odours or lose their colour due to friction or sweat. To be certified with the SG-SCHADSTOFFGEPRÜFT seal, products must undergo laboratory testing. Finished products bearing the seal may be tested at random to ensure continued compliance.

OEKO-TEX® Standard 100

The Oeko-Tex® Standard 100 is a private and independent globally uniform testing and certification system for textile raw materials, intermediates and end products at all stages of production. The system was established in 1992. Oeko-Tex® 100 does not address the whole life cycle, but instead focuses on harmful substances in the final product and the risks they may pose for end-users. Oeko-Tex® 100plus is also available for products that are manufactured at production sites that are certified with Oeko-Tex® 1000 (see next section). More than 9,500 manufacturers in more than 90 countries are approved and 95.000 product certificates have been issued.[206] This huge success is partly due to the fact that the Oeko-Tex® logo is well known in many European countries and some distributors tend to exclusively sell Oeko-Tex labeled textiles, e.g., the supermarket chain Lidl sells almost exclusively Oeko-Tex labeled clothing products. The Oeko-Tex® documentation and supportive testing is obtained by the end-product analysis.

OEKO-TEX® Standard 1000

To complement the product-related Oeko-Tex® Standard 100, the Oeko-Tex® Standard 1000 is a testing, auditing and certification system for environmentally-friendly production sites throughout the textile processing chain[207].

To qualify for certification according to the Oeko-Tex® Standard 1000, companies must meet stipulated criteria in terms of their environmentally-friendly manufacturing processes and provide evidence that at least 30% of total production output is already certified under Oeko-Tex® Standard 100 (e.g., avoidance of hazardous substances, optimization of energy consumption, among others).

[206] Ökotex-news 2/2011

[207] The approach is not specifically based on LCA

Licences cover spinners, dying houses and finishers. The number of current licences is approximately 60.

Bluesign System

The Bluesign® system was established in 2000 amongst an integrated international network of stakeholders with headquarters in Switzerland. The holistic approach of the Bluesign® system originally designated for the textile industry considers the entire production process by thoroughly auditing the components and processes used[208]. The dual goal of the so-called Input Stream Management component of this system is to ensure elimination of unsustainable substances before they enter the production cycle, and to produce products in an environmentally friendly and resource-efficient way, combining both to economic and ecological advantage. The criteria are based on the "Best Available Technology" concept and require a high level of safety for humans and the environment, and a high degree of sustainability for production.

The Bluesign® bluetool is a web-based application for evaluation of chemicals, dyestuffs and auxiliaries based on consumer safety and environmental criteria according to the Bluesign® standard substances list (BSSL). The Bluesign® Bluefinder allows manufacturers of textiles and accessories to conduct online searches for Bluesign® approved chemical products. The Bluesign® Bluefinder is provides the preferred list of safe chemicals, dyestuffs and auxiliaries for the textile industry. With Bluefinder, a supplier can access pre-screened and more sustainable textile preparations (dye systems, detergents and other process chemicals used in the manufacturing process). The Bluefinder enables suppliers to effectively manage restricted substances and provides the opportunity to increase water and energy efficiency.

NIKE announced a strategic partnership with the Swiss company Bluesign Technologies to accelerate the supply of sustainable materials and chemicals used. The Bluesign tools will be rolled out across NIKE's global supply chain, which spans nearly 50 countries and more than 800 contracted factories[209].

ShoeLaw Platform

Environmental Legislation among European Footwear Industries Platform (ShoeLaw[210]) was launched within the framework of the European Union LIFE+ programme.[211] According to the project information, nowadays, the European SME companies consisting of 10-20 workers operate within a "business culture" framework that does not consider long-term strategic planning for environmental activities. Therefore, the project goal was to develop an IT industry self-diagnosis tool to improve the environmental standards and the level of legislative compliance within the footwear production process of each individual company.

[208] www.bluesign.com/

[209] http://nikeinc.com/news/nike-partners-with-bluesign-technologies-to-scale-sustainable-textiles

[210] www.shoelaw.eu

[211] LIFE08 ENV/E/000147

Based on a process which involved an initial round of self-diagnosis follow by individual advisory and second-round check, 40 selected companies achieved 6% overall environmental legal compliance improvement, as shown on Figure 33[212].

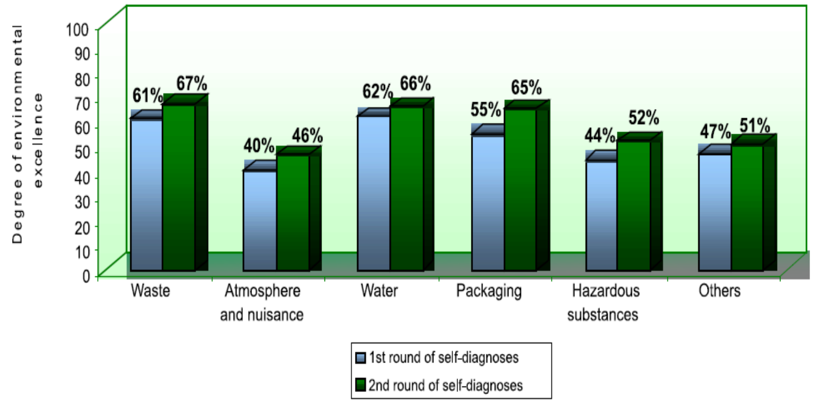

Figure 33: Evolution of the environmental performance of the companies within ShoeLaw project

III. Footwear assembling

Table 39 presents examples of environmental eco-innovations in the footwear production process.

There are several examples of environmental impact reduction during the shoe production process, e.g., Mandala shoes[213] claim to achieve leather gloss by polishing with a skittle shaped glass, and the lubrication is accomplished with vegetable waxes and fat. The main production-related eco-innovation activities may be grouped as:

- Optimization of assembly to reduce the quantity of raw materials
- Assembly modification to eliminate unwanted substances (solvent replacements)
- Promotion of end-of-life separation (use of seams)
- Promotion of waste recovery and recycling

According to Tatàno et al. (2008)[214], specific footwear waste production estimates from the sector Italian Marche Region indicates that, on average, more than 13,100 tonnes of shoe manufacturing wastes are produced annually. Therefore, the waste management system should encompass disposal of the final product and waste from the production.

[212] http://www.shoelaw.eu/imagenes/noticias/shoelaw_laymans_report_eng.pdf

[213] http://www.mandalashoes.com/anterior/ingles/info.html

[214] Tatàno F, Acerbi N, Monterubbiano C, Pretelli S, Tombari L, Mangani F. Shoe manufacturing wastes: energy characterisation and emissions from combustion tests. In: Cossu R, Diaz LF, Stegmann R, editors. Proceedings "Venice 2008, 2nd international symposium on energy from biomass and waste". Italy: CISA (Environmental. Sanitary Engineering Centre.Publisher; 2008.

Table 39: Optimisation of assembling and VOC emissions reduction

Technique	Examples and results	Source
Reduce VOC emissions by using solvent-free pressure systems	The Bulgarian shoe manufacturer Valeo noted that the production of its goods resulted in the release of over 60 tonnes of VOCs per year. By incorporating modern filtration units, training staff and the precise observation and documentation of the entire production processes, VOC emissions were reduced by 70 percent. The extensive investments of the company paid for themselves quickly. Thanks to modern equipment, Valeo saved around 50,000 euros a year in operating costs. In addition, thanks to regular training, most of the workforce is able to respond rapidly to and resolve environmental problems that arise.	(Umwelt Bundes Amt, 2011)
Reduce VOC emissions by using hot-melt adhesives or water-based adhesives	Hanwag (producer of alpine shoes) has managed to lower VOC emissions by up to 40% by using dispersion adhesives in the gluing of bindings and employing pre-coated materials.	(Umwelt Bundes Amt, 2011)
Reduce VOC emissions by using seams in lieu of glue	El Naturalista and Po Zu use this technique to avoid glues; this allows for better isolation of different materials during the end of life phase.	www.elnaturalista.com
Use of water-based finishes (polishes, creams, waxes, dressings, varnishes) or finishes with reduced VOC content	Simple Shoes uses water-based glues instead of solvent-based glues[215]. The following brands also use water-based glues: OTZ Shoes, OceanMinded, Vans, Legero group.*	www.footsolutions.com/ www.oceanminded.com www.eco-coach.com Stakeholder questionnaire
Direct injection of soles or sole components using thermo-plastic elastomers	Shoe manufacturers have been able to reduce their solvent emissions from approximately 60 g/pair to approximately 15–20 g/pair, with the simultaneous rationalisation of work stages.	(Umwelt Bundes Amt, 2011)
Optimisation of cutting and assembling	Reduces the production of raw materials used and the amount of wastes. Introduction of recovery system from waste generated during the footwear assembly. Reuse and recycling. Loints of Holland use simple designs in order to minimise consumption of glues.	(Umwelt Bundes Amt, 2011) www.lointsofholland.com

IV. Packaging

Most brands consulted optimise their packaging by reducing its size and the weight, and by the using 100% recycled and recyclable materials. Some also use 100% recycled paper or bio-plastics as shoe box fillers.

[215] Simple Shoes, 2008 (cf. Task 3)

For example, Jambu, Groundhog Shoes and Inditex Group, among others, use 100% recycled and recyclable packaging for their products. Additionally, the external secondary packaging of Inditex Group forms part of the closed-loop take-back scheme[216]. Puma developed a reusable bag which consumes much less material/fuel/water than the traditional shoes box (65% less cardboard and 60% decrease in manufacturing-related fuel and water)[217].

Figure 34 : Puma eco design packaging[217]

Puma commissioned an LCA to compare the current packaging systems[218] with the Puma's eco-innovative packaging called the "Clever Little Bag"[219] (represented by Figure 34) and another eco-design option (pulp box and polymer bag). This study highlighted that the Clever Little Bag has about half the overall impact of the current solution in many impact categories (e.g., primary energy, climate change, acidification, eutrophication potential, and photochemical ozone formation)[220].

V. End of life

In Europe, it is estimated that the amount of waste arising from postconsumer shoes could reach 1.2[221]-1.5[222] million tonnes per year. The sector industries contribution accounts for another 90,000 tonnes of waste derived from by-products and process rejects[223].

[216] Personal communication with a person from Inditex

[217] http://www.fuseproject.com/

[218] Classic shoe box made of 100% recycled material and stuffing paper

[219] Design option consisting of a non-woven polymer bag and a paperboard piece ("bone") providing stability and separating the shoes

[220] http://www.puma.com/pdfs/lca-report.pdf

[221] Michael James Lee, M.J., Rahimifard, S. 2012. An air-based automated material recycling system for postconsumer footwear products. Resources, Conservation and Recycling 69, pp 90– 99

[222]http://www.eco-naturalista.eu

Footwear appears to be one of the key recycling targets of the future, considering that around 95 % of the shoes purchased end up in the municipal waste stream[224]. Nonetheless, footwear recycling and material recovery efforts continue to be hindered by (1) lack of well-established recovery systems and (2) incorporation of a variety of materials and chemical compounds into the same product that make possible recycling technology extremely challenging.

Establishment of municipal footwear segregation system appears to be the most effective way to increase the feasibility of reusing and recycling old shoes. The Centre for Sustainable Manufacturing and Reuse/Recycling Technologies (SMART) at Loughborough University investigated possible options to minimise the environmental impact of footwear waste and they proposed several viable options for footwear waste management, as present in Figure 35.

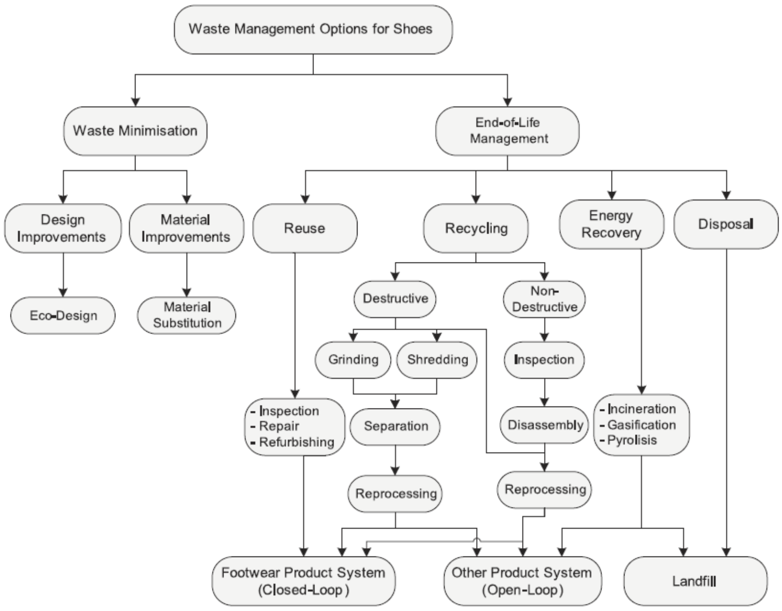

Figure 35: Different options for footwear waste management proposed by Loughborough University[225]

In this sense, the ICO AG Take-Back System (a part of SOEX Group) represents a closed-loop product cycle for textiles and shoes. Collections of used shoes and textiles are brought to sorting centres, where their fate as second-hand products or recycled materials is determined.[226]. PUMA's "Bring me back" recycling programme was established in collaboration with ICO System. Approximately 2% of collected products that are too soiled for recycling or reuse, are incinerated [227]. Approximately 10%

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[223] http://www.eco-naturalista.eu

[224] Fry, C. (2010). Shoe recyclers aim to kick the landfill habit. Engineering and Technology magazine, 18 October 2010. Available at: http://eandt.theiet.org/magazine/2010/16/shoe-recyclers.cfm

[225] Staikos, T. & Rahimifard, S. (2007) Post-consumer waste management issues in the footwear industry. Journal of Engineering Manufacture 221 pp. 363- 368

[226] http://www.ico-spirit.com

[227] www.puma.com

of the collected second hand shoes are not suitable for reuse due to their condition, and consequently end up in landfill[228]. Using another approach, Marks and Spencer, offers a £5 off voucher at M&S stores to individuals who bring used M&S clothes, shoes and bags to the Oxfam Shop.[229] United Shoe Recycling Company has adopted a similar approach[230].

Using an organized textile network and a slightly more comprehensive approach, in 2011 the Cáritas Chavicar Foundation in cooperation with El Naturalista within the framework of the European Eco-innovation project in 2011 gathered 3.918 tons of waste consisting of paper, cardboard, textile, footwear, electronic waste, and furniture. Recovered footwear was designated for reuse or recycling[231].

Lee et al[232] studied the potential for development a material recycling process for mixed post-consumer footwear waste. The process consists of using a mechanical grinding process to facilitate material recovery and incorporating the salvaged material into a variety of applications such as surfacing materials, insulation boards and underlay products. The footwear industry will also be able to use the salvaged materials to make new soles and insoles.

Some brands such as Nike and El Naturalista have also implemented shoe recycling programs that involves bringing the used shoes to designated shops, where a decision is made to either recycle or compost them or by sending with an objective to either recycle them or compost them. More than 12,000 pairs of shoes with recycled insoles have been sold through El Naturalista project[233].

Nike's program called "Reuse a Shoe" consists of recovering shoes destined for the trash heap to make secondary raw materials for new shoes or other products such as sports surfaces. Since the program was established in 1990, more than 23 million of pairs of shoe have been recycled, contributing material to 320 sports surfaces.

Another approach taken by some companies is to use biodegradable materials in shoe construction. For example, Legero group uses biodegradable shoe outsoles[234]. El Naturalista has its program called recycle-it-yourself (RYF), where manufactured shoes are composed of natural materials and dyes which pose *de minimus* threat to the environment. The consumer can separate the shoe into compostable components and compost these components along with natural compost.

[228] Rahimifard, S., Staikos, T., Coates, G. (2007). Recycling of footwear products. A position paper prepared by Centre for Sustainable Manufacturing and Reuse/recycling Technologies (SMART). Loughborough University.

[229] http://plana.marksandspencer.com/about/partnerships/oxfam

[230] www.unitedshoe.co.uk/

[231] http://www.caritas.es/noticias_tags_noticiaInfo.aspx?Id=5819

[232] (James Lee et al., 2012)

[233] http://www.eco-naturalista.eu

[234] Personal communication with a person from Legero group

Puma calculated that 31 waste disposal trucks are required to transport to treatment plant 100 thousands pairs of conventional PUMA Suede sneakers, while only 12 trucks are required for 100 thousands pairs of InCycle Puma because they end up in an industrial composting facility system[235].

Figure 36 shows the different stages of the biodegradation process of the PUMA InCycle Basket lifestyle sneaker.

Figure 36 : Different stages of the biodegradation process of the PUMA InCycle Basket lifestyle sneaker[236]

The boot manufacturer, Kamik invites owners who no longer need their boots to give them at their entourage or associations, before to send them at Kamik which put in places sites where the boots can be collected and then sent for recycling. Kamik makes over two million 100% recycled boots per year[237].

Birkenstock encourages their customers to repair shoes. The brand website contains information regarding local shoe repairers.

Some products are designed specifically to facilitate recycling. Following the Think philosophy of the modular trainer designed by Ben Chappell. In order to make the different parts of this shoe easier to separate at the end of life, as shown on the Figure 37, the shoe consists of five independent modules made of recyclable material and these can be easily separated and replaced. No adhesives are used in the footwear assembly, being replaced by mechanical locks instead[238].

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[235] http://about.puma.com/new-puma-shoe-and-t-shirt-impact-the-environment-by-a-third-less-than-conventional-products/

[236] http://about.puma.com/puma-introduces-biodegradable-and-recyclable-products/

[237] http://www.kamik.com/kamik_spring11/en/recycle.shtml

[238] http://www.yankodesign.com/2007/07/25/fully-modular-recycable-trainer/

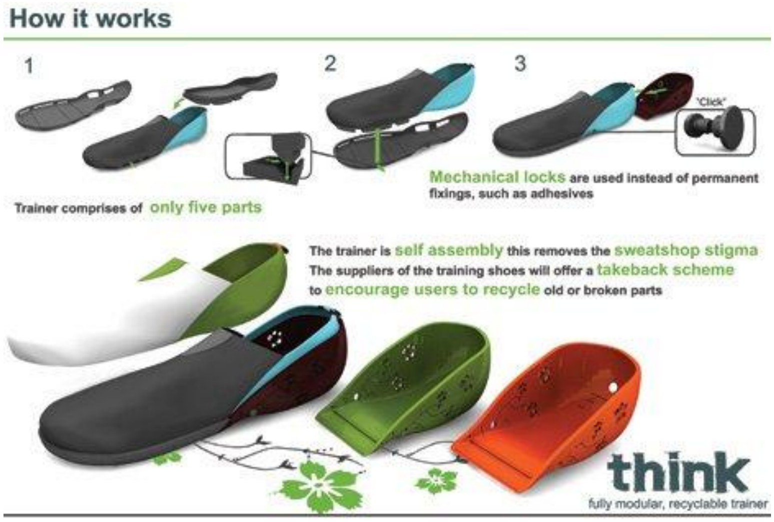


Figure 37: Think concept of modular footwear

2.6.5. Eco-innovations per brand

I. Summary table

Table 40 and Table 41 present a non-exhaustive list of environment innovations that have been applied by different footwear brands and related industries. The information was gathered from brand websites, annual or environment and sustainable development reports, questionnaires, and personal communications with registered stakeholders.

Table 40: Best-practices per footwear brand[239]

Market segment	Brand	Use of materials of reduced environmental impact	Use of recycled materials	Assembly optimisation	Minimizing VOC emissions	Hazardous substances management	End of life management
Ballet shoes	Reneu: www.reneushoes.com/	X	X				
Boots, sandals (man, woman, children)	Kamik: www.kamik.com	X	X				X
Mainly flip-flops (men, women)	OceanMinded: www.oceanminded.com	X	X		X	X	
Sandals	Chaco Hipthong Ecotread:		X				
Sandals	Lafuma: www.lafuma.com/	X					
Sandals, town footwear	Noshu: www.noshufootwear.com/	X	X				
Sandals (men, women)	Teva Lennox Sandals		X				
Sandals, town footwear (man, woman, child)	Woodland (Pro Planet): www.woodlandworldwide.com/proplanet	X	X		X	X	
Football shoes – Sport / Sneakers	Nike: www.nike.com/	X	X			X	X
Sneakers	Blackspot: https://www.adbusters.org/campaigns/blackspot	X	X				
Sneakers	Brooks: www.brooksrunning.com	X	X			X	X
Sneakers	Veja: www.veja.fr	X	X			X	
Sneakers	New Balance : http://www.newbalance.com/	X		X		X	X

[239] Empty spaces mean that no specific information was found, however it should be noted that the table may not be exhaustive for all brands and respective best practices

Market segment	Brand	Use of materials of reduced environmental impact	Use of recycled materials	Assembly optimisation	Minimizing VOC emissions	Hazardous substances management	End of life management
Sport / sneaker	Adidas: www.adidas.com/	X	X	x			
Sport / sneaker	Puma: www.puma.com	X		X		X	X
Sports	Ethletic: www.ethletic.de	X					
Leather footwear	Pikolinos: www.pikolinos.com/					X	
Town footwear (man, woman, children)	Birkenstock: www.birkenstock.de	X					
Town footwear (woman)	Charmone: www.charmoneshoes.com	X	X			X	
Town footwear (man, woman)	El naturalista: www.elnaturalista.com	X	X			X	X
Town footwear (man, woman, children)	Jambu: www.jambu.com/	X	X				
Town footwear (man, woman)	Josef Seibel: www.josef-seibel.com		X	X		X	
Town footwear (man)	Keen Ventura: www.keenfootwear.com	X					
Town footwear (man, woman)	Loints of Holland: www.lointsofholland.com				X	X	
Town footwear (woman)	Mohop: www.mohop.com	X	X				
Town footwear (man, woman)	OTZ Shoes: www.otzshoes.com	X		X		X	
Town footwear (man, woman)	Patagonia: www.patagonia.com/footwear	X	X			X	
Town footwear (man, woman)	Po Zu: www.po-zu.com/	X	X	X	X	X	
Town footwear (man, woman, children)	Simple Shoes: http://www.simpleshoes.com/	X	X				

Market segment	Brand	Use of materials of reduced environmental impact	Use of recycled materials	Assembly optimisation	Minimizing VOC emissions	Hazardous substances management	End of life management
Town footwear (man, woman)	Sole: http://www.yoursole.com/us	X	X			X	
Town footwear (man, woman, children)	The North Face: www.thenorthface.com	X	X				
Town	Timberland (Earthkeepers): www.timberland.com	X	X			X	
Town footwear (man)	Vans: www.vans.com	X			X		
Town footwear (woman)	Zoe & Zac: www.zoeandzac.com	X	X			X	
Town	Inditex Group (TEMPE) : www.inditex.com/	X		X	X	X	
Town	Terra Plana : http://terraplana.com.au/	X					X

Footwear sector-related industries that produce different footwear components for final assembly were also addressed via web-site checks or personal communications. This survey information is summarized in Table 41. According to the information gathered within this section, the activities adopted to improve environmental performance of production can be classified in six main categories:

- Use of more sustainable materials
- Use of recycled materials
- Assembly optimisation
- Limiting VOC emissions
- Minimizing hazardous substances
- End of life management

Table 41: Eco-innovations for related industries

Brand	Market segment	Use of better materials	Use of recycled materials	Assembly optimisation	Limiting VOC emissions	Minimizing hazardous substances	End of life management
Ecopell	Tanner					X	
Texon	Diverse raw materials		X				
Mucos Kork	Soles	X				X	
Amann LifeCycle Threads	Production of threads for sewing	X	X				
Tencel (Lenzing)	Spinning					X	

II. Market penetration

Some figures are presented within this report, but more global figures are not available or difficult to collect. A lot of brands communicate on their eco-innovative activities, but they generally do not provide substantiating numerical data, mainly for reasons related to confidentiality. Hence, this make it impossible to evaluate accurate data regarding application of industry best–practices application, such as quantity of recycled materials, use of organic fibre, and environmental benefits reflected on the European market scale.

3 Task 3: Technical Analysis

3.1 Objectives

The general aim of this task is to assess the environmental impacts of footwear in a way that allows identifying the areas with the highest improvement potential. Relevant non-environmental impacts (e.g., health-related issues) need to be assessed as well.

This task aims at investigating the environmental performance of footwear product group as characterized in the previous tasks. This includes three elements:

1. Literature review: Literature regarding the environmental assessment and improvement potential of the product group are reviewed; results are compared and critically assessed regarding robustness of the results (methodology, data quality, age, etc.).
2. Analysis of the environmental impacts of footwear along the life-cycle is performed based on collected data and other available data, standards, and tools. Wherever possible, the methodological guidelines provided by the Product Environmental Footprint (PEF) are followed. The assessment is performed in a way that is representative for the scope of the product group as defined in the previous tasks. Additional data collection has been proposed to the registered stakeholders in order to increase the reliability and relevance of the results.
3. Identification and assessment of environmental impacts which are not detected through standard LCA tools, or non-environmental impacts of relevance (e.g., health related issues). This is done through regulation and literature reviews, and stakeholder dialogue. Specifically, a discussion is included on hazardous substances and the potential to substitute them with safer components or via the use of alternative materials or designs, wherever technically feasible, particularly with regard to substances of very high concern referenced in Article 57 of the Regulation (EC) No 1097/2006 (REACH).

3.2 LCA literature review

3.2.1. Identification of LCA and LCA-related studies

The scientific publications and other literature sources related to footwear sector have been considered to set up the framework for the analysis of the environmental performance of the product group under revision. Consequently, all major LCA or LCA related sources were examined, such as:

- International Journal of LCA,
- Environmental Product Declaration (EPD) available on the GEDnet and Environdec platform,
- Environmental Impact Assessment Review,
- Federation websites,
- Seeds4green platform
- Product Category Rules (PCR)
    - The BPX 30-323-1 is a PCR for footwear being developed by the ADEME-AFNOR in the framework of the French environmental labelling, in application of the law “Grenelle de l’environnement”.
    - Two PCR of relevance are available in the framework of the International EPD System®[240]:
        - Bovine leather (published)
        - Footwear (final draft)
- Papers and reports on environmental assessment of footwear with the special attention paid to the eco-design principles
- Papers and Reports focused on a specific footwear life cycle stage (e.g., tannery)

The research focused on footwear, however, in order to supplement the information on the variety of materials used, special attention was paid to the original proposal of the scope extension to other leather products, supported by the fact that leather is one of the main materials used for footwear manufacturing as specified within Task 2: Market analysis. There are several studies that do not analyse footwear itself, but rather, focus on specific lifecycle stages or Eco design in order to improve environmental performance of the shoe sector. The list of LCA and LCA-related studies analysed is specified in Table 42. The reported studies were sorted according to their relevance to the footwear LCA.

In addition to the abovementioned literature review, supported by EPDs and PCRs, the following standards and documents has been considered as being highly relevant:

[240] International EPD Consortium: www.environdec.com

- The ISO 14040, Environmental management - Life cycle assessment, describes the principles and framework for life cycle assessment (LCA) including: definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, the relationship between the LCA phases, and conditions for use of value choices and optional elements.
- The ISO 14044 - Specifies requirements and provides guidelines for life cycle assessment (LCA) including: definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, relationship between the LCA phases, and conditions for use of value choices and optional elements.

  All the studies considered within this review are performed in accordance with the ISO 14040-44 standards.
- The **ILCD Handbook,** developed by the European Commission and providing a series of guidelines on how to perform an LCA study. These are consistent with the Standards ISO 14040-44 and have been established through extensive public consultation of stakeholders.
- The Product Environmental Footprint (PEF) is being developed by the European Commission in order to harmonize LCA practices in Europe. **This standard will be followed as much as possible for the specific LCA.**
- The European Food Sustainable Consumption and Production Round Table developed a framework assessment methodology for the environmental assessment of food and drink products (ENVIFOOD Protocol). They are currently testing this methodology through pilot studies.
- The paper from UNIDO reviewing the methodologies and made recommendations for harmonization in the Life Cycle Assessment/Carbon Footprint in the leather processing.
- The European Commission, Best Available Techniques (BAT) Reference Document for the Tanning of Hides and Skins, Final Draft, 2013.
- The Preliminary background report for the revision of EU Ecolabel criteria for other product groups (e.g., Textiles).

References to those documents will be made. Standards such as PAS 2050, and WRI/WBCSD were not taken into account because they are viewed as being mono-criterion (i.e., they only consider climate change).

Table 42: LCA and LCA-related literature

#	Title	Type of document	Quantitative results [241]	Author	Time	Geography
1	Life Cycle Analysis of leather	LCA study	X	BLC (Leather Technology Center)	2007	International
2	LCA of Italian and Spanish bovine leather	LCA study	X	BRUNO et al.	~ 2006	Italy, Spain
3	Material flows in the life cycle of leather, Journal of Cleaner Production	LCA study	X	Center of Environmental Studies	2009	India
4	Manufacturing-focused emissions reductions in footwear production	Carbon footprint	X	Cheah et al.	2012	International
5	Simplified Life Cycle Assessment - Hot Spot Identification in the Leather Production Chain	Hot spot identification	X	CPI (Cleaner Production Institute)	2009	Pakistan
6	Leather for clothing, upholstery, footwear, leather goods, accessories and interior design	EPD	X	DANI	2011	Italy
7	Sustainable and safe design of footwear integrating ecological footprint and risk criteria	Environmental footprint and risk assessment	X	Herva et al.	2011	Spain
8	Life Cycle Assessment Of Glove Leather In Elico-Gloving And Hide Unit	LCA study	X	Kebede Bekele	2007	Ethiopia
9	Application of Life Cycle Assessment to Footwear, International Journal of LCA	LCA study	X	Milà et al.	1998	Spain
10	Use of Life Cycle Assessment in the Procedure for the Establishment of Environmental Criteria in the Catalan Eco-label of Leather	LCA study	X	Milà et al.	2002	Spain
11	Sustainability Assessment of Nike Shoes	Environmental assessment of materials	X	NIKE	2010	International
12	Life Cycle Assessment as a Tool for the Environmental Improvement of the Tannery Industry in Developing Countries, Environ. Sci. Technol. Journal	LCA study	X	Rivela et al.	2004	Latin America
13	Analyzing the Environmental Impacts of Simple Shoes	LCA study	X	University of Santa Barbara, California.	2008	US
14	Environmental Improvement Potential of Textiles (IMPRO-Textiles)	LCA and improvement potential	X	JRC-IPTS	2012	Europe
15	Principes généraux pour l'affichage environnemental des produits de grande consommation: Partie 1 : Méthodologie d'évaluation des impacts environnementaux des chaussures	PCR		ADEME	2010	France

[241] "X" means that the study provides a quantitative Life Cycle Assessment

#	Title	Type of document	Quantitative results 241	Author	Time	Geography
16	Finished Bovine Leather (*PCR for footwear in progress*)	PCR		International EPD System	2011	-
17	Leather Footwear	PCR		International EPD System	2013	-
18	MEAT AND DAIRY PRODUCTION & CONSUMPTION Exploring the livestock sector's contribution to the UK's greenhouse gas emissions and assessing what less greenhouse gas intensive systems of production and consumption might look like	Working paper		Centre for Environmental Strategy University of Surrey	2007	UK
19	Survey and health assessment (sensitisation only) of chromium in leather shoes	Health assessment		EPA	2011	Denmark
20	GHG emissions from animal food chains - Development of a quantification model using Life Cycle Analysis method	Tool and assessment	X	FAO	2010	International
21	Recent Developments in Cleaner Production and Environment Protection in World Leather Sector	Paper		IUE	2008	International
22	Life Cycle Assessment/Carbon Footprint in the Leather Processing; Review of methodologies and recommendations for harmonization	Literature review		UNIDO	2012	International

3.2.2. Screening of the quality of LCA studies

In order to rationalize the LCA literature analysis and to draw conclusions from it, the following quality assessment methodology was used, as indicated in Figure 38.

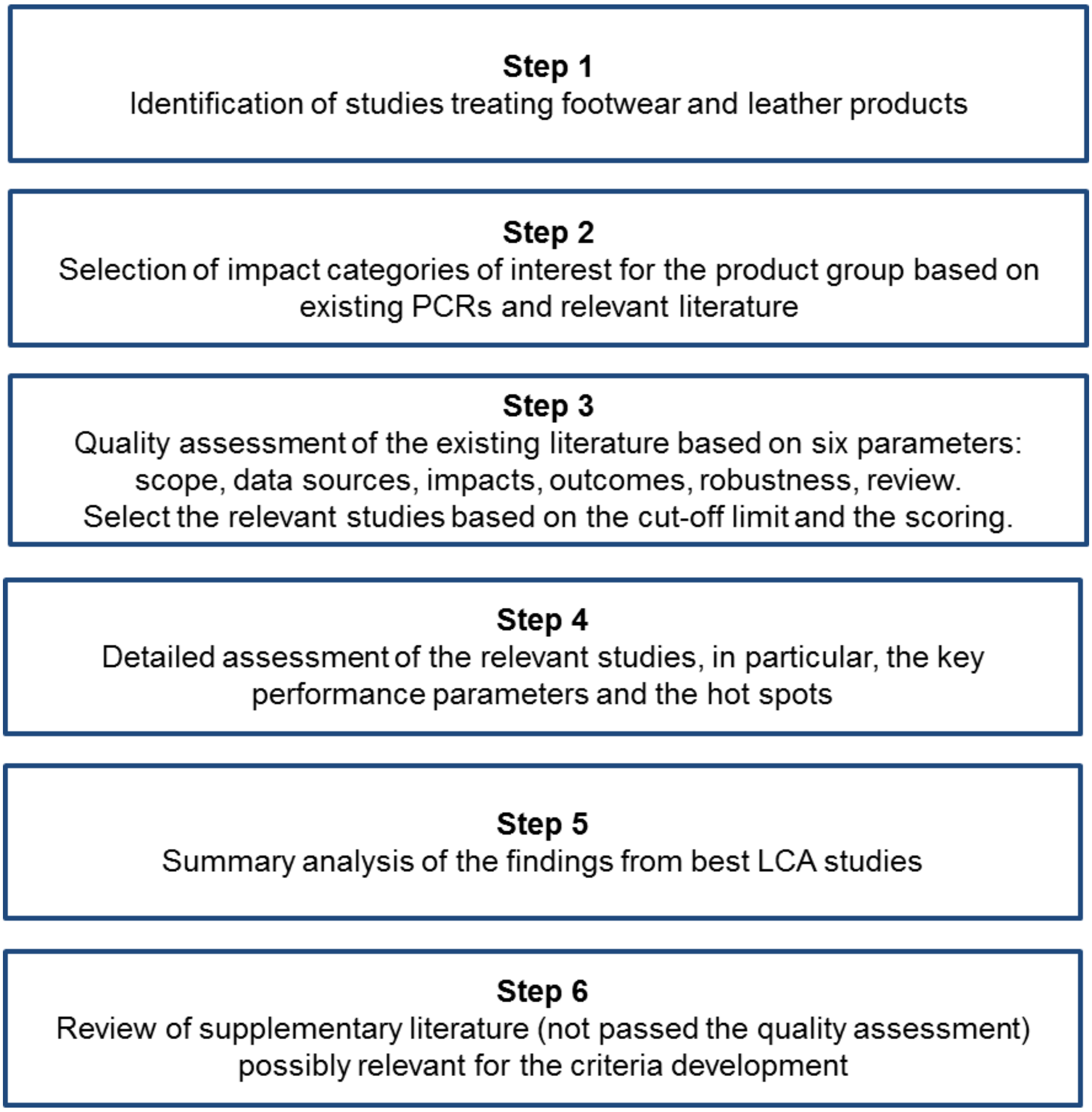


Figure 38: Methodology for the LCA literature assessment

Because of diversity of the studies analysed, the functional units and the system boundaries[242] will differ depending on the product under study and the specific objective.

From preliminary review of 22 papers of plausible relevance to the environmental impact of footwear, 13 studies (numbers 1 through 13 according to Table 42) have been further analysed because they assess quantitatively environmental impacts of footwear or leather.

The other nine studies have been classified as falling beyond the scope of the current LCA review because they do not fulfil at least one of the following cut-off principles:

- They do not provide quantitative results and/or
- They do not specifically focus on leather products or footwear.

More specifically, studies 14 (IMPRO-Textiles, 2013) and 20 (FAO, 2010) have not been analysed because they focus on textiles and animal food chains, respectively.

The studies selected for further assessment and presented in the Table 42 (studies 1 through 13) assess:

- Leather as an intermediate material (7 out of 13),
- Footwear using leather as the main material (4 out of 13),
- Footwear using different materials: leather, textiles, and synthetic materials (1 out of 13),
- Footwear using synthetic materials (1 out of 13).

In order to complete the information gathered from the literature, a specific LCA will be performed for the purposes of the EU Ecolabel revision (see chapter 3.3).

3.2.3. Impact categories of interest

The ILCD Handbook and the PEF guideline recommend analysing 14 impact categories each related to a different environmental area (see Annex V for the list). For the purposes of the current study, the aim is to identify a narrower set of impact categories relevant to footwear and related materials. This is done with the support of appropriate documents, such as:

- Existing PCRs
    - The BPX 30-323-1 is a PCR for footwear being developed by the ADEME-AFNOR in the framework of the French environmental labelling, in application of the law “Grenelle de l’environnement”.[243]
    - Two PCRs of relevance are available in the framework of the International EPD System®[244]:

[242] As mentioned in the ILCD Handbook, functional unit is a central element on LCA. Without it a meaningful and valid comparison of product is not possible. The system boundaries must also be equivalent to make fair comparison possible (see more detail in the additional LCA chapter 3.3)

[243] No 15 in Table 42

[244] International EPD Consortium: www.environdec.com

  - Bovine leather (published)[245]
  - Footwear (final draft)[246]
- Existing LCA literature.

The impact categories recommended by the reported PCRs are presented in Table 43:

Table 43: Impact categories and impact assessment methods from the PCRs

Impact categories	PCRs from EPD (leather and footwear)245-246	BP X 30-323-1 (footwear)243
Climate change	IPCC[247]	IPCC 2007
Ozone depletion	Solomon & Albritton, 1992, in Nordic Guidelines on Life-Cycle Assessment, Nord 1995:20, Nordic council of Ministers, Copenhagen	
Acidification	CML (Guinée et al., 2002)	
Photochemical ozone formation	CML(Guinée et al., 2002)	
Eutrophication	CML (Guinée et al., 2002)	EUTREND model (Struijs et al, 2009b) as implemented in ReCiPe
Resource depletion		EDIP 97 (2004) - Hauschild and Wenzel, 1998a-update 2004

Even if EPD does not strictly include resource depletion as an impact category under potential environmental impacts in the 2 PCRs, the use of non-renewable resources should, however, be listed in the Environmental Product Declaration as "environmental performance related information." This category is then still considered as relevant with respect to the PCRs of EPD.

NB: The LCIA methods recommended and classified by ILCD Handbook and PEF are available in Annex V. More detailed information is available in the following reference: ILCD Handbook - Recommendations for Life Cycle Impact Assessment in the European context, 2011.

The selected impact categories of interest for the footwear EU Ecolabel are then the ones from the existing PCRs:

- **Climate change**

  Each greenhouse gas is characterized by a different global warming potential, calculated on the basis of the global warming potential of CO2, and a time-horizon. Each greenhouse gas is assigned a characterization factor, which expresses how many times more potent

[245] No 16 in Table 42

[246] No 17 in Table 42

[247] International Panel on Climate Change, (Climate Change 2007, Direct Global Warming Potentials, 2007)

the warming potential of this greenhouse gas is compared to CO2 (for which the characterization factor is, by definition, equal to 1) when averaged over the time horizon considered. The characterization factors used are usually taken from IPCC 2007.

This category includes the effects of all greenhouse gases, including biogenic carbon and is expressed in *kg eq. CO2*.

- **Acidification**

Acid gases that are released into the air or produced from reaction of the non-acid components of air emissions are incorporated into atmospheric water vapour and the ensuing precipitation, leading to "acid rain." Acidic precipitation has a deleterious impact on plants, soil and surface waters, leading to leaf damage and acidification of the soil. Soil acidification affects the solubility and availability of plant nutrients and trace elements that plants require for growth. This may also lead to an increased uptake up of heavy metals which adversely affect the plant growth.

Major acidifying emissions are NO_x, NH_3, and SO_2. The last is the reference flow used by the method of characterization developed by the Institute of Environmental Sciences (CML) from the University of Leiden.

- **Ozone depletion**[248]

The concentration of the reactive oxygen compound ozone (O_3) is significantly higher in the stratosphere than in other parts of the atmosphere, e.g., the troposphere. A number of substances, some of which occur naturally in the stratosphere, are involved in the breakdown of ozone: long-lived chlorine and bromine compounds, methane (CH_4), nitrous oxide (N_2O), and water vapour (H_2O).

The reaction systems are complex. However, there is an international consensus about the issue and there is an international agreement based on the Montreal protocol concerning phase out of the relevant substances. The atmosphere receives ultraviolet radiation from the sun. Ozone molecules in the stratosphere absorb large quantities of this UV radiation, thus removing the life-threatening UV-C radiation and reducing the harmful UV-B radiation.

Reduction in the ozone concentration in the stratosphere would probably have a serious effect on the life on the surface of the Earth. It can cause damage to plants, animals, and humans. In the area around the South Pole (which is considered to be the most affected) deleterious effects on phytoplankton have been observed. Phytoplankton is a primary producer in every aquatic food chain, and dramatic consequences can, therefore, be expected. Ozone depletion will also adversely affect humans by increasing risks for certain medical conditions such as skin cancer and reduced immune defence.

The Ozone Depletion Potentials (ODPs) published by the World Meteorological Organization uses CFC-11 as reference flow.

[248] (Danish Ministry of the Environment, 2005)

- **Photochemical ozone formation**

  Photochemical ozone, also called tropospheric ozone or summer smog, is a type of air pollution derived from vehicular emission and industrial fumes that is suspected of damaging vegetation and biogenic material.

  All of these chemicals are usually highly reactive and oxidizing. Photochemical smog is therefore considered to be a problem of modern industrialization. It is present in all modern cities, but it is more common in cities with sunny, warm and dry climates and a large number of motor vehicles. Because it travels with the wind, it can affect sparsely populated areas as well.

  The LOTOS-EUROS is a 3D chemistry transport model designed to simulate air pollution in the lower troposphere. The model is differentiated spatially and averages are used for European factors. The impact category is expressed in kg eq. NMVOC[249].

- **Eutrophication**

  Water eutrophication involves a perturbation of the aquatic medium due to excessive concentrations of eutrophying nutrients that can lead to proliferation of aquatic plants, such as algae. These algae prevent sunlight from reaching the lower depths in a water body, which causes decrease in photosynthesis and oxygen production. Moreover, oxygen is consumed during decomposition of dead algae. Both effects reduce oxygen concentration in the water, which can cause fish-kills and anaerobic decomposition (decomposition without the presence of oxygen) of organic matter in the water column and sediments. Hydrogen sulphide and methane produced during anaerobic decomposition can lead to the destruction of the eco-system.

  Different assessment methods are recommended depending on the milieu. Aquatic eutrophication is assessed through the EUTRED model (Struijs et al, 2009b) which is implemented in ReCiPe. This method distinguishes freshwater systems (only P-emissions considered) and marine systems (only N considered). Terrestrial eutrophication is assessed through the Accumulated Exceedance method (Seppälä et al. 2006, Posch et al, 2008) and uses kmol N as reference flow.

- **Resource depletion**

  The impact category *depletion of abiotic resources* quantifies the resource consumption (such as zinc ore and crude oil). This is calculated based on an evaluation of the availability of economically exploitable resources.

  Generally, antimony is adopted as the reference element and it is used to develop resource characterization factors, termed "abiotic depletion potentials" (ADP). ADPs for different abiotic resources are expressed in kg eq. antimony (kg eq. Sb) to facilitate aggregation and comparison of different abiotic resource impacts on a normalized scale.

[249] Non-Methane Volatile Organic Compounds

Usually, most LCA studies subjected to further analysis display results for 3 to 10 impact categories (see Table 44). These categories include the ones selected before. NB: Water and resource depletion are often evaluated as direct flows, not being considered as separate impact categories.

Regarding the choice of LCIA[250] methods, after the publication of the PCR for footwear, the ADEME-AFNOR decided to follow the PEF requirements. The PCRs from EPD recommend obsolete LCIA methods, not classified by ILCD Handbook[251]. Furthermore, within the analysed LCA studies, the LCIA methods used are often not mentioned and not homogenous, thus, hindering the feasibility of direct comparison and straightforward selection of a set of the LCIA methods.

For the purpose of the current analysis, the recommendations set in the ILCD Handbook have been addressed in order to analyse the best methodological approach to assess which impact assessments methods could be considered as the most appropriate for the identified impact categories.

Following the same line, Table 44 presents the impact categories displayed by the studies and shows the related categorisation from ILCD on “the overall acceptance by stakeholders”[251]. Assessment methods are assigned scores from A to E, where:

- A represents full compliance,
- B represents compliance in all essential aspects,
- C represents compliance in some aspects,
- D represents little compliance, and
- E represents no compliance.

In Table 44, “na” means that the impact category was not assessed by the study, “ns” means that the LCIA method was not specified by the study, and “nc” means that it was not classified by ILCD. Many studies only mention the impact categories evaluated but without mentioning or explaining the LCIA method used, or that obsolete LCIA methods (i.e., not classified by the ILCD) were used.

None of the impact categories were assessed for the following studies:

- Study 3 (Center of Environmental Studies, 2009) gives results for direct emissions, being at the levels of elementary flows;
- Study 5 (Cleaner Production Institute, 2009) uses its own evaluation system based on “significance points” (from 1 to 3);
- Study 7 (Herva et al., 2011) uses “Ecological Footprint” which is a single indicator based on “the space required to support an activity by means of the area needed to provide the resources consumed and to absorb the wastes generated.”

As Table 44 shows it, few studies actually follow the accurate ILCD specified impact categories.

[250] Life Cycle Impact Assessment

[251] For more details, refer to (ILCD Handbook - Recommendations for Life Cycle Impact Assessment in the European context, 2011)

Table 44: Impacts categories in LCA studies

#	Author	Functional Unit	Studied product	Impact categories											
				Climate change	Ozone depletion	Ecotoxicity	Human toxicity	Particulate Matter	Ionising radiation	Photoch. ozone form.	Acidification	Eutrophication	Water depletion	Resource depletion	Land transformation
1	BLC (Leather Technology Center)	NA	Leather	A (IPCC)	Not assessed (na)	na	na	na	na	Not classified (nc)	C (CML)	BC (CML)	Direct flow	nc	na
2	BRUNO et al.	200 kg of salted hide	Leather	Not specified (ns)	na	ns	ns	na	na	ns	ns	na	na	na	na
3	Center of Environmental Studies	100 m² of leather	Leather	na	na	na	na	na	na	na	na	na	na	na	na
4	Cheah et al.	1 pair of shoes	Shoes	A (IPCC)	na	na	na	na	na	na	na	na	na	na	na
5	CPI (Cleaner Production Institute)	1 leather jacket	Other leather product (jacket)	na	na	na	na	na	na	na	na	na	na	na	na
6	DANI	1 m² of leather	Leather	A (IPCC)	nc	na	na	na	na	nc	C (CML)	nc	na	na	na
7	Herva et al.	1 pair of shoes	Shoes	na	na	na	na	na	na	na	na	na	na	na	na
8	Kebede Bekele	1 sqf finished glove leather product	Other leather product (gloves)	nc		nc	nc			nc	nc	nc			
9	Milà et al.	1 pair of shoes	Shoes	nc	na	na	nc	na	na	na	nc	nc	nc	nc	na
10	Milà et al.	1 ton of salted hide	Leather	nc	na	nc	nc	na	na	nc	nc	nc	na	na	na
11	NIKE	1 kg of raw materials	Raw materials	nc	na	na	na	na	na	na	na	na	nc		nc

#	Author	Functional Unit	Studied product	Impact categories											
				Climate change	Ozone depletion	Ecotoxicity	Human toxicity	Particulate Matter	Ionising radiation	Photoch. ozone form.	Acidification	Eutrophication	Water depletion	Resource depletion	Land transformation
12	Rivela et al.[252]	1 ton of salted hide	Leather	D	C	nc	na	nc	nc	na	C	CD	na	C	C
13	University of Santa Barbara, California.	1 pair of shoes	Shoes	ns	ns	ns	ns	na	ns	ns	ns	ns	na	na	na
Number of studies considering the impact category				**10**	**3**	**5**	**5**	**1**	**2**	**6**	**8**	**7**	**3**	**3**	**2**

Green frames = selected categories selected form the analysed PCRs
"na" means that the impact category was not assessed by the study, "ns" means that the LCIA method was not specified by the study, and "nc" means that it was not classified by ILCD.

[252] Eco-indicator 99 has been used for all impact categories

The following categories are not considered in the existing PCR[253] schemes, either because methods are not reliable (partially or completely), or because the category is not considered relevant for the product group or it is difficult to implement and assess:

- **Ecotoxicity and human toxicity**: the LCIA methods recommended by the ILCD Handbook are not reliable (II/III in ILCD classification). However, in the framework of the EU Ecolabel revision, the environmental impacts related to hazardous substances will be evaluated qualitatively through the analysis of the respective legislations (e.g., REACH), literature and information gathered from stakeholders.
- **Particulate Matter/Respiratory Inorganics**: although the recommended LCIA method is reliable, the impacts will be assessed qualitatively, similarly to the toxicity-related categories.
- **Ionising Radiation – human health effects**: has not been considered as an impact of relevance for the product group under study.
- **Land use**: The recommended LCIA method (see Annex V) has a low reliability (III in ILCD classification). The particular relevance of this impact category depends on the amount of land used for farming and animal breeding and on the allocation factor assigned to the footwear supply chain.
- **Water consumption** with scarcity methods: The recommended LCIA method has a low reliability (III in ILCD classification). It demands development to be implemented considering that the current databases do not detail water elementary flows per geographical area.

If included in the analysed studies, the results for these impact categories by will be displayed separately within the further steps of analysis as containing potentially valuable information and conclusions that could be extracted.

3.2.4. Quality assessment

In order to develop valuable conclusions, the LCA literature needs to be assessed with respect to the data quality, assumptions and environmental indicators. Only studies that achieve adequate quality in these areas were further considered. Following this purpose, a semi-quantitative approach, similar to the one proposed by PEF, has been used.

I. Methodology

The quality of the LCA studies that pass the pre-selection stage (i.e., studies that give <u>quantitative</u> results) were scored according to the adapted assessment method focusing on six parameters:

1. Scope
2. Data sources
3. Impacts

[253] (BP X 30-323-1, 2010), (International EPD Consortium®, 2013)

4. Outcomes
5. Robustness and
6. Review.

The objective is to score each of the six parameters based on the qualitative and quantitative considerations. Each parameter was assigned a score from 1 (very poor) to 5 (very good). Table 45 presents the adopted scoring system for each parameter listed above. The overall score is calculated by summing up the points awarded. The maximum possible score is 30.

Simultaneously, the minimal requirements for a study to be considered as relevant (independently of its score), are:

- The functional unit and its proper definition;
- The assumptions of the study shall respect ISO 14040 standard;
- Satisfactory broadness (with respect to the six impact categories identified in chapter 3.2.3) or at least quality C of the indicator(s) used according to ILCD;
- The outcomes of the study should be relevant and applicable to the revision process.

Studies that do not meet the minimal requirements or achieve a reasonable score, even if not taken into account within LCA revision, could still be relevant to address other issues of interest (e.g., hazardous substances, waste management).

Table 45: Scoring methodology of LCA studies (6 parameters)

#	Item	Scoring	Cut-off limits
1	**Scope**	5 = coherent LCA for broad group of products of interest 3 = coherent LCA for some products of interest 1 = streamlined LCA for some products of interest	Functional unit properly defined and relevant for this revision. Assumptions of the study shall respect ISO 14040 standard.
2	**Data sources**	The following scores shall be assessed for each stage of the life cycle (raw materials, manufacturing, distribution, use phase, packaging, end of life): *A. Temporal representativeness:* 5 = data refers to less than 3 years ago. 3 = data refers to 3–5 years. 1 = data refers to more than 5 years ago. *B. Geographical representativeness*: 5 = data for specific country of interest and relevant for the EU Ecolabel. 3 = Average data at continental level and relevant for the EU Ecolabel. 1 = Average data at World level. *C. Technology representativeness* 5 = Data for specific technology used and of relevance for the EU Ecolabel 3 = Data reflecting the average technologies used 1 = Data related to technologies not often used.	

#	Item	Scoring	Cut-off limits
		For each stage, the sum of the scores assigned to the parameters A, B and C is calculated. Overall score on data is the sum of the scores calculated for each stage and reported on scale of 5.	
3	**Impact assessment categories**	5 = satisfactory broadness (with respect to the 6 impact categories identified) AND all indicators of interest are evaluated as A or B (best in class) according to ILCD 2 = at least one indicator is of interest AND all indicators of interest are evaluated as A or B (average class) according to ILCD 1 = at least one indicator is of interest AND all the indicators of interest are evaluated as C (average class) according to ILCD.	At least one indicator(s) used is classified at least as "C" according to the ILCD handbook.
4	**Outcomes**	5 = The outcomes of the study are of relevance for the criteria revision and they could be applied directly to many key-issues. 3 = The outcomes are somehow of relevance for the criteria revision and they can be applied directly to some key-issues. 1 = The outcomes are somehow of relevance for the criteria revision and they can be used to partially address some key-issues.	The outcomes of the study must be relevant and applicable to the revision process.
5	**Robustness**	5 = The overall quality of the study is good and sensitivity analysis is performed to analyse and manage most important sources of uncertainty and variability. 3 = The overall quality of the study is good (in terms of modelling, assumptions, data gaining, impacts assessment, presentation and discussion of results, findings). 1 = Minimal requirements are satisfied.	
6	**Review**	5 = independent 3rd party review (e.g., certification) 3 = independent review (e.g., paper) 1 = no review	

II. Scoring of studies

Table 46 indicates the scoring calculated for each existing pre-selected LCA literature following the guidelines of Table 45 and the minimal requirements.

Table 46: Scores of existing LCA literature

#	Author	SCORE total	Scope	Data quality	Impact categories	Outcomes	Robustness	Review
1	BLC (Leather Technology Center)	Disregarded - functional unit is not properly defined. The study gives relative results but the functional unit is not given.						
2	BRUNO et al.	**18.4**	3	3.4	1	5	5	1
3	Center of Environmental Studies	Disregarded - insufficient broadness with respect to the 6 impact categories identified. 3 out of 6 of the selected impact categories are displayed.						
4	**Cheah et al.**	**25.8**	5	4.8	3[254]	5	5	3
5	CPI (Cleaner Production Institute)	Disregarded - insufficient broadness with respect to the 6 impact categories identifies. None of the selected impact categories are displayed. The study uses own categories and scores.						
6	DANI	**18**	5	5	1	3	1	3
7	Herva et al.	Disregarded - insufficient broadness with respect to the 6 impact categories identified. None of the selected impact categories are displayed. The study uses own categories and scores.						
8	Kebede Bekele	**16**	3	3	1	5	3	1
9	**Milà et al.**	**20**	5	3	1	5	3	3
10	**Milà et al.**	**24.6**	5	3.6	1	5	5	5
11	NIKE	Disregarded - insufficient broadness with respect to the 6 impact categories identified. 1 out of 6 of the selected impact categories is displayed.						
12	**Rivela et al.**	**20**	3	3	1	5	5	3
13	**University of Santa Barbara, California.**	**20.9**	5	3.9	1	5	3	3

3.2.5. Critical review and summary of selected studies

Based on the scoring results, it is determined that 5 studies with a score equal or higher than 20 will be further analysed, following the prioritization from the highest to the lowest score ranked as follows:

- Cheah et al.
- Milà et al. (2002)

[254] Only one category (climate change) is displayed but has a score "A" according to ILCD Handbook

- University of Santa Barbara, California (2008)
- Milà et al. (1998)
- Rivela et al (2004)

The main outputs from remaining literature will be nonetheless outlined in a further step, mainly to provide added-value information, and confirm the key environmental area previously identified.

I. (Cheah et al., 2012)

Overview

Table 47 presents an overview of a very recent study published in the Journal of Cleaner Production by researchers of the Massachusetts Institute of Technology.

Table 47: Overview of Cheah et al., 2012

Title	Manufacturing-focused emissions reductions in footwear production
Authors	Lynette Cheah, Natalia Duque Ciceri, Elsa Olivetti, Seiko Matsumura, Dai Forterre, Richard Roth, Randolph Kirchain
Reference and year	2012
Type of study	Carbon footprint with respect to ISO 14040
Scope	Cradle to grave
Functional unit	A pair of size 9 men's ASICS GEL-KAYANO 17 shoes
System boundaries	Included: raw material extraction and processing, production scrap, packaging material, manufacturing, assembly, transportation to key market location, use phase, end of life Excluded: manufacturing and transport of the equipment to the factory
Assumptions	Materials for which LCI are not available are approximated by the best existing match. They account for ~1 % of all impacts.
Data sources and quality	**Raw materials** Collected data for weight and material of each part **Manufacturing** Collected data for all processes in China **Distribution/transportation** Collected data **Use phase** Estimation on the washing instructions **Packaging** Collected data **End of Life** Average scenario
Impact assessment categories/ methods	Climate change (IPCC)
Robustness	The most important impacts are well highlighted. The scope is very well defined, and assumptions are clearly stated. Data are adapted to the local situation. Uncertainty is evaluated.
Review	Peer-reviewed, Journal of Cleaner Production

Results and outcome

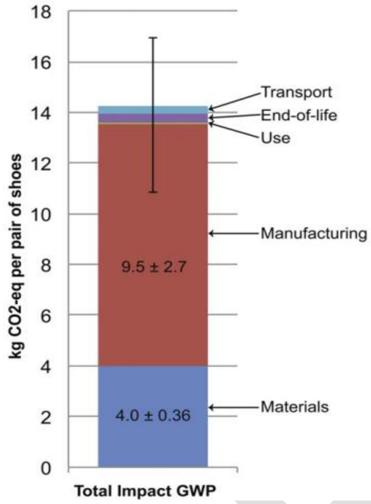


Figure 39: Total carbon footprint

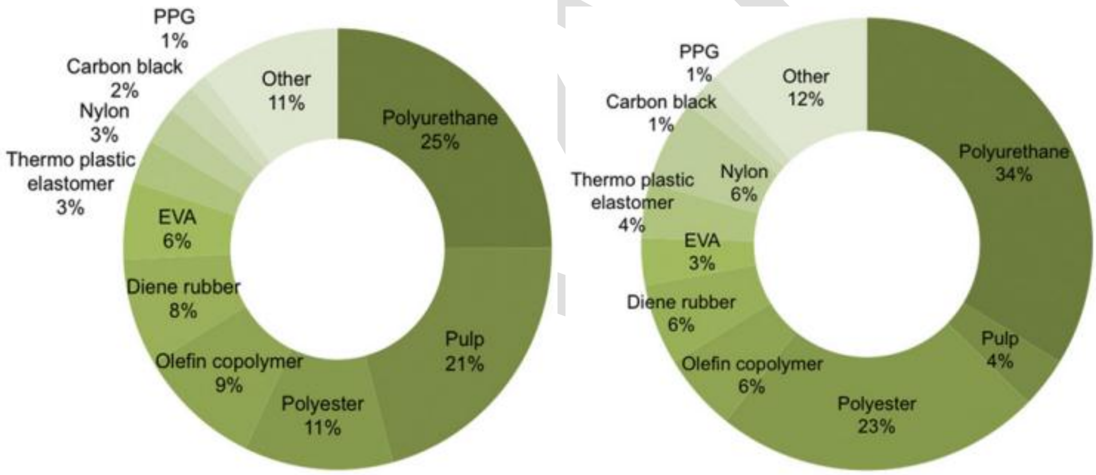


Figure 40: Breakdown by material (left: mass – right: carbon footprint)

The study determined that most of the emissions are released during shoes' material processing (29%) and manufacturing phase (68%).

The biggest impact on climate change is due to the shoes manufacturing, mostly energy consumption (about half electricity and half heat). Impact of manufacturing mainly depends on electrical mix. A step of great impact within manufacturing is injection-moulding. In terms of the manufacturing phase, finding cleaner alternatives for heating, pursuing energy-efficiency improvements related to the sole production and assembly processes, and reducing machinery idle time would help to lower the climate change related to the product.

For the material processing phase, the use of polyester and polyurethane in the shoes' upper is found to contribute to almost 60% of emissions from this phase. Substituting a less carbon-intensive material, such as a recycled material, could greatly reduce the impact. Also, shifting to printing design elements onto the shoe rather than affixing additional material can save energy and material. Material scrap losses represent about 30% of the total emissions, so this point could also be improved by optimising the input materials management.

There are negligible emissions expected over the shoes' use phase, and the transportation and end-of-life phases only contributed nominally to the shoes' overall impact.

Few impacts are due to transportation, use and end of life.

From this analysis, the key performance parameters are:

- The amount and type of energy used for manufacturing,
- The amount and type of materials used.

II. (Milà et al., 2002)

Overview

Table 48 presents an overview of the study. Even if the scope is reduced (cradle to gate), this study is relevant because it evaluates one of the main processes in shoe production, the leather production, and it takes into account the agricultural steps. In addition, an intermediate product such as leather has many possible applications. Therefore, cradle-to-gate evaluation makes sense so it can be used by the different sectors for which the downstream phases are specific.

This study is of particular relevance because it was performed in order to develop criteria for an Ecolabel.

Table 48: Overview of (Milà et al., 2002)

Title	Use of Life Cycle Assessment in the Procedure for the Establishment of Environmental Criteria in the Catalan Eco-label of Leather
Authors	Llorenç Milà i Canals, Xavier Domènech, Joan Rieradevall, Rita Puig and Pere Fullana.
Reference and year	2002
Type of study	Attributional LCA according to ISO 14040
Scope	Cradle to gate
Functional unit	1000 kg of salted hide
System boundaries	**Included:** agriculture, cattle raising, slaughterhouse, storage and tannery, production phase of the main ancillary materials (see cut-off criteria), energy and transport-delivery. **Cut-off criteria:** for ancillary materials: mass criterion of 5%. Production of those materials that did not reach the 5% basis, but were suspected to be relevant, has been included (fertilisers, pesticides, chromium salts)
Assumptions	**Allocation rules** In the tannery, the two main products are leather (allocation factor: 94.5% in the operations up to splitting) and splits (5.5% in the operations up to splitting). In the slaughterhouse, the allocation factor for hides is 7.7% (meat: 90.6%; other by-products: 1.7%); i.e., only 7.7% of the environmental burdens produced upstream of the skinning operation are allocated to the hide.
Data sources and quality	**Raw materials** Collected data from Catalunia factories and from foreign industries (chromium mining and processing, fertiliser and pesticide production) **Manufacturing** Collected data **Distribution/transportation** Collected data
Impact assessment categories (see Table 44 for ILCD classification)	Climate change Human Toxicity Ecotoxicity (Aquatic - and Terrestrial) Photochemical Ozone Formation Nutrification Acidification Resource depletion (abiotic and biotic) and water consumption are evaluated as a sum of direct flows, and not through an LCIA method
Robustness	The scope is reduced (cradle to gate) but the most important impacts and phases are well highlighted. Data are adapted to the local situation.
Review	A critical revision has been performed by one of the authors.

Results and outcomes

Table 49 presents the absolute results for the functional unit (1000 kg of salted hide):

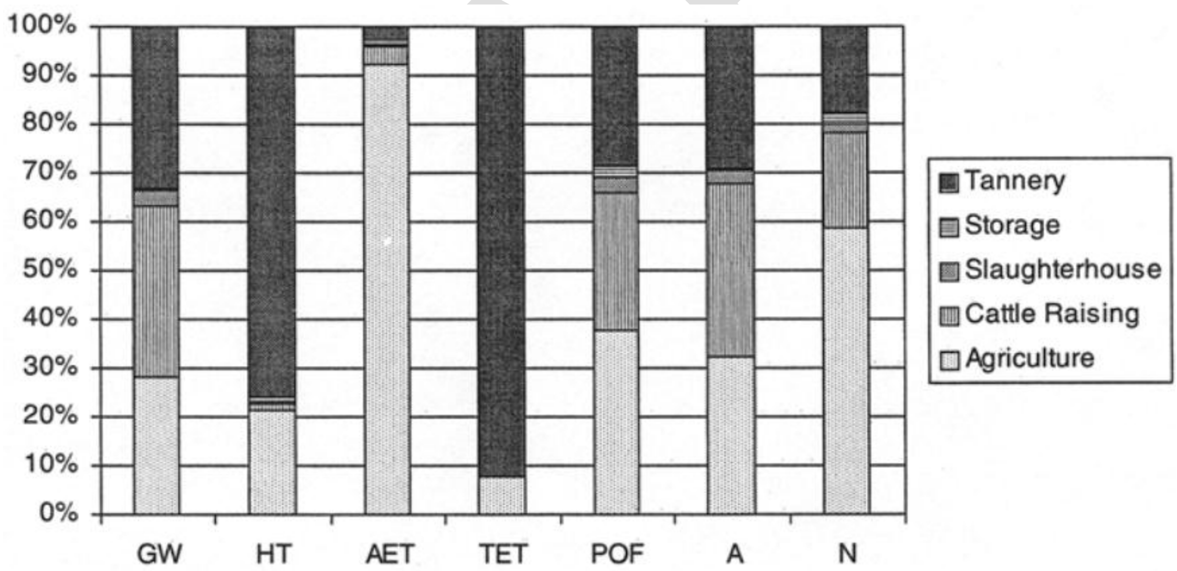
Table 49: Absolute results of (Milà et al., 2002)

Impact category	Unit	Result

Biotic resource consumption (sum of flows)	kg	38 600
Abiotic resource consumption (sum of flows)	kg	88 700
Climate change	kg CO2 eq.	19 800
Human toxicity	kg Pb_{air} eq.	2.56
Aquatic toxicity	kg Zn_{water} eq.	0.259
Terrestrial toxicity	kg Zn_{soil} eq.	1.75
Photochemical ozone formation	kg ethane eq.	4.55
Acidification	kg SO2 eq.	228
Eutrophication	kg PO_4^{3-}	72.1

The following figure shows the relative impacts of each life cycle stage, for each of the assessed impact categories[255].

Figure 41: Relative results of Milà et al., 2002



The main hot spots identified by the studies are:

- Tannery is an important stage in most of the impact categories, mainly due to the landfilling of the tannery wastes. These emissions are responsible for tannery contribution to climate change, photochemical ozone formation, acidification and eutrophication. Tannery energy consumption also poses remarkable environmental

[255] GW = Climate change; HT = Human toxicity; AET = Aquatic toxicity; TET = Terrestrial toxicity; POF = Photochemical ozone formation; A = Acidification; N = Nutrification (= eutrophication).

burdens through emissions to the atmosphere, although they are not as relevant as landfill emissions.

- Agriculture and - to a lesser extent - cattle raising also play a very important role in most of the impact categories. Agriculture has a big impact due to the related energy consumption and use of fertilisers. Cattle raising has a significant impact due to the emissions associated with animal care. This conclusion is especially remarkable if one bears in mind the that only 7.7% of the impacts generated in this phase have been allocated to leather.

- The slaughterhouse and storage phases play a minor role in creation of environmental impacts during the life cycle of leather.

The conclusions of the study highlight the following key performance parameters:

- Quantity of fertilisers during agriculture;
- Quantity of gas emitted by the cattle and its management (a possible improvement would be to use a gas collection system in the stable);
- Quantity of solid wastes generated during tanning and management of this waste (incineration, recycling, landfill);
- Amount of chromium used and sent to landfill or emitted to processing water;
- Energy consumption associated with agriculture and tanning.

III. (Simple Shoes, 2008)

Overview

Table 50 presents an overview of the study. This study was performed by researchers of the Donald Bren School of Environmental Science and Management, University of Santa Barbara, California. The principal goal was to compare four products of Simple Shoes on an environmental basis.

Table 50: Overview of (Simple Shoes, 2008)

Title	Analyzing the Environmental Impacts of Simple Shoes
Authors	Kyle Albers, Peter Canepa, Jennifer Miller, Trish Holden, and John Melack (University of Santa Barbara, California)
Reference and year	2008
Type of study	Attributional LCA according to ISO 14040 (comparison of 4 products)
Scope	Cradle to grave
Functional unit	The amount of material required to cover and protect two sample sized feet (pair of shoes) - Men size US 9[256] - Women size US 7[257]
System boundaries	**Included** From the production of raw materials to the disposal of the shoes to landfill. Process of shoe assembly: only energy information. **Excluded** Use phase, disposal of process wastes or the manufacturing of ancillary materials, production lifecycles associated with the building of the machines, the manufacturing facilities and transportation vehicles, as well as additional operations (lighting, heating of building and production of fuels and electricity) – most of them excluded because data unavailabe)
Assumptions	End-of-life: landfilling. Calculations through Gabi software. European assumptions when no Chinese or US data available Aggregation of energy consumption
Data sources and quality	Emission profiles are from GaBi software. **Raw materials** Collected data representative of Simple Shoes. **Manufacturing** Collected data representative of Simple Shoes. **Distribution/transportation** Collected data representative of Simple Shoes. **Packaging** Secondary data: packaging material used as close to the real material used as possible + energy from literature **End of life** Secondary data (Simple Shoes are assumed to be landfilled)
Impact assessment categories (see Table 44 for ILCD classification)	Climate change Human, Marine, Terrestrial and Freshwater Toxicity Potentials Photochemical Ozone Formation Ozone Depletion Acidification Eutrophication Ionising Radiation
Robustness	The lifetime differences among the 4 products are not evaluated. Data quality is good because the data are mainly based on primary data. No sensitivity analysis was performed.
Review	Review by PhD students of the university (not independent).

[256] Corresponds to size 43 in Europe

[257] Corresponds to size 37½ in Europe

Results and outcome

Four types of shoes were studied and compared in the framework of this study, as presented below:

- Shoe 1 is designed for low impact use and hanging out with friends. The shoe contains jute uppers, a bamboo lining, removable natural latex and cork pedbed with a cotton canvas cover, bamboo linings, and layered natural crepe outsole, and it uses water-based cements.
- Shoes 2 uses similar materials as shoe 1. The main difference is the use of recycled car tires for the shoe outsole.
- Shoe 3 utilizes both natural and conventional materials. This shoe involves die cutting and sewing washed leather, and it contains organic cotton canvas uppers and organic cotton linings. Unlike the other shoes explored in this study, Shoe 3 wraps uncured rubber around the sidewall, toecap and heel cap of the sneaker to provide durability and an improvement in design appeal.
- Shoe 4 is the Simple Shoes original product designed to compete with other popular skate and surf sneakers. Similar to the other shoes, the suede upper is die cut and stitched together to form the upper. The outer sole and sidewall are [produced by pouring virgin rubber into a mould; this moulded rubber is stitched to the cow suede upper. An EVA foam sock liner is glued into the shoe to form a spongy insole and the shoe is then laced with nylon laces.

Table 51 presents the absolute results for the 4 types of Simple Shoes.

Table 51: Absolute results of (Simple Shoes, 2008) [258]

	Shoe 1	Shoe 2	Shoe 3	Shoe 4
AP [kg SO2-equiv.]	0.0171	0.0143	0.0092	0.0695
EP [kg P-Equiv]	0.0033	0.0028	0.0015	0.0179
FAETP [kg DCBEquiv.]	0.0402	0.0338	0.0414	0.1623
GWP [kg CO2-Equiv.]	1.672	1.681	1.808	7.51
HTP [kg DCBEquiv.]	8.482	7.189	10.469	41.03
ODP [kg R11-Equiv.]	1.48E-06	1.15E-06	7.10E-07	7.59E-07
POCP [kg Ethene-Equiv.]	3.99E-03	2.81E-03	1.12E-03	1.68E-03
RAD [DALY]	1.40E-08	1.41E-08	1.54E-08	1.95E-08
TEPT [kg DCBEquiv.]	39.42	33.35	48.51	190.96
MAET P [kg DCBEquiv.]	140.25	131.28	266.61	796.12

[258] Global Warming Potential (GWP), Human, Marine, Terrestrial and Freshwater Toxicity Potentials, (HTP, MAETP, TETP, FAETP), Photochemical Ozone Create Potential (POCP), Ozone Depletion Potential (ODP), Acidification Potential (AP), Eutrophication Potential (EP) and Radioactive Radiation (RAD)

Table 52 below presents the relative results for the shoe 1. Although not displayed, the relative results for the other shoe types of shoes are similar.

Table 52: Relative results of (Simple Shoes, 2008) (Shoes 1)

% Contribution of emissions per phase	End-of-life	Transportation	Materials Production and Manufacturing	Packaging
AP [kg SO2-equiv.]	0.7	18.97	78.42	1.91
EP [kg P-Equiv]	15.78	10.81	71.5	1.92
FAETP [kg DCBEquiv.]	0.12	0.97	98.07	0.84
GWP [kg CO2-Equiv.]	15.39	11.84	68.25	4.53
HTP [kg DCBEquiv.]	0.01	0.08	99.86	0.05
ODP [kg R11-Equiv.]	0.03	0.03	99.12	0.83
POCP [kg Ethene-Equiv.]	1.59	4.98	92.45	0.99
RAD [DALY]	0.08	0.07	99.85	0
TEPT [kg DCBEquiv.]	0	0	100	0
MAET P [kg DCBEquiv.]	1.43	2.53	90.7	5.34

The hot spots highlighted by the study are detailed below:

- The Simple Shoe environmental impacts occur mainly during the production phase. Production of all the raw materials (natural or synthetic) consumes natural resources.
- Shoes 3 and 4 have a bigger overall environmental impact than the other shoe styles studied. Shoe 3 and 4 are more aligned with conventional footwear materials that traditionally require more energy intensive processes. Reasons for the high photochemical ozone formation impact in shoes 1 and 2 may also be related to the material composition. These shoes are composed of materials which come from natural fibres and release ethane which is a VOC and capable of creating smog.
- Conventional shoes have significantly higher emissions in eight of the ten impact categories because of leather component, which has bigger impacts than other materials (up to 5 times for the climate change). The rank of shoe material (from highest to lowest) impacts on climate change and energy consumption is: Leather, Nylon 6, Silicone rubber, PU foam, EVA, latex rubber, PET, conventional cotton, crepe rubber, recycled PET, organic cotton, and hemp.

Table 53: Materials classification primary production energy by Simple Shoes, 2008[259]

Material	Primary Production Energy

[259] Source: PE International (GaBi 4.0) Extended DB

	(Lower Heating Value in MJ per kg of material[260]
Crepe Rubber	0.3
Hemp	2.44
Organic Cotton	16.18
Ethylene Vinyl Acetate (EVA)	16.57
Cotton	18.77
Polyethylene Terephthalate (PET)	22.77
Polyurethane (PU) Foam	27.63
Silicone Rubber	47.25
Nylon 6	55.59
Leather	56.95

Clearly, the key performance parameters identified in this study are the type and quantity of materials used.

IV. (Milà et al., 1998)

Overview

Table 54 presents an overview of the study.

[260] Lower Heating Value (or net calorific value) is the feedstock energy, plus all the contribution of primary energy requested during extraction, processing and production of materials.

Table 54: Overview of (Milà et al., 1998)

Title	Application of Life Cycle Assessment to Footwear
Authors	Llorenç Milà, Xavier Domènech, Joan Rieradevall, Pere Fullana, Rita Puig
Reference and year	1998
Type of study	Attributional LCA according to ISO 14040
Scope	Cradle to grave
Functional unit	1000 hours of protection of the feet
System boundaries	**Included** Grass production, cattle, carcass, slaughterhouse waste, tannery, production of footwear, distribution, end of life **Excluded** production of plastics, rubber, chemical products used during the life cycle of the shoe - primarily in the tannery, but also during use , metallic components, etc.
Assumptions	The allocation of environmental burdens to leather was based on economic allocation with a value of 7.6% as the relative economic value of hides. Emissions at the work place have not been included; potentially toxic substances emitted during footwear manufacture come mainly from the adhesives used.
Data sources and quality	**Raw materials** Secondary data for cattle raising and for hides (humidity…) **Manufacturing** Secondary data: hypothesis taken to evaluate the impacts of an average tannery **Distribution/transportation** Secondary data: assumptions on trade **Use phase** Excluded **Packaging** No detail **End of Life** Secondary data based on waste management in the study area
Impact assessment categories /methods (see Table 44 for ILCD classification)	Climate change Acidification Eutrophication Human Toxicity Resource depletion (abiotic and biotic) and water consumption are evaluated as the sum of direct flows, and not through an LCIA method
Robustness	The scope is wide (from cradle to grave) and the most important environmental impacts are well highlighted. Data are adapted to the local situation but could be more precise (a lot of assumptions are made). Improvement options are proposed but they are very broad. No sensitivity analysis is performed.
Review	Published in the International Journal of LCA

Results and outcome

Figure 42 provides the relative results provided by (Milà et al., 1998).

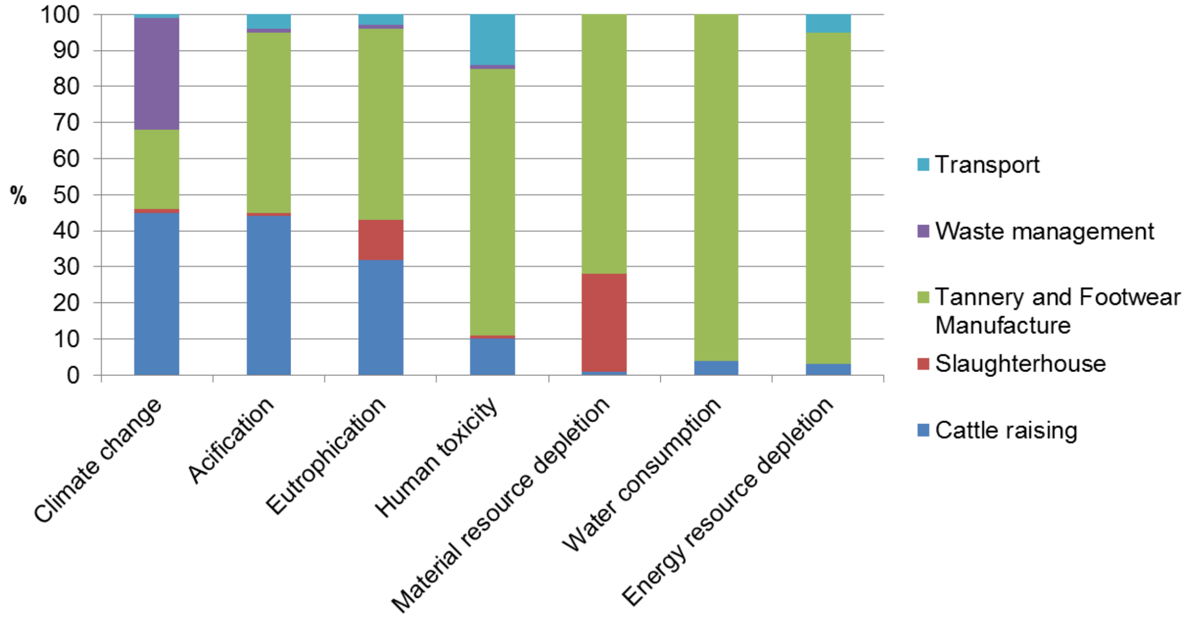


Figure 42: Relative results of (Milà et al., 1998)

NB: the study does not provide absolute results for the different impact categories.

The following hot spots are highlighted by the study:

- The upstream of leather production is an important contributor to the climate change, acidification and eutrophication. This means that boundary setting will be of critical importance for the final results because these results directly depend on the allocation choice. This contribution comes from the emissions related with the slurry and excreta production. Ammonia (NH3) coming from this source is responsible of 36-40% of the Eutrophication and Acidification Potentials generated during the whole life cycle of the functional unit. Nitrous oxide (N20) produced in the denitrification of the excreta generates more than 50% of the climate change for the cattle raising phase.
- Tannery has a big impact on water eutrophication potential and this phase is also important for its non-renewable resource consumption. Nearly 50% of the non-renewable raw materials and 70% of the water consumed during the life cycle are used at this stage. Water consumption also implies a huge waste water production, which is mainly contaminated with nitrogenised organic matter, thus contributing to eutrophication (50% of the overall impact).
- The waste management step is only relevant for the climate change as it is based in landfilling without energy recovery. If a bigger incineration proportion was used, the acidification would probably have been more important.
- The energy consumption during footwear manufacturing is an important impact generator phase, due to the characteristics of the electricity production.

V. (Rivela et al., 2004)

Overview

This LCA study was developed in order to support environmental improvement of tanneries in developing countries, particularly in Latin America.

Table 55: Overview of (Rivela et al., 2004)

Title	Life Cycle Assessment as a Tool for the Environmental Improvement of the Tannery Industry in Developing Countries
Authors	B. Rivela, M. T. Moreira, C. Bornhardt, R. Meä Ndez, and G. Feijoo
Reference and year	2004
Type of study	Life cycle assessment
Scope	Cradle to gate
Functional unit	1 ton of wet salted hides
System boundaries	The tanning process in this study comprises all the steps from the raw hide to the "crust for finishing" leather using chromium as the core tanning compound. Three main subsystems were considered for evaluation of the process: • Beamhouse; • Tanyard; • Retanning; • Energy and chemicals supply. Dressing and finishing were not included because they strongly depend on the article produced; it is rather difficult to obtain representative data on these processes, making a comparison of the whole life cycle very difficult.
Assumptions	Dressing and finishing were not included because they strongly depend on the article produced. The subsystems linked to chemical production were inventoried from bibliographic data. Assignment of the environmental loads associated with the different sources of electricity was made from BUWAL 250 database.
Data sources and quality	**Raw materials** Primary data for all the outputs and inputs of the processes Secondary data for data related to chemicals **Manufacturing** Primary data: for energy consumption Secondary data: for electricity mix (Chile level)
Impact assessment categories (see Table 44 for ILCD classification)	Carcinogens Respiratory organics Respiratory inorganics Climate change Radiation Ozone layer Ecotoxicity Acidification and eutrophication Land use Minerals Fossil fuels Human health Ecosystem quality Resources

Robustness	The scope is reduced (cradle to gate), but the most important environmental impacts are well highlighted. Normalization of the results is done. Improvement options are proposed. A sensitivity analysis is performed for the improvement options proposed.
Review	Peer-reviewed, Environmental Science and Technology

Results and outcomes

Table 56 gives the results of (Rivela et al., 2004).

Table 56: Impact levels of Rivela et al., 2004 – Ecoindicator 99

Category	Unit	Beamhouse	Tanyard	Retanning	Wood furnace	Total
			Characterization Step			
Carcinogens	DALY E7[261]	0.182	2.26	2.85	0.0447	5.34
Respiratory organics	DALY E10	0.952	3.69	0.0345	8.59	13.27
Respiratory inorganics	DALY E7	1.73	2.38	0.0773	1.78	5.97
Climate change	DALY E7	0.284	0.367	0.035	0.836	1.52
Radiation	DALY E11	1.22	5.1			6.32
Ozone layer	DALY E11	1.44	1.34	0.0281	0.555	3.36
Ecotoxicity	PAF*m²yr[262]	0.0189	7.3	2.59	0.00346	9.91
Acidification/ eutrophication	PDF*m²yr E3[263]	3.99	30.1	0.256	5.37	39.72
Land use	PDF*m²yr E3	0.231	0.659		1.16	2.05
Minerals	MJ surplus E4	0.516	1.37		0.634	2.52
Fossil fuels	MJ surplus E1	0.815	2.15	0.142	0.739	3.85
			Damage Assessment			
Human health	DALY E7	2.2	5.01	2.96	2.67	12.84
Ecosystem quality	PDF*m²yr E1	0.0611	7.6	2.59	0.0688	10.32
Resources	MJ surplus E1	0.815	2.16	0.142	0.74	3.86

The key environmental areas highlighted by the study are:

- The categories “Carcinogens” and “Ecotoxicity” have a high impact contribution in the tanyard and retanning subsystems.
- The main contribution to respiratory organics occurs in the wood furnace subsystem;

[261] disability adjusted life years

[262] potentially affected fraction

[263] Potentially disappeared fraction

- Respiratory inorganics and climate change categories are greatly affected by energy consumption; both beamhouse and tanyard subsystems more dependent on the use of energy.
- In the acidification/eutrophication category, airborne ammonia emissions from deliming (tanyard) is the most significant aspect with the highest value.
- The chromium content of wastewater from tanyard and retanning subsystems accounts for significant toxicological impacts, so the contribution of chromium to ecosystem damage is noticeable. Ammonia air emissions from the deliming step are also significant.

3.2.6. Identification of environmental hot spots and key impacts in LCA studies

Based on analysis of the selected LCA literature, the objective is to identify which life cycle phases should be focused on when reviewing the EU Ecolabel[264]. The analysis is done separately for leather production and footwear production because the system boundaries and the functional units are too different to draw comparative conclusions in highlighting the hot spots.

I. Footwear

Table 57 presents the environmental hot spots highlighted by the relevant footwear LCA studies.

Table 57: Footwear - Highlighted hot spots[265]

Life cycle stages		Milà et al.	Simple shoes	Cheah et al.
Agriculture, breeding and slaughtering		++	--	Out of scope
Production of input materials	Synthetic materials	Out of scope	+	+
	Leather	++	++	Out of scope
	Natural fibres	Out of scope	+	Out of scope
Manufacturing and assembling	Energy consumption	++	--	++
	Other	--	--	--
Distribution	Packaging	--	-	-
	Transport	-	-	-
Use phase		Out of scope	Out of scope	-
End of life		-	-	-

The studies do not focus on the same shoe types: they are produced in different countries; use different materials, etc. However, the following hot spots in common are clearly identified:

- **Production of input materials**, particularly leather and synthetic materials;

[264] The goal of the EU Ecolabel is to identify the main hot-spots of the product group under revision .

[265] Legend: ++: very relevant; +: quite relevant; -: not relevant; --: not highlighted by the study

- **Manufacturing** of finished product.

Distribution, use, and end-of-life phases are of minor importance.

Production of input materials

Production of leather is specifically analysed in the following chapter.

In general, aggregated data giving the final impacts of the production of plastics are used in lots of LCA studies[266]. Therefore, no detail allowing to analyse further where the impacts of plastics production come from is provided by the studies. Reviewed studies generally compare only impacts of different synthetic materials and important sources of impacts could be: polyurethane, polyester, nylon, and silicone (Cheah et al., 2012; Simple Shoes, 2008). However, these conclusions must be handled with caution because they come from two studies which analyse specific types of footwear comprised in part of these materials. This means that other synthetic materials may not have been evaluated and that the results of the assessment could change if the design or composition of footwear changes.

The main impacts related to the production of synthetic material come from:

- Depletion of fossil resources;
- Energy consumption for processing (such as injection-moulding).

The study that takes both leather and synthetic materials into account shows that they have less environmental impacts than leather (Simple Shoes, 2008).

According to (Simple Shoes, 2008), natural fibres have lower impact than leather and synthetic material on climate change and energy consumption, but production of natural fibres may emit VOCs which contributes to photochemical ozone formation.

As only one study considers the use of natural fibres, this conclusion must be interpreted with caution.

In addition, environmental evaluation of textile fibres was specifically addressed in the recent revision of the EU Ecolabel for textiles[267]. The issues identified as relevant from LCA perspective were as follows:

- Cotton: The ecotoxicity associated with the use of agrochemicals and the resource impact of water use for irrigation;
- Synthetic fibres (acrylic, nylon, polyamide, polypropylene): The climate change and ecotoxicity impact of energy use to manufacture fibres;
- Cellulose fibres (viscose): The climate change and ecotoxicity impact of energy use to manufacture fibres;
- Raw material and feedstocks required to manufacture cellulose, synthetic fibres, soaping agents and softeners;

[266] PlasticsEurope, for example, provides such data (see Annex IV)

[267] (Revision of the European Ecolabel and Green Public Procurement Criteria for Textile Products, 2012)

- Process energy and ecotoxicity associated with the fabric formation, finishing, and printing and dyeing stages of production;
- Fuel use and climate change impacts associated with air freight and shipping to distribute the products;
- Energy and ecotoxicity associated with the use phase of textile products;
- The potential benefits of more sustainable systems for resource use associated with the disposal phase.

Manufacturing of finished product

The LCA review shows the relevance of this phase mainly because of the significant energy consumption (electricity and heat) used for the manufacturing processes (e.g., cutting, stitching). The relative importance of this phase will depend on the type of raw materials used and on how well the industry manages its energy use.

The impacts also depend on the country where the product is manufactured and its electricity grid mix. Electricity produced from different energy sources (nuclear, coal, hydro) shows very different environmental profiles.

II. Leather

Table 58 presents the environmental hot spots highlighted by the relevant LCA studies related to leather.

Table 58: Leather - Highlighted hot spots[265]

	Life cycle stages	Milà et al.	Rivela et al.
Upstream	**Agriculture and cattle raising**	++	Out of scope
	Slaughterhouse	+	Out of scope
Tannery	**Energy consumption**	+	+
	Use and emission of chemicals		++
	Solid wastes at tanning	++	
Downstream	**Transport**	Out of scope	Out of scope

The analysed studies' results are cross-linked. Nevertheless, the conclusions and the "hot spots" highlighted are not identical, considering that the data sources, functional units, impact categories, system boundaries or other methodological choices are different. Differences among studies hinder the ability of direct comparison (e.g., subdivision of phases, absolute or relative results, impact categories considered).

Despite those differences, the following hot-spots are clearly identified:

- **Upstream processes (agriculture, cattle raising and slaughtering)**: those phases have a major impact. In addition, they are very sensitive because of the allocation choice between leather and meat/milk production.
- **Processing of leather**: this phase is generally the most detailed one, especially when the study focuses on leather.

As specified in the reviewed LCA analysis, **transport** through the supply chain is generally negligible.

PCR of International EPD System® focuses on the analogous hot spots.

Some other area of concern may be missing since LCA does not usually assess them because methodologies are not yet robust enough, such as hazardous substances-related issues described as non-LCA impact (see Section 3.4).

Upstream process: Animal breeding and slaughtering

According to Milà et al.(1998), animal breeding and slaughtering have a relative environmental impact up to 45 % of the footwear life cycle, whereas, only 7.7 % of this impact is allocated to the leather production (following an economic allocation). Impacts come from:

- Fertilizer emissions during agricultural phase;
- Slurry and excreta production from animals;
- Energy consumption.

These upstream phases of leather are particularly sensitive because there is no common agreement about the possible specification of the allocation rules among the animal products (i.e., milk, meat, hide/skin, fat, hair, bones, hooves/horns, internal organs, manure, brain, blood) considering that existing standards are not consistent on this methodological choice:

- Overly generic guidelines are provided by ISO standards and PEF guidance and these hinder setting a universally acceptable allocation rule.
- The PCR from ADEME-AFNOR does not specify recommendations for allocating environmental burdens to the food-processing sector.
- The system boundaries of the two PCRs from the International EPD System® are not the same: for footwear, the system begins at the exit gate of slaughterhouse; whereas, for leather, farming and slaughterhouse are included within the boundaries. The PCR for footwear recommends a mass allocation.
- The ENVIFOOD Protocol may provide some useful indications on system boundaries and the most appropriate allocation rules. It is currently being tested through pilot projects and first results should be available by the end of 2013[268].

Furthermore, according to UNIDO's LCA methodological review in leather processing[269],

[268] http://www.food-scp.eu/node/72

[269] UNIDO, Life Cycle Assessment/Carbon Footprint in the Leather Processing (Review of methodologies and recommendations for harmonization), October 2012

"it is important to recognize the implications of the different cases in which raw hides and skins are to be considered as a waste, as a by-product or as a co-product of the milk and meat industry. If the raw hides and skins are considered as waste of the milk and meat industry, the whole environmental impact (…) has to be allocated to the main product of the economic value chain (milk and meat) whereas raw hides and skins considered in the basic LCA studies as "recovered waste". This implies that agriculture and animal farming, as processes of the upstream module, shall be excluded from System Boundaries of LCA studies on leather. If, (more consistently with international legislation) we also analyse the case in which raw hides are to be considered as a by-product or co-product of the milk and meat industry, some may argue that part of the environmental impacts (…) have to be allocated to the co-product itself, on the basis of different allocation criteria."

If the second proposal were to be considered, according to the LCA state-of-the-art the allocation should be based on mass, other physical relationships, or the economic values of the co-products.

Processing of leather

The following aspects of leather processing are highlighted by the selected studies:

- Energy consumption: it is always analysed and has an impact on climate change, acidification, resource depletion…
- Solid wastes: A significant amount of solid wastes are generated from tanning; only 20 – 25 %[270] of the weight of the raw hide or skin is processed to leather.
- Use and emission of chemicals: their consumption has an impact on eutrophication, acidification, toxicity and ecotoxicity. Special focus is given to consumption, emissions (to water, in landfills) and recovery (at tannery, at incineration) of chromium from the chromium tanned leather. Rivela et al., 2004, also highlights the emissions of ammonia that occur during the deliming step. Table 59 presents the substances generally used in the production of leather.

[270] Source: BREF, 2013

Table 59: Main and auxiliary process chemicals consumed by the conventional process for producing salted bovine hides[271]

Chemical consumption	Approx. (%)
Standard inorganic chemicals (without salt from curing, acids, bases, sulphides, chemicals containing ammonium)	40
Standard organic, not mentioned below (acids, bases, salts)	7
Tanning chemicals (chromium, vegetable, and alternative tanning agents)	23
Dyeing agents and auxiliaries	4
Fatliquoring agents	8
Finishing chemicals (pigments, special effect chemicals, binders and cross-linking agents)	10
Organic solvents	5
Surfactants	1
Enzymes	1
Biocides	0.2
Others (sequestering agents, wetting agents, complexing agents)	1

3.2.7. Review of supplementary literature

In order to supplement the information gathered from the relevant literature and to show complementary information on the environmental profile of the footwear manufacturing sector, LCA studies which have not reached the minimal quality score have also been considered.

In general terms, all the literature consulted is in line with the conclusions drawn before. Moreover, four additional studies are of interest because they address environmental issues not completely covered by the analysed literature:

- (BLC - Leather Technology Centre, 2007): Comparison of tanning technologies,
- (Herva et al., 2011) and (Kurian et al., 2009): Hazardous substances,
- (Environmental Improvement Potential of Textiles (IMPRO-Textiles), 2013): Environmental impacts of textiles.

I. Comparison of tanning technologies

BLC[272] performed an environmental comparison of three types of tanning: chromium, vegetable, and aldehyde. According to them, none of the different types of tanning (chromium, vegetable, and aldehyde) has a better life-cycle outcome than another. The results are affected by the impact analysed: chromium and aldehyde show similar results while, for example, vegetable tanning consumes more water but produces less waste. In addition, vegetable leather is more durable, and, therefore, it is generally used in soles.

[271] source: (BREF Tanning of Hides and Skins, 2013)

[272] Leather Technology Center: www.blcleathertech.com/

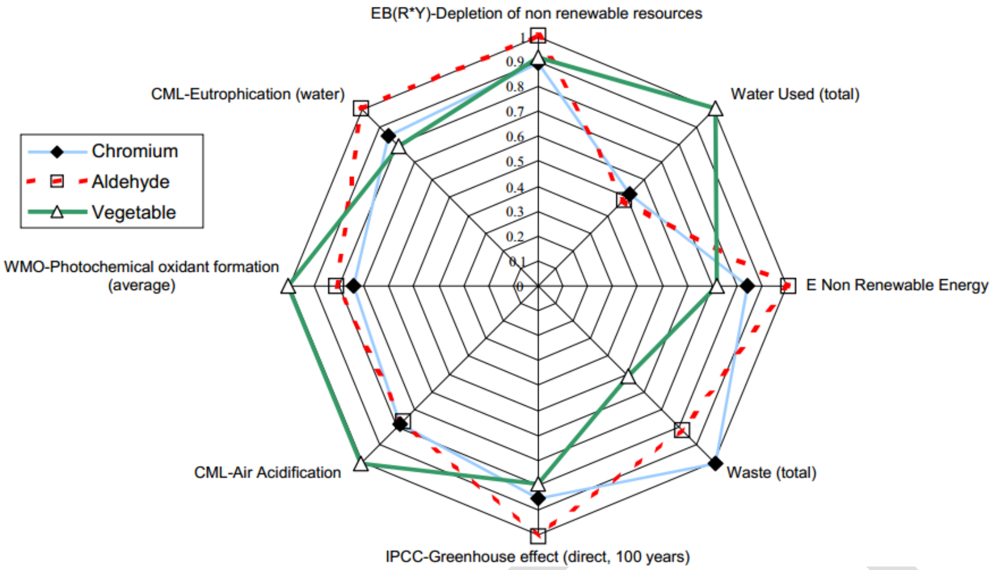


Figure 43: Comparison of tanning technologies[273]

II. Hazardous substances

Two other studies (Herva et al., 2011 and Kurian et al., 2009) focus on substances-related issues and provide more detailed information on the types of chemicals used in leather processing. However, they do not provide results for recognized LCA impact categories. In addition, the results are not detailed as they can be at substances level.

Note: The impacts related to hazardous substances will be analysed further in chapter (see section 3.2.6) treating environmental issues not precisely detected by LCA and defined as "non-LCA impacts".

III. Environmental impacts of textiles

The JRC has recently produced a study addressing the “Environmental Improvement Potential of Textiles”[274].

The LCA results of interests are those that deal with fabric production, since the downstream steps (in particular the use phase) are different for shoes than for clothing and household textiles. Figure 44 shows the environmental impact of textile consumption in the EU-27 according to midpoint and endpoint categories and material. The impact assessment method considered is ReCiPe.

[273] source: (BLC - Leather Technology Centre)

[274] (Environmental Improvement Potential of Textiles (IMPRO-Textiles), 2013)

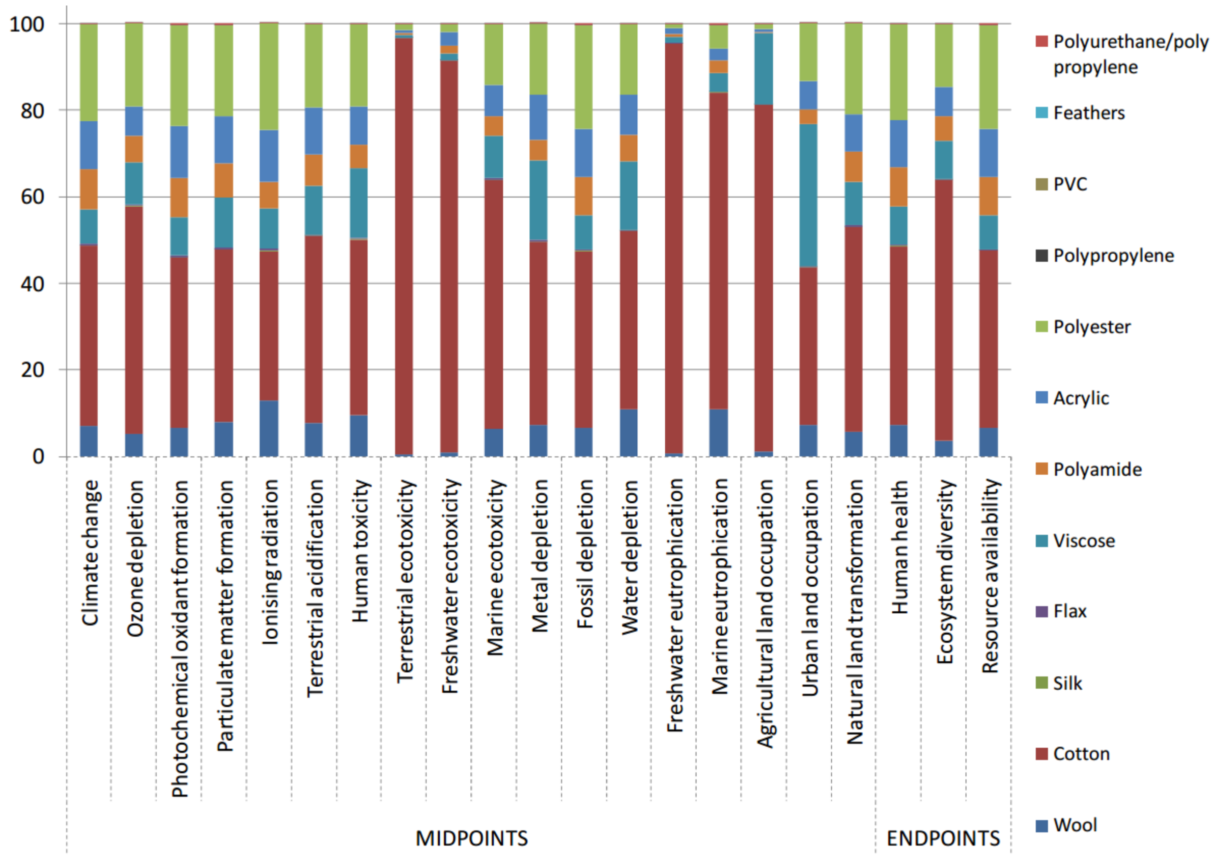


Figure 44: Breakdown by material (in %) of the environmental impacts due to the production phase

The main conclusions of the study are detailed below.

- Cotton is the dominant fibre type in terms of environmental impacts. This is because cotton fibre is the main fibre type used in textiles (more than one third of the fibre production). In addition, environmental impacts per kilogram of fibre are higher for cotton than for the other fibres.
- The main environmental impacts from cotton production arise from the high use of fertilisers and pesticides. Insecticides can be released into the ground and the water (through leaching) and are significant contributors to ecotoxicity. Phosphorus and phosphate compounds from the raw material production process are responsible for most of the potential freshwater eutrophication impacts.
- Polyester has the second most significant environmental impact; after cotton, it is the second most consumed fibre on the European market. Cotton and polyester, account for 35 and 40%, respectively, of the global fibre market[275]. As a synthetic fibre, polyester requires large amounts of energy to be produced; accordingly, it is an important

[275] The role and business case for the existing and emerging fibres in sustainable clothing. 2010. Report from Department for Environmental, Food and Rural Affairs

contributor to energy-related indicators such as. climate change and ionising radiation (nuclear energy is mainly used to produce electricity). Polyester recycling could significantly reduce the quantity of energy required. Since agricultural production is not part of the supply chain, the ecosystem impacts are lower than for cotton.

- Although it represents only 8 % of all fibres by mass, viscose also appears as a relatively high contributor for some impact categories, mainly for categories related to land occupation issues. Viscose is made from sulphate pulp, which is one of the main products from pulp and paper mills.

DEFRA (2010) has also classified the textiles fibres with respect to the different environmental impact categories (Figure 45). The results of this analysis have shown that current dominant fibres such as cotton and polyester have relatively high environmental impacts but that their technical qualities and low cost make them appealing to both industry and consumers. Recycling polyester, via waste textiles or other polyester waste streams, can significantly cut energy use, resource depletion and greenhouse gas emissions. Organic cotton production can reduce the toxicity, energy use and GHG emission environmental impacts of growing cotton and has the potential to deliver added social benefits. However, consumption of organic cotton needs to be encouraged above the current low levels. It is important to note that organic cotton yields are generally lower, consequently, a commensurate increase in agricultural land development can be expected as organic cotton replaces traditionally grown cotton. Some niche and emerging fibres have considerably smaller environmental profiles but are incompatible with the existing industrial infrastructure (e.g., hemp, flax) or are still under development (e.g., PLA). Consequently, niche fibres are expected to remain so for the foreseeable future.

Decreasing environmental impact ↓

Energy use	**Water use**	**Greenhouse gases**	**Waste water**	**Direct land use**
Acrylic Nylon Polyester/PTT *Regen. cellulosic (viscose, Modal)* PLA/Cotton/Lyocel Wool *Natural bast fibres* [1](nettle, hemp,flax)	Cotton Silk Nylon *Regen. cellulosic* Acrylic Hemp Wool *Natural bast fibres* Polyester	Nylon *Synthetic* Polyester Lyocell PLA Viscose Modal Cotton *Natural bast fibres* Wool	Wool *Regen. cellulosic* *Natural bast fibres* Nylon Polyester	Wool Ramie Cotton Flax Hemp Viscose and Modal Jute PLA Lyocell *(Synthetic)*

Figure 45: Classification of textile fibres on environmental impact categories[275]

These conclusions are in general terms aligned with the IMPRO study. However, the comparison is not straightforward because the IMPRO study gives results at the European market level, while DEFRA (2010) gives results on the basis of unit mass of fibre, independent of its relative importance on the market.

3.3 Specific case study of LCA for footwear

3.3.1. Goal of the study

The scope of the EU Ecolabel for footwear is broad, therefore, in addition to the literature review, a specific LCA was performed in order to assess the previously highlighted findings. This additional LCA assesses the environmental impacts of an average pair of shoes based on the material segmentation established in Task 2: Market analysis.

More precisely, the study will focus on the following points:

- Identify the “hot spots” of the studied system, i.e., critical stages, processes and materials which contribute significantly within each environmental impact category.
- Conduct a sensitivity analysis for relevant key performance parameters (e.g., energy consumption, amount of materials used) along the life cycle and identify the most relevant ones. The values considered for the sensitivity analysis take into account different sets of parameters defined as variable from one pair of footwear to another.
- Develop conclusions that address the most important criteria areas of relevance for the revision, including their priority and feasibility.

Because the goal of the study is not to quantify in absolute terms the environmental performance of a pair of shoes, the analysis will focus on relative figures (percentage of contribution). However, absolute results will also be displayed for the completeness of the study.

3.3.2. Methodology

I. Compliance with ISO 14040

This analysis is performed on basis of the **Life Cycle Assessment (LCA) Methodology**. LCA is a method for compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle. The general methodology for LCA is used as described in the IS014040:2006 and ISO14044:2006 standards.

II. Compliance with PEF

This analysis will also follow the Product Environmental Footprint (PEF) guide as much as possible, including the structure of the report and the methodological rule considered for multi-functionality in recycling situations. However, some of the requirements of PEF methodology were not fully applied for the goals of this specific LCA:

- PEF requires using the ILCD nomenclature and properties
- PEF requires specifying, justifying and reporting the key areas that would be covered by a PEFCR for footwear,
- PEF requires performing a data quality assessment for studies intended for external communication.

Implementation of ILCD nomenclature and properties

Requirement for PEF studies on ILCD nomenclature and properties**:**

All relevant resource use and emissions associated with the life cycle stages included in the defined system boundaries shall be documented using the International Reference Life Cycle Data System (ILCD) nomenclature and properties.

PEF requires using the ILCD nomenclatures and properties[276] (or format), that is to say. The list of elementary flows in the Resource Use and Emissions Profile gathered in the LCI.

The ILCD format is currently implemented in commercial software but it was not available for this study. The LCI data used for the purposes of this study were obtained mainly from Ecoinvent and use the EcoSpold format. The translation between different data formats is not trivial and requires substantial amount of work and interpretation.

Development of a PEFCR[277] for footwear

Requirement for PEF studies on PEFCR:

In absence of PEFCRs, the key areas that would be covered in PEFCRs (as listed in the PEF Guide) shall be specified, justified and explicitly reported in the PEF study.

Several methodological assumptions must be made because PEF does not provide sufficiently precise guidance on them. The following points would then require discussions and agreement between PEF experts, for example, through the development of a PEFCR:

- What is the functional unit and how should the durability of footwear be calculated?
- The choice of allocation rules for animal breeding and slaughterhouse; shall the leather be considered as a co-product or by-product of meat and milk production? In case of a co- or a by-product, which allocation rules shall be chosen (economic, mass…)?
- The choice of impact categories: PEF requires by default display of the results for all 15 existing impact categories. PEFCR will specify the list of impact categories relevant for the product group.

These points will be discussed in the report. In particular, the second point will be assessed through a sensitivity analysis. As other PCRs exist (ADEME-AFNOR and from EPD), they will be used to complete these methodological choices.

[276] European Commission - Joint Research Centre - Institute for Environment and Sustainability (2010f). International Reference Life Cycle Data System (ILCD) Handbook – Nomenclature and other conventions. First edition. EUR 24384.Publications Office of the European Union, Luxembourg. http://lct.jrc.ec.europa.eu/assessment/publications.

[277] Product Environmental Footprint Category Rules

Data quality assessment

In order to compare this analysis with the LCA literature review, the quality of the study conducted will be evaluated through the same scoring system used for the literature review (see chapter 3.2.4). This approach differs a bit from the one recommended in the PEF guidance, which is summarized in the frame below.

Requirement for PEF studies on data quality:

Data quality requirements shall be met by PEF studies intended for external communication, i.e., B2B and B2C. For PEF studies (claiming to be in line with this PEF Guide) intended for in-house applications, the specified data quality requirements should be met (i.e., are recommended), but are not mandatory. Any deviations from the requirements shall be documented. Data quality requirements apply to both specific and generic data.

The following six criteria shall be adopted for a semi-quantitative assessment of data quality in PEF studies: technological representativeness, geographical representativeness, time-related representativeness, completeness, parameter uncertainty and methodological appropriateness.

In the optional screening step a minimum "fair" quality data rating is required for data contributing to at least 90% of the impact estimated for each EF impact category, as assessed via a qualitative expert judgement.

In the final Resource Use and Emissions Profile, for the processes or activities accounting for at least 70% of contributions to each EF impact category, both specific and generic data shall achieve at least an overall "good quality" level (the 70% threshold is chosen to balance the goal of achieving a robust assessment with the need to keep it feasible and accessible). A semi-quantitative assessment of data quality shall be performed and reported for these processes. At least 2/3 of the remaining 30% (i.e. 20% to 30%) shall be modelled with at least "fair quality" data. Data of less than fair quality rating shall not account for more than 10% contributions to each EF impact category.

The data quality requirements for technological, geographical and time-related representativeness shall be subject to review as part of the PEF study. The data quality requirements related to completeness, methodological appropriateness and consistency, and parameter uncertainty should be met by sourcing generic data exclusively from data sources that comply with the requirements of the PEF Guide.

With respect to the data quality criterion of "methodological appropriateness and consistency", the requirements as defined in Table 6 shall apply until the end of 2015. From 2016, full compliance with the PEF methodology will be required.

The data quality assessment of generic data shall be conducted at the level of the input flows (e.g. purchased paper used in a printing office) while the data quality assessment of specific data shall be conducted at the level of an individual process or aggregated process, or at the level of individual input flows.

III. LCA Software used for the specific LCA: RangeLCA

Assessment of the lifecycle impacts was performed with the support of the RangeLCA (see Annex VII). The basic concept of RangeLCA is that results must represent the diversity of individual cases (rather than a typical case with its few alternative scenarios).

From a mathematical point of view, this concept leads to the use of random variables, rather than fixed "typical values”. A range of different values (for which calculations are made with a sufficient number of iterations) are used to produce results statistically relevant.

For each parameter for which data vary in a wide range, all values between their extreme values (min-max) are considered, attributing a certain probability of occurrence and appropriate probability distribution to each value. The results obtained through this method provide a wide range of possible combinations for the variability of the different parameters and data, and also the synergetic effects and potential compensations.

Classification of the results according to the value of a parameter makes it possible to identify the sensitivity of the results according to this parameter. In practice, it is possible to determine automatically the parameters for which the results are most sensitive, as shown in the Figure 46.

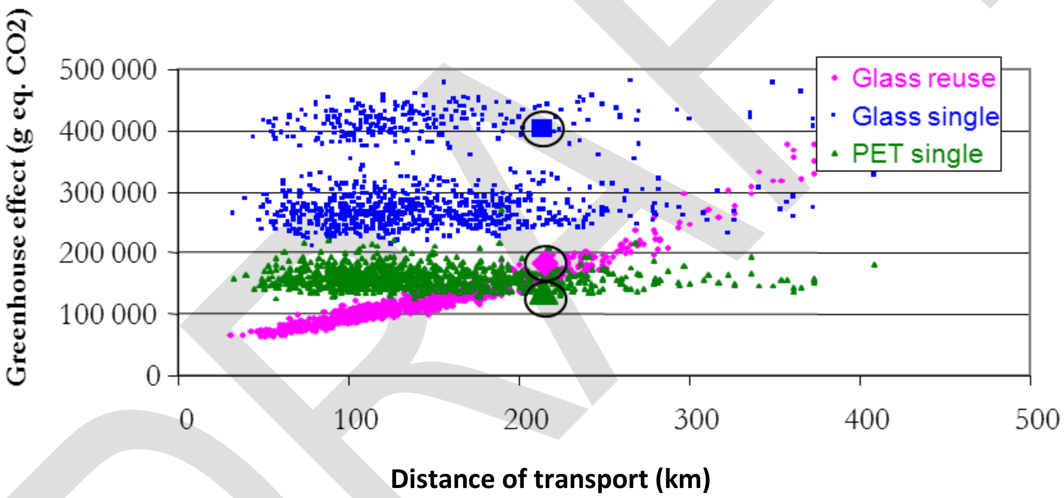


Figure 46: RangeLCA approach – sensitivity analysis

The slope represents the relative importance of the parameter (in the example the distance of transport) on the final results (in the example the greenhouse effect). The dispersion of the points represents the variability/uncertainty due to others parameters. In one figure, we can thus identify the relative influence on the parameter in abscissa (slope analysis), identify the break-even point where one system becomes better/worse than another and have robust conclusion taking into account the variability of all parameters together.

Carrying out a data inventory, this software can also calculate automatically the contributions to the different elementary flows (emissions in air, water, soil, etc.). Also, the total impacts can be derived for each process. This makes it possible to focus the research on the key hypotheses and data.

For more information on the tool, refer to Annex VII.

3.3.3. Scope of the study

I. Functional unit and reference flow

An important phase of the LCA consists in accurately defining the functional unit, which is the function fulfilled by the system studied. The environmental impacts are calculated referring to a “reference flow”. The functional unit should be defined to allow accurate measurements and calculations.

Any functional unit should ideally reflect the function of a product in terms of quantity, quality/performance and durability in order to make consistent comparisons between products[278]. In order to assess “how many” products are required to fulfil the functional unit, it is necessary to evaluate the durability of the product in hand. However, quantitative evaluation of this parameter is very complex because it is subject to a variety of variables, such as technical factors (resistance of the product), weather conditions and fashion factors; fashion often determines if consumers dispose of a product because it does not follow current fashion trends, and not because its state of usage.

Different reference documents can be considered to define the functional unit and durability:

- The PEF guidance does not provide specific indications for different products.
- The PCR from ADEME-AFNOR in the framework of the environmental labelling proposes evaluation of the durability based on product mechanical resistance, calculated with respect to NF and ISO standard tests.
- PCRs from International EPD System® do not require evaluating the durability of products, but only to declare it. The person who performs the LCA can then choose how to assess the durability, which may lead to inconsistences between studies.

The chosen functional unit for this LCA is adapted from the PCR from (ADEME-AFNOR, 2010), which takes into account the time factor (as required by PEF):

To wear and use appropriately shoes in good conditions for one year.

Note: The duration of “one year” must be considered with caution. This “one year” represents 365 days that the product is actually worn. In other terms, if a consumer owns a pair of shoes and uses it once every two days during one year, the corresponding usage time is half a year.

This functional unit does not take into account variations of use and functionality (e.g., sport, trekking, all-day, etc.), nor fashion aspects, because the PCR was developed for town footwear only. The ADEME-AFNOR working group is currently working on adaptation of this PCR to other types of footwear.

The **reference flow** is the amount of product necessary to satisfy the functional unit. In order to ensure comparability among products as well as consistency of the method, the PCR from ADEME-AFNOR (2010) established a method for the calculating the reference flow. The reference flow depends on the mechanical resistance of the shoes, which must be estimated by using several

[278] PEF methodology precisely defines the functional unit through 4 characteristics: “what”, “how much”, “how well”, and “how long”

standard tests. These tests are from the Norme Française (NF) with corresponding ISO norms, as detailed in Table 60.

Table 60: Test methods proposed by ADEME-AFNOR

Test method	ISO norm	Unit
Whole shoe - Upper sole adhesion	ISO 17708	daN / cm
Insoles - Abrasion resistance	ISO 20868	mm³
Outsoles - Flex resistance	ISO 17707	Cycle
Uppers, linings and insocks - Tear strength	ISO 17696	daN
For the lining Textiles - Determination of the abrasion resistance of fabrics by the Martindale method -- Part 2: Determination of specimen breakdown	ISO 12947-2	Cycle

By default, in particular if the tests have not been performed, the reference flow is two pairs of shoes. This assumption was also considered also for this study, meaning that a consumer uses two pairs of shoes every year. This choice does not impact the analysis, the purpose of which finding the hot spots and key performance parameters. Absolute results for other reference flows can be calculated by proportion. This approach does not allow comparing different pairs of footwear with respect to their durability.

For more information, consult the Annex VIII which provides detailed explanation of the reference flow methodology of the ADEME-AFNOR PCR.

II. System boundaries

The system boundaries considered are presented in the Figure 47.

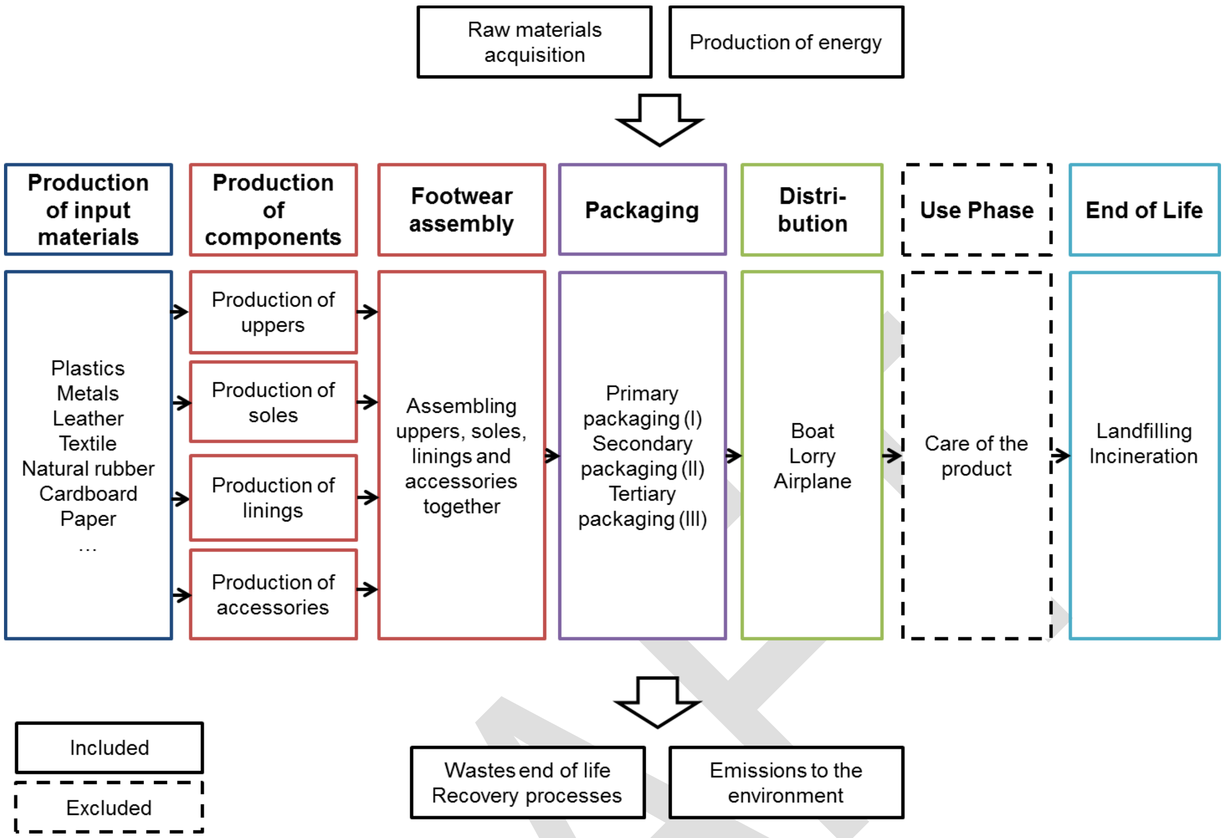


Figure 47: System boundaries[279]

The Figure 47 presents the system boundaries covered by the study:

- Upstream processes:
  - Extraction of raw materials and processing into intermediate products to be used in the manufacturing of footwear;
  - Transport of these input materials up to the footwear manufacturing site(s) by truck, boats and plane;
  - Production and supply of packaging (primary, secondary and tertiary).
- Core process: production of the footwear, including processing of intermediate products (so-called input materials) into components (upper, sole, and linings), and assembly of the footwear.
- Downstream processes:
  - Distribution of the packed footwear, up to its retailing store (going through different warehouses);
  - The end of life of footwear treated as household waste.

[279] Source: RDC Environment

The use phase is excluded in the current analysis. Nowadays, the average footwear is not specifically maintained by the consumers; footwear care is generally limited to mechanical cleaning or brushing. In some specific cases, waxes and other care products may be used, but they are considered as negligible in reference to the other life cycle stages. This approach is consistent with the PCR of ADEME-AFNOR, Milà et al. (1998) and Simple Shoes (2008) that exclude the use phase from the system boundaries. Cheah et al. (2012) highlights that the use phase accounts for less than 1 % of global warming potential (see. chapter 3.2.5). However, the period of time that one pair of shoes is actually used in appropriate conditions will have a dramatic effect on the overall impacts.

III. Impact categories

The impact categories considered in the assessment are those selected previously for evaluation of the studies found in the literature (see chapter 3.2.3). The LCIA methods chosen are those recommended by PEF. This means that the indicators considered are nine, rather than six, because the category eutrophication is split into terrestrial, aquatic/freshwater and aquatic/marine, and the category resource depletion is split into water, fossil and renewable. The categories assessed are presented (in bold) in the Table 61.

Table 20 includes all of the impact categories recommended by PEF. However, the focus of this analysis has been only on the ones that were considered more relevant for this product group according to methodology applied to previous literature review analysis. In addition, some LCIA methods are not reliable, or the ILCD does not recommend any LCIA method.

Table 61: Impact categories and LCIA methods recommended by PEF (all) and considered in this study (bold)

Impact category	Acronym	Recommended LCIA method by ILCD	Evaluated	ILCD classification	Reason for exclusion
Climate change	**GWP**	**IPCC**	**Yes**	**I**	
Ozone depletion	**OD**	**WMO**	**Yes**	**I**	
Human toxicity (cancer and non-cancer effects)	-	USEtox	No	II/III	Low reliability
Particulate matter/Respiratory inorganics	-	RiskPoll	No	I	Format issues
Ionising radiation, human health	-	Frischknecht et al.	No	II	Format issues
Ionising radiation, ecosystems	-	-	No	-	No recommended LCIA method
Photochemical ozone formation	**POF**	**Lotos-Euros**	**Yes**	**II**	
Acidification	**A**	**Accumulated exceedance**	**Yes**	**II**	
Eutrophication, terrestrial	**TE**	**Accumulated exceedance**	**Yes**	**II**	
Eutrophication, aquatic, freshwater	**FE**	**ReCiPe**	**Yes**	**II**	
Eutrophication, aquatic, marine	**ME**	**ReCiPe**	**Yes**	**II**	
Ecotoxicity (freshwater)	-	USEtox	No	II/III	Low reliability
Ecotoxicity (terrestrial and marine)	-	-	No	-	No recommended LCIA method
Land use	-	SOM	No	III	Format issues / low

Impact category	Acronym	Recommended LCIA method by ILCD	Evaluated	ILCD classification	Reason for exclusion
					reliability
Resource depletion, water	**WC**	**Frischknecht et al.**	**Direct flow**	**III**	**Format issues**
Resource depletion, fossil and renewable	**RD**	**CML**	**Yes**	**II**	

3.3.4. Data sources and description

I. Data collection

In order to have relevant and reliable data for evaluating the environmental impacts of footwear, a questionnaire was developed and sent to registered stakeholders. The total number of response was 13. Of these, four did not provide any quantitative information, only general comments on performing this LCA.[280]

The questionnaire addressed the different life cycle stages considered from the footwear supply chain perspective. Most stakeholders did not provide responses for all stages; only one stakeholder addressed all of them. Table 21 below details how many answers were received for each life cycle stage.

Table 62: Questionnaire's answers

Input materials	Manufacturing of footwear	Packaging and Distribution	End of life	Focus on leather production
6	4	4	1	4

II. Characterization of the data

There are two types of data used in LCA studies:

- **Model parameters**: quantitative information expressing the relationships between unit processes and the product system (e.g., transport distance, incineration rate, electricity consumption);
- **Elementary flows**: input/output from the product system to the environment and vice versa, corresponding to the use of resources and emissions, i.e., the so-called LCI.

Parameters can be:

[280] http://susproc.jrc.ec.europa.eu/footwear/docs/Footwear_Questionnaire_II.xls

- **Specific (or primary)** - Definition of primary data from ISO 14067: quantified value originating from a direct measurement or a calculation based on direct measurements of a unit process of the product system at its original source.
- **Generic (or secondary)** - Definition of secondary data from ISO 14067: quantified value of an activity or life cycle process obtained from sources other than direct measurement or calculation from direct measurements.).

III. Description and documentation of elementary flows

Elementary flows used for this study are secondary data mainly obtained from the **Ecoinvent** database v2.2[281], one of the most common and used database at the European level.

Other sources of LCI were also used for the study, because some data are not available in Ecoinvent or because these other sources are considered as having a better quality: PlasticsEurope 2005 was used for the production of plastics pellets, Worldsteel was used for the production of steel, European Association of Aluminium (EAA) was used for aluminium, and GaBi 4[282] was used for the production natural rubber, and leather imitation (PVC, PU). ELCD[283] was not directly used because of nomenclature and property issues (as expressed in chapter 3.3.2[284]). However, when data from Ecoinvent were old and better quality data existed in ELCD, the most relevant elementary flows were corrected using ELCD data. This was the case for copper.

The full table of LCI data used is presented in Annex VI. The annex specifies for what materials and what processes that LCI data are used.

IV. Description and documentation of model parameters

Because this LCA does not address one specific pair of shoes, but rather average footwear for the European market, all parameters are introduced as variable parameters of mainly three types:

- Uniform distribution between two extreme values (minimum and maximum) when the average is not known among several values,
- Discrete distribution between different scenarios when the scenarios are exclusive,
- Normal distribution around a typical value when the average value is known or estimated.

Analysis of Input materials

Agriculture, breeding and slaughtering

[281] (ecoinvent) http://www.ecoinvent.ch/

[282] GaBi is the name of the database developed by PE International

[283] European reference Life Cycle Database

[284] ELCD uses the ILCD nomenclature and properties as this specific LCA uses Ecospold

As found by several researchers (Milà et al.), (UNIDO, 2012), (DANI, 2011), the allocation rule related to agriculture, breeding and slaughtering is a factor that could have a great influence on the results. Therefore, it has been decided conduct a separate sensitivity analysis of this environmental issue in order not to perturb the conclusions drawn for the other phases. It is also important to mention that currently there is no complete LCI available for this life cycle phase, so all impact categories could not be assessed.

A specific chapter (3.3.6) will discuss the variability of the results depending on the assumed allocation rule, and its related sensitivity. This discussion is based on the results of Milà et al. (2002) on four impact categories: climate change, photochemical ozone formation, eutrophication and acidification. The results must be interpreted with caution because final LCIA results are used from one study, representing one specific situation. Uncertainty around these results has been introduced as variable parameter (normal distribution of a multiplying factor) in order to assess the importance on having accurate data.

In this sense, Milà et al. (2002) used an economic allocation which corresponds to an allocation rule of 7.7 % of cattle impacts to leather. The last revision of the EU Ecolabel for footwear[285] considered a mass allocation corresponding to 6 % of the impacts allocated to leather. If one considers the skins and hides as a by-product of meat and milk industry, the allocation rule could be assumed to be equal to 0 %, being equivalent to considering that the main function of cattle rising is producing meat and milk products. In other words, the system boundaries of leather production would only start at the exit of the slaughterhouse.

For the purposes of this study, the allocation rule has been set as uniform parameter: from 0 to 50%

<u>Footwear composition (bill of materials)</u>

Footwear can be composed of many different materials depending on several parameters (e.g., use, fashion)[286]. Therefore, an average pair of footwear is considered by using the data previously gathered[287] for the market volume segmentation based on the material composition of footwear consumed in EU27 in 2011 (see Table 63). This mass balance presented below is consistent with that reported by Lee et al. (2012):

- Rubber fraction: 35-55 %
- Foam and leather: 30-50 %
- Textiles: 15-25 %
- Metal fraction: 5-10 %

The mass balances are not perfectly comparable because Lee et al. (2012) does not differentiate foam and leather, and because the study does not address wooden shoes. Given that, an uncertainty distribution is introduced for the mass of the input materials, influence on the variation of the results is assessed through sensitivity analysis.

[285] (Study for the Footwear Criteria Revision, 2008)

[286] Refer to chapter 1. Task 1: Stakeholder survey, statistical and legal review, scope and definition proposalfor more details

[287] See chapter 2. Task 2: Market analysis

In the LCI database used, 19 materials have been identified based on analysis of the most common materials used in footwear production.

The mass of each component is then set as a variable parameter and is equally shared among corresponding category. The total mass of footwear varies from 400 to 1200 g (according to stakeholders' feedback).

Example - mass of cotton is equal to: 0.19*U(400,1200)/3, where U(400,1200) represents a uniform distribution between 400 and 1200 g.

The Table 63 presents the market segmentation from Eurostat and the materials considered for the LCA modelling, with the range of values calculated.

Table 63: Average material composition of footwear

Eurostat nomenclature	Composition of footwear			Materials assumed for the modelling
	Min	EU27 consumption in 2011	Max	
Rubber and plastics uppers	20 %	43 %	69 %	Natural rubber, Fake leather PU, Fake leather PVC, ABS, PU, Latex, EVA, Polyethylene
Leather uppers	10 %	24 %	49 %	Average leather
Textile uppers	7 %	19 %	41 %	Cotton, Acrylic, Polyester
Wooden soles	0 %	1 %	3 %	Non sustainable wood, Sustainable wood, Cork
Unspecified composition	5 %	13 %	31 %	Nylon, Aluminium, Steel, Copper

The figure for the unspecified composition has been attributed to accessories (e.g., buttons, rivets…) not mentioned by the Eurostat statistics.

Modelling leather

Leather has mainly been modelled by using the data available in the COTANCE Social and Environmental Report 2012[288]. The Confederation of National Associations of Tanners and Dressers of the European Community (COTANCE) is the representative body of the European Leather Industry. Those data have been completed with the information gathered from stakeholders.

Modelling textiles

Textiles have been modelled directly by using existing LCI (from PlasticsEurope 2005 and ecoinvent v2.2).

[288] (Social and Environmental Report, 2012)

Modelling synthetic materials

Synthetic materials have been modelled directly by using existing LCI (from PlasticsEurope 2005, ecoinvent v2.2, or GaBi 2011).

The Table 64 summarizes the parameters used for production of input materials.

Table 64: Parameters – Input materials

Material	Data	Value	Distribution	Source
Leather	Chemicals	Min: 1.96 kg/m² Max: 2.09 kg/m²	Uniform	COTANCE report 2012
	Electricity consumption	Min: 1.9 kWh/m² Max: 2.1 kWh/m²	Uniform	COTANCE report 2012
	Water consumption	Min: 129 l/m² Max: 132 l/m²	Uniform	COTANCE report 2012
	Wastes	Min: 2.12 kg/m² Max: 2.16 kg/m²	Uniform	COTANCE report 2012
	Surface density	Min: 5 kg/m² Max: 10 kg/m²	Uniform	Two stakeholders
Cotton	Origin of production	USA China	Discrete	-
Each material	Mass	Min: 21 g/pair Max: 63 g/pair	Uniform	-
Footwear	Mass	Min: 400 g/pair Max: 1200 g/pair	Uniform	Stakeholders and literature

Manufacturing of footwear

Manufacturing of footwear has been modelled by using parameters gathered from stakeholders and existing LCI of ecoinvent v2.2.

Two different electricity grid mixes have been considered in order to show the variability on this parameter: Chinese electricity mix and European electricity mix. Those two mixes have been chosen because they represent most of the footwear in the European market[289] and because they show very different characteristics from an LCA point of view. As shown in Table 24, the Chinese electricity mix uses more fossil fuels, such as coal, while European electricity mixes use a significant share of nuclear.

[289] Refer to chapter 2. Task 2: Market analysis for more details

Table 65: Electricity grid mixes of China and Europe[290]

	China	Europe
Coal	79%	26%
Oil	1%	3%
Gas	1%	24%
Nuclear	2%	25%
Hydroelectricity	17%	15%
Wind power	0%	3%
Other	0%	4%

The Table 66 summarizes the parameters used for the product manufacturing.

Table 66: Parameters – Manufacturing

Life cycle stage	Data	Value	Distribution	Source
Electricity consumption	Consumption	Min: 0.5 kWh/pair Max: 6 kWh/pair	Uniform	4 stakeholders French PCR
	Mix	Europe China	Discrete	Task 2
Heat consumption	Consumption	Min: 0.5 MJ/pair Max: 2 MJ/pair	Uniform	2 stakeholders
	Mix	Natural gas Hard coal Fuel	Discrete	-
Adhesive	Mass	Min: 20 g/pair Max: 100 g/pair	Uniform	2 stakeholders
Solvent	Mass	Min: 20 g/pair Max: 80 g/pair	Uniform	2 stakeholders
VOC emissions		Min: 18 g/pair Max: 22 g/ pair	Uniform	2 stakeholders
Wastages rate	Percentage	Min: 0 % Max: 20 %	Uniform	3 stakeholders
	End of life	Landfill Recycle/reuse Incineration	Discrete	-

[290] IEA, 2008

Transport, distribution and packaging

Transport, distribution and packaging have been modelled by using activity data gathered from stakeholders and existing LCI from COPERT IV[291] (transport – Table 26) and ecoinvent v2.2 (packaging – Table 27).

Table 67: Parameters – Transport

Life cycle stage	Data	Value	Distribution	Source
Input materials supply	Distance	Min: 100 km Max: 2000 km	Uniform	3 stakeholders
Truck continental distribution	Distance	Min: 500 km Max: 2000 km	Uniform	French PCR
Intercontinental transport	Distance	Min: 10000 km Max: 20000 km	Uniform	French PCR
	Share of airplane transport vs. boat	Min: 0 % Max: 5 %	Uniform	-
Truck transport final distribution	Distance	Min: 500 km Max: 1000 km	Uniform	French PCR

Table 68: Parameters – Packaging

Life cycle stage	Data	Value	Distribution	Source
Packaging I	Mass of cardboard	Min: 20 g/pair Max: 150 g/pair	Uniform	4 stakeholders
	Recycling content/rate	Min: 70 % Max: 100 %	Uniform	2 stakeholders
	Plastic bag (PE, PP, PS)	Min: 30 g/pair Max: 60 g/pair	Uniform	-
Packaging II	Mass of cardboard	Min: 500 g Max: 1500 g	Uniform	2 stakeholders + confidential data from RDC
	Amount of products per secondary packaging	Min: 10 Max: 20	Uniform	2 stakeholders + confidential data from RDC
Packaging III	Mass of plastics (PE)	400 g	-	Assumptions
	Mass of pallet	25 kg	-	ecoinvent
	Amount of products per tertiary packaging	325	-	Assumptions

[291] http://www.emisia.com/copert/General.html

End of life

For the end of life scenario, footwear is supposed to be treated as household waste. Landfill and incineration are the two main treatment systems in Europe. Distribution between the two scenarios has been taken from Eurostat[292] based on data from 2011:

- 38 % for incineration and
- 62 % for landfill.

For sensitivity analysis, a uniform distribution from 0 to 100% has been assumed for the two scenarios, with the constraint that the sum of the two parameters adds up to 100%.

Landfill

The landfill has been modelled via the calculation module ecoinvent v2.2. The major principles of this module are the following:

- The waste is characterized through its main chemical elements.
- Coefficient transfers for each chemical element to the outputs of the landfill site are used to model the emissions to air and water as a function of
    - The waste composition.
    - The degradation rate of each material, over 100 years. For plastics and metals, the degradation rate is close to 0.

  These coefficient transfers come from theoretical models, because no measurements have been possible on the time scale required (>100 years).
- The biogenic carbon is accounted separately from fossil carbon

Some materials present in the display are not modelled in ecoinvent tool. Therefore, their end of life is estimated based on the most representative material in the same component.

Incineration

Incineration has been modelled via the calculation module ecoinvent v2.2. The major principles of this module are the following:

- The characterization of waste regarding the main chemical elements (see table above).
- Coefficient transfers for each chemical element to the outputs of the incinerator are used to model the emissions to air, water, bottom ash and residual smoke from household waste incineration as a function of the waste composition. These coefficient transfers come from an average mass balance done on the input and output of different incinerators.
- The consideration of energy consumptions and of chemicals for flue gas cleaning

Energy recovery has then been added so that it is taken into account.

[292] (Eurostat database) http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/themes

In addition, the carbon balance has been checked and corrected, as needed.

Some minor materials present in the shoes are not modelled in Ecoinvent tool. Therefore, their end of life is estimated as for the most representative material in the same component.

Energy recovery at the incinerator level implies the following yields[293]:

- Electrical energy recovered: 11%

  The electricity mix which substitutes the electricity produced is the European average electricity mix.

- Thermal energy recovered: 32 %

  The thermal energy mix which substitutes the heat produced is the European average mix.

Besides, the lower heating value taken into account for the different types of materials are taken from :

- ecoinvent.
- Evaluation en vue de la détermination de la grandeur des compartiments coupe-feu, VKF / AEAI / AICAA, 2007.

3.3.5. Impact assessment results (without agriculture, breeding and slaughtering)

I. Absolute results

Table 69 presents the absolute results for the functional unit and reference flow defined in chapter 3.3.3. Minimum, average and maximum values have been calculated by considering the overall variability of parameters. The reference flow was set equal to 2 in compliance with the PCR of ADEME-AFNOR. This means that a consumer uses two pairs of shoes per year. In order to compute the absolute results for other reference flows, one must simply multiply the results by the proper reference flows.

[293] Source: ELCD database using data from CEWEP (the Confederation of European Waste-to-Energy Plants)

Table 69: Absolute results per functional unit – Reference flow = 2

Impact category	Minimum	Average	Maximum
Climate change (kg CO2 eq.)	12.8	20.8	31.6
Ozone depletion (kg CFC11 eq.)	9.96 E-7	16.2 E-7	24.8 E-7
Photochemical ozone formation (kg NMVOC)	7.45 E-2	11.1 E-2	15.8 E-2
Freshwater eutrophication (kg P eq.)	8.08 E-4	13.8 E-4	21.0 E-4
Marine eutrophication (kg N eq.)	1.50 E-2	2.62 E-2	4.03 E-2
Water consumption (m³)	0.240	0.661	1.44
Resource depletion (kg Sb eq.)	8.74 E-2	14.5 E-2	20.3 E-2
Terrestrial eutrophication (kmol N eq.)	1.56 E-1	2.70 E-1	4.25 E-1
Acidification (kmol H+ eq.)	7.29 E-2	13.9 E-2	25.5 E-2

NB: Normalised results are not provided because there are currently no recognised factors at European level. In particular, there are no recommended factors in PEF.

II. Sensitivity analysis

The sensitivity analysis allows identification of the life cycle phases and parameters which have the most influence on the final results. The sensitivity of a phase or a parameter depends on the impact category considered, therefore, the analysis is performed for the different impact categories analysed.

Key performance parameters

Table 70 shows the key performance parameters identified based on the program RangeLCA and the statistical distribution of all parameters.

The parameters are classified and the five most significant are presented in Table 70 for each impact category. The sensitivity analysis of each parameter is based on its statistical distribution and influence on the results. A score = 1 indicates the most significant parameter while score = 5 indicates the 5th most significant parameters.

The influence of a parameter on a specific indicator is calculated by comparing the variation of final results in relation to the variation of this parameter. This gives a trend for all parameters which is then normalized according to the global variation of results in order to make a fair comparison among all of them.

The indicator of each parameter is calculated using the following formula:

$$i = \frac{p}{\frac{y_{max} - y_{min}}{x_{max} - x_{min}}}$$

Where:

- p is the slope of the linear interpolation of all possible results in relation to the parameter.
- y_max and y_min are respectively the maximum and the minimum possible values of all possible results.
- x_max and x_min are respectively the maximum and the minimum possible values for the parameter considered.

The bigger is an indicator, the more it influences the results. Indeed, it means that the correlation coefficient is strong and that the variation of other parameters does not influence much the variation of results, compared to this parameter.

i = 1 means that the results only depend on the parameter under study.

i = 0 means that the results do not depend at all on the parameter under study.

The different parameters of calculation are displayed in the figure below.

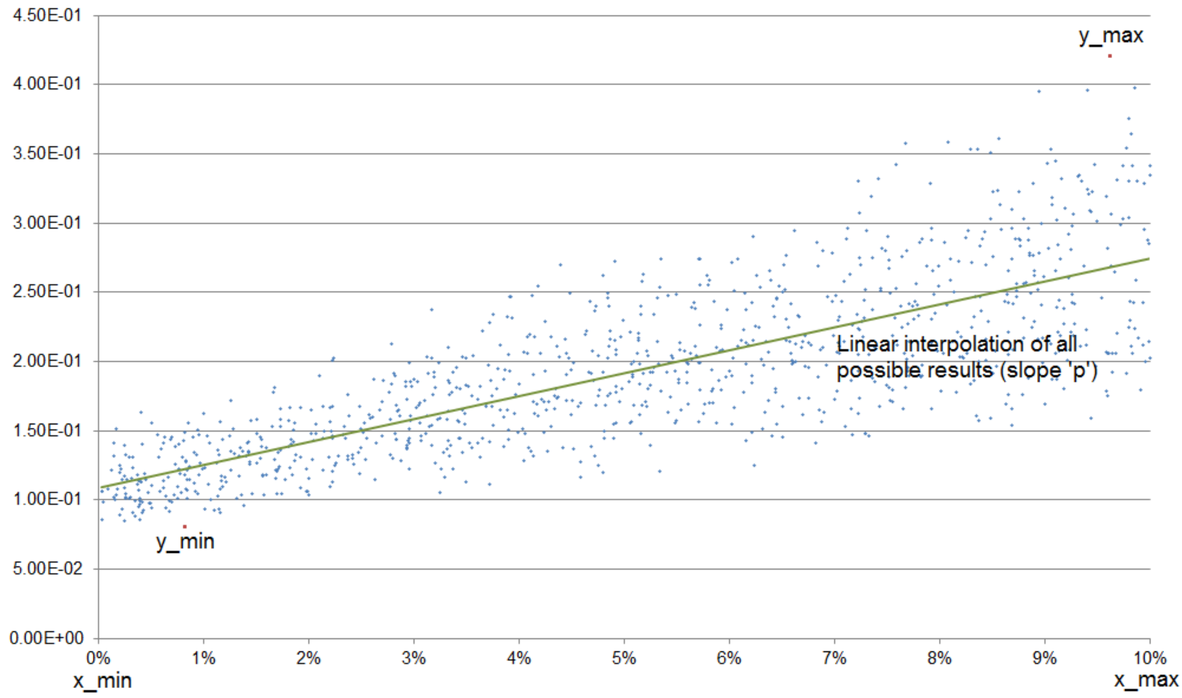


Table 70: Relevant key performance parameters[294]

	Distribution	GWP	OD	POF	FE	ME	WC	RD	TE	A
Energy consumption (manufacturing)	0.5 to 6 kWh	1	3	1	1	1		1	1	1
Electricity mix (manufacturing)	Equal share between China and Europe	2	4	2	3	2		3	2	2
Mass of footwear and choice of input materials	400 to 1200 g	3	1	4	2	3	1	2	3	3
Wastage rate	0 to 20 %	4	2		4	4	2	4	4	
Share of airplane for intercontinental transport	0 to 5 %	5	5	5		5			5	4
Incineration rate at end of life	0 to 100 %							5		5
Quantity of VOC emissions	15 to 25 g			3						

Note: score 1 indicates the most significant parameter while 5 is the 5th most significant parameters of all

As shown in Table 29, the following parameters are clearly the most significant ones:

- Electricity consumption during manufacturing process;
- Electricity mix during manufacturing process;
- Mass of footwear and choice of input materials.

To a lesser extent, the other parameters are also significant to some impact categories.

Wastage rate is a significant parameter because it directly relates to the mass of input materials. The more wastage rate is big, the more input materials are required.

Reminder

Durability is the most sensitive parameter of all on <u>absolute results</u> because part of the reference flow. However, in our analysis of “hot spots” and “key performance parameters”, we have fixed it in order to identify others “hot spots”.

Identification of hot spots (most contributing life cycle stages)

Figure 11 below shows the relative results for each environmental category for **<u>average</u>** values of parameters.

[294] GWP: Climate change, OD: Ozone depletion, POF: Photochemical ozone formation, FE: Freshwater eutrophication, ME: Marine eutrophication, WC: Water consumption, RD: Resource depletion, TE: Terrestrial eutrophication, A: Acidification.

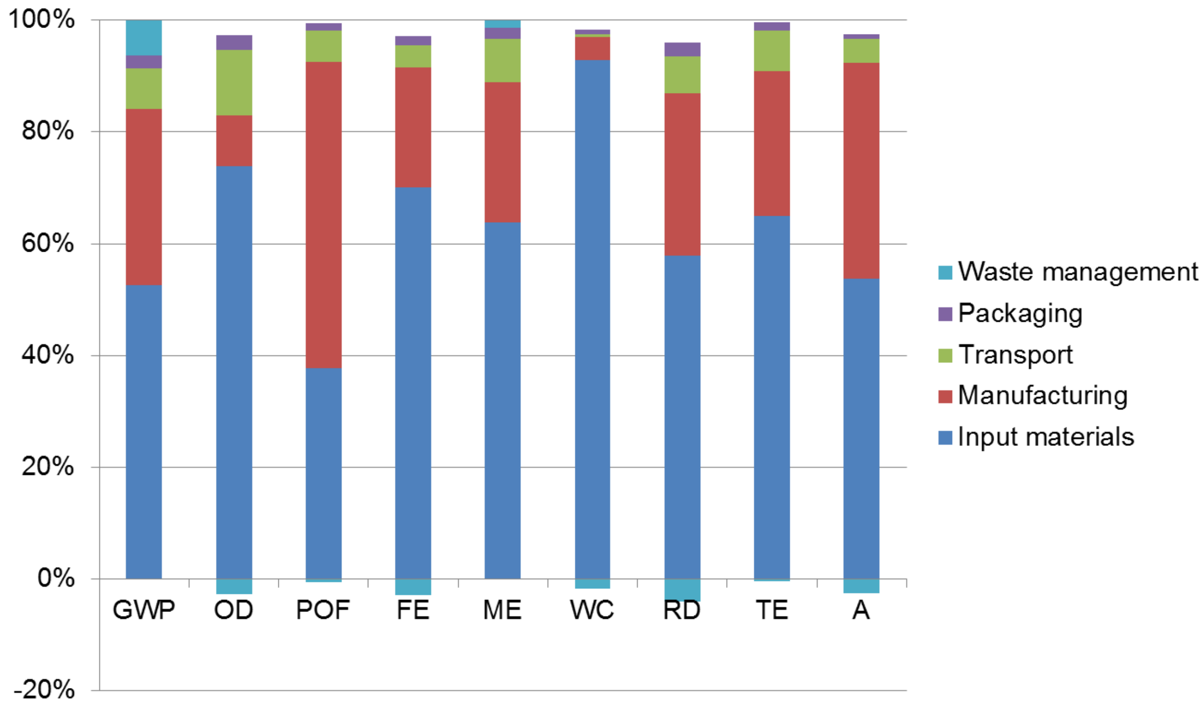


Figure 48: Relative results – Average scenario

For all categories, the impacts are mostly due to the production of input materials (40 to 90 %) and the manufacturing of footwear (5 to 60 %). Distribution has an impact of 2 to 15 % on overall results. Other life cycle stages are of minor importance.

Because data age, data source and study assumptions related to input materials are very different, fair comparisons among different materials cannot be done; thus, no detail is given per material.

Production of input materials has an especially high impact on water consumption due to the production of natural fibres (e.g., some cotton production techniques require lots of water - flood irrigation).

The impacts related to manufacturing are primarily due to the electricity consumption (5 % to 40 % of impacts). Impacts of manufacturing are especially high for photochemical ozone formation due to the VOC emissions related to the use of glues and solvents (37 % of impacts).

Figure 49, Figure 50 and Figure 51 show all possible results when considering all parameters variable (see chapter 3.3.4). One thousand iterations are run for which each parameter has one of its possible values according to its statistical distribution, and independently to the other parameters (unless they are connected).

In other words, each point on the graph represents one possible result representing one possible combination of parameters, i.e., one possible scenario divided into 5 relevant phases marked with respective colour.

The vertical spread of scatter plots represents the variability of contributions on impact categories depending on the variability of parameters. The more it is scattered, the more the variability of parameters influences the results. For the input materials, the variability is mainly due to the mass of the footwear and the type of materials. And for the manufacturing, the variability is mainly due to electricity consumption and electricity grid mix.

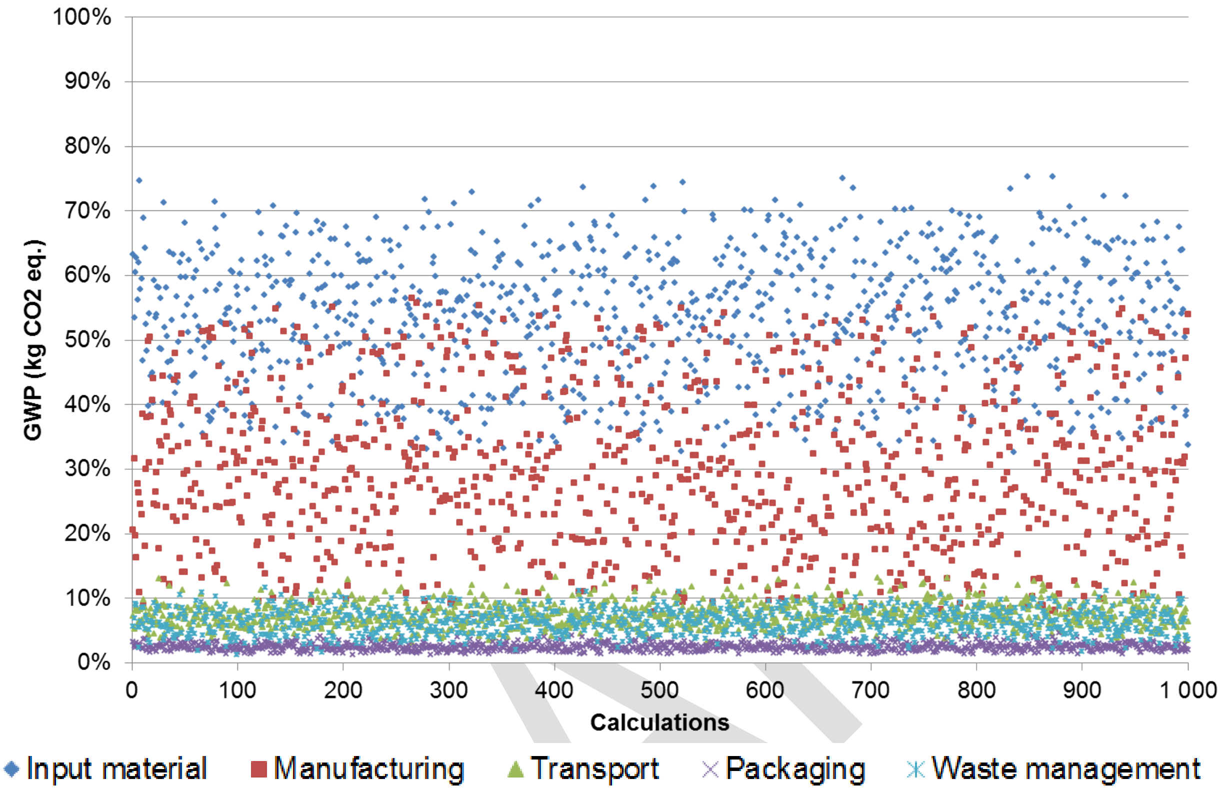


Figure 49: All possible results – Climate change

For climate change (Figure 49 and Table 71), the input materials and footwear manufacturing are always the most significant phases. Input materials are on average more significant than manufacturing, accounting for 35-75% of climate change impact.

For some sets of parameters, however, manufacturing can be more impactful than input materials. This is particularly the case when electricity consumption is high and that the mass of footwear is low (implying less input materials).

Table 71: Distribution of phases – Climate change

Phase	Min	Max
Input materials	35 %	75 %
Manufacturing	10 %	55 %
Transport	3 %	13 %
Packaging	1 %	5 %
Waste treatment	1 %	10 %

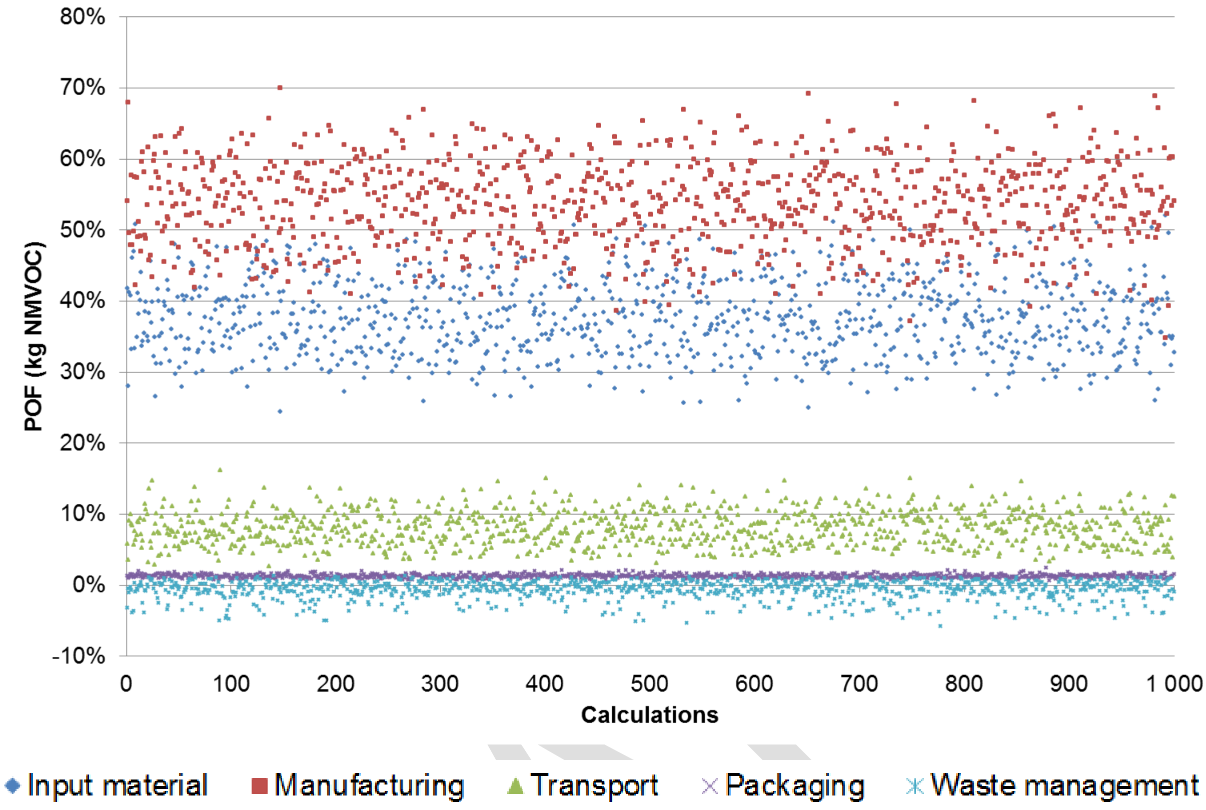


Figure 50: All possible results – Photochemical ozone formation

For photochemical ozone formation (Figure 50 and Table 72), the input materials and the manufacturing of footwear are the most significant phases. However, in this case, manufacturing is on average more significant than input materials, accounting for 35-70% of overall photochemical ozone formation. However, for some sets of parameters, input materials can then be more impactful than manufacturing.

End of life impacts are negative because energy is recovered during incineration and at the landfill, which avoids production of electricity and heat from fossil energy.

Table 72: Distribution of phases – Photochemical ozone formation

Phase	Min	Max
Input materials	25 %	50 %
Manufacturing	35 %	70 %
Transport	3 %	15 %
Packaging	1 %	2 %
Waste treatment	-5 %	1 %

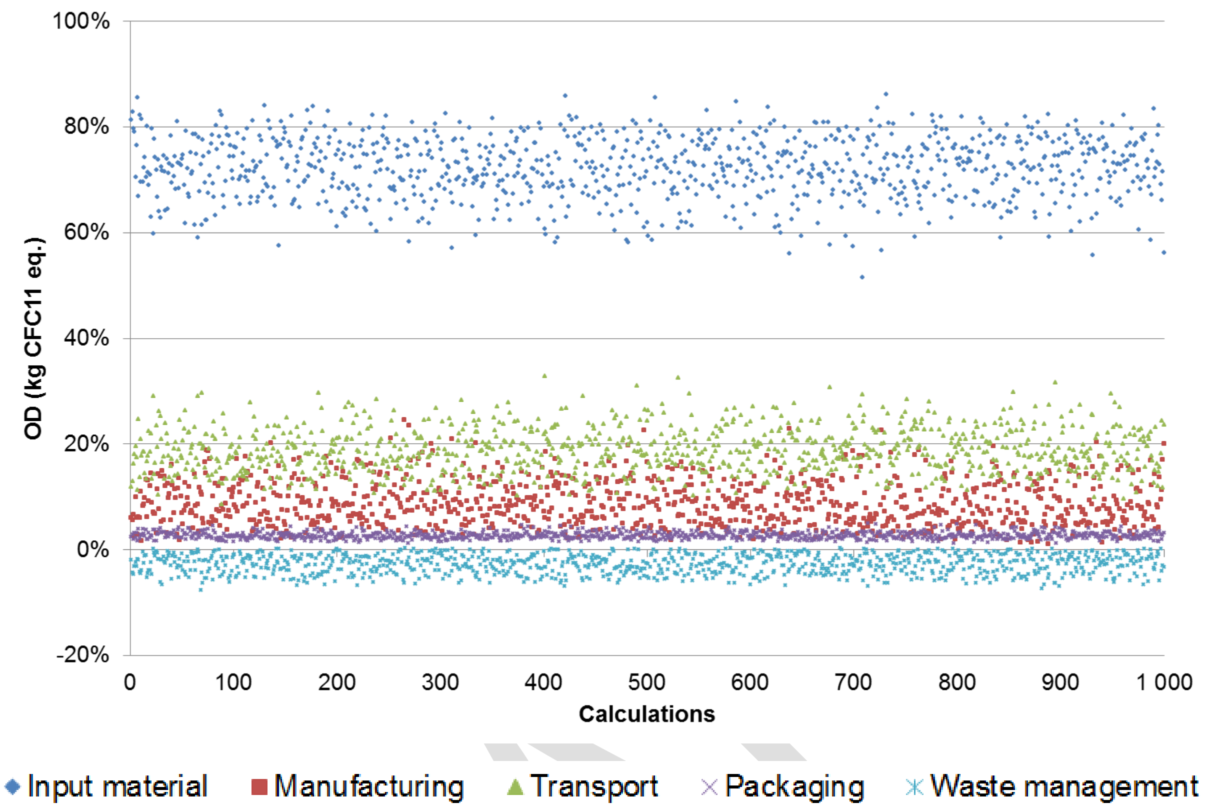


Figure 51: All possible results – Ozone depletion

For ozone depletion (Figure 51 and Table 73), production of input materials is clearly the phase with the most impacts (50-85%). In this case, manufacturing has lower results while transport show bigger results than for other impact categories.

The graphs for the other impact categories are not displayed in this report, because they do not present new conclusions with beyond those mentioned previously. They are presented in Annex VIII for further information.

Table 73: Distribution of phases – Ozone depletion

Phase	Min	Max
Input materials	50 %	85 %
Manufacturing	1 %	25 %
Transport	10 %	30 %
Packaging	1 %	5 %
Waste treatment	- 8 %	0 %

Variability of hot spots depending on the most significant parameters

This section shows the variability of results according to the sensitivity of the most significant parameters:

- Electricity consumption (consumption and grid mix) (Figure x)

- Mass of footwear (Figure y),
- Share of airplane for intercontinental transport (Figure z),
- Incineration rate (Figure A),
- VOC emissions (Figure B).

Discussion on wastage rate is not included because it mainly influences the amount of input materials and, therefore, related conclusions are similar to those for the mass of footwear.

Durability is discussed separately because it does not influence the hot spots, only the absolute results.

Electricity consumption

Figure 52 and Figure 53 present the variability of results with respect to the electricity consumption.

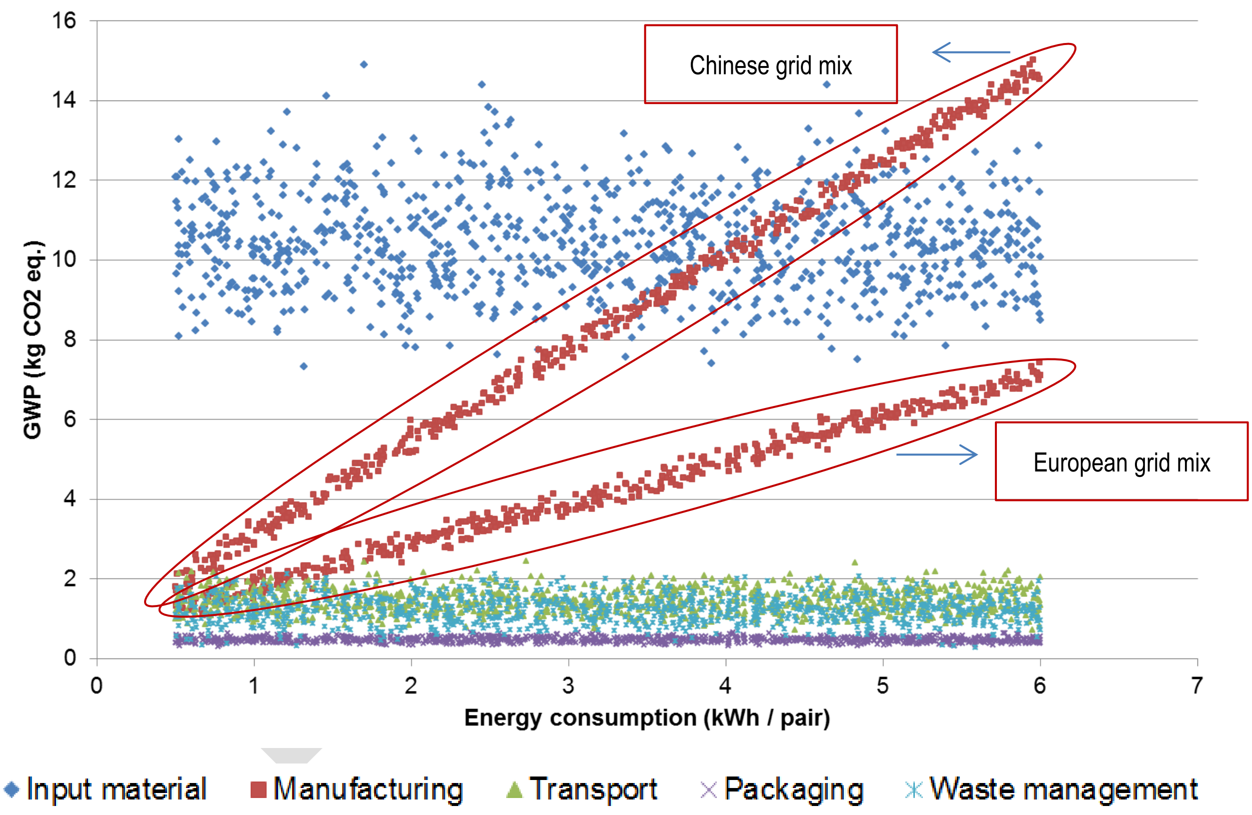


Figure 52: Sensitivity of electricity consumption – Climate change

Figure 52 shows that impacts related to climate change are bigger when the electricity consumption for product manufacturing is bigger. Two different scatter plots representing the two electricity grid mixes for manufacturing were considered for the modelling: the Chinese and European electricity mix. Chinese electricity mix has a bigger impact on GWP because it uses more classic fossil fuels such as coal. In addition, the relevant impacts of nuclear power (significantly used in Europe) are not assessed through LCA and therefore have a lower impact.

When the European electricity mix is used, the manufacturing stage GWP impacts are always lower results than those related to the production of input materials. When the Chinese electricity mix is used, the GWP impacts of manufacturing are lower than the impacts related to input materials when electricity consumption is less than 3 kWh / pair and always greater when electricity consumption is greater than 5 kWh / pair. Between the two situations, GWP impact will depend on the input materials phase and mainly on the choice of input materials.

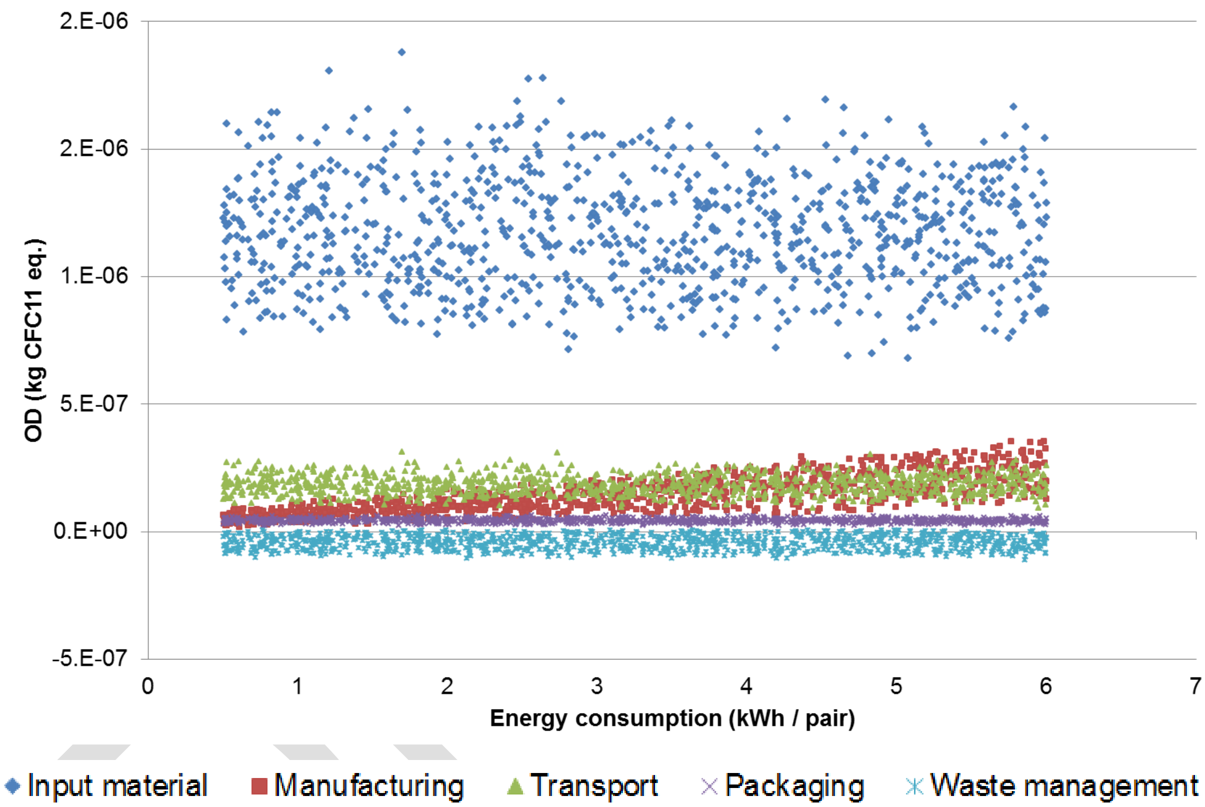


Figure 53: Sensitivity of electricity consumption – Ozone depletion

Figure 53 shows that electricity consumption has much less influence on the ozone depletion.

For the other impact categories, interpretations are close to the ones drawn here or in between (see Annex VIII).

<u>Mass of footwear and choice of input materials</u>

Figure 54 and Figure 55 present the variability of results with respect to the mass of footwear.

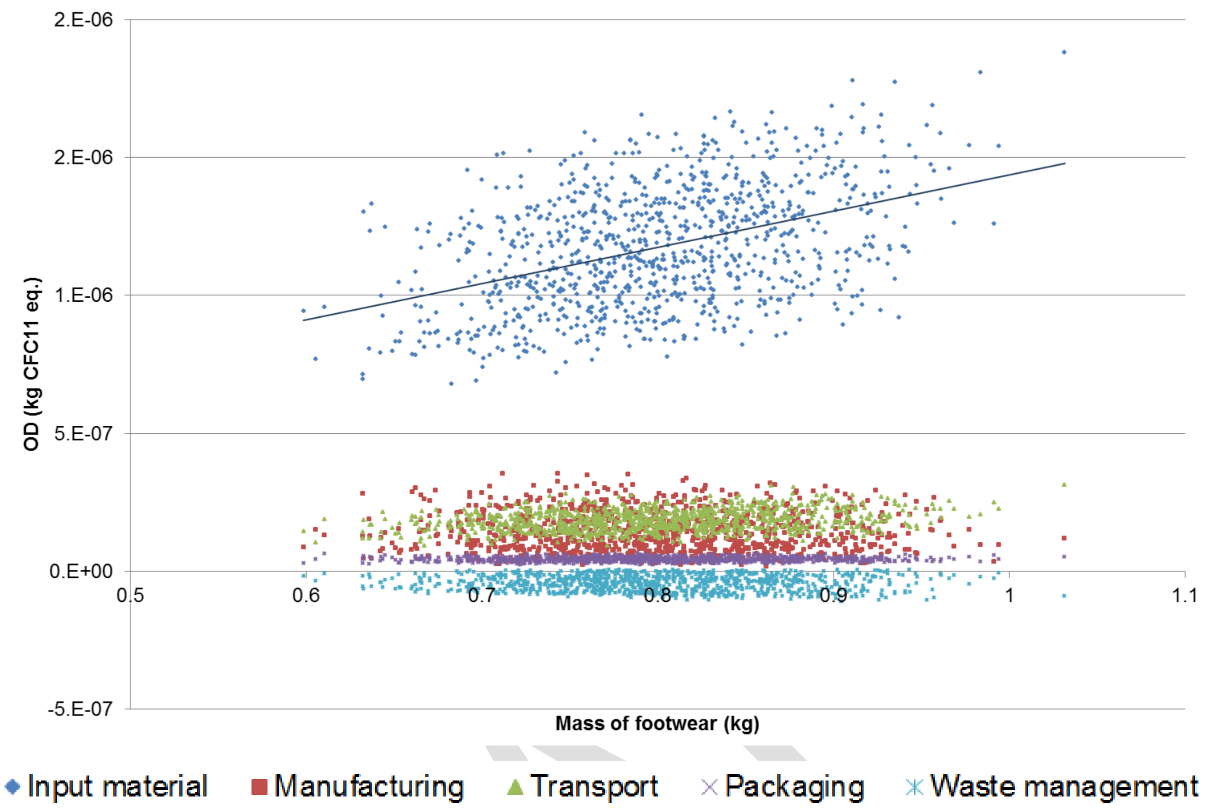


Figure 54: Sensitivity of mass of footwear – Ozone depletion

Figure 54 shows that ozone depletion impacts vary in direct proportion to the mass of footwear, i.e., larger mass yields greater ozone depletion impact. This concept is quite logical when considering that more input materials are required for higher mass footwear. The vertical variability is due to all other variable parameters and in particular to the choice of materials for the input materials phase. The impacts vary greatly between the uses of different materials.

The impacts of leather (modelled with data from COTANCE) mainly come from:

- Energy consumption on all impact categories,
- Production of chemicals, in particular chromium and solvents, on all impact categories,
- Emissions of solvents on photochemical ozone formation,
- Treatment of waste water on eutrophication,
- Treatment of solid wastes on eutrophication,
- Water consumption,

In general terms, the impacts of synthetic materials mainly come from:

- The extraction of feedstock,
- The energy consumption for compounding the polymers

As aggregated data from existing databases are used, it is more difficult to go into more details.

The impacts related to textiles mainly come from:

- Extraction of feedstock and the yarning of fibres;
- Process energy associated with the production of fabric and finishing;
- Consumption of water for natural fibres.

The impacts of metals and wood are relatively small because of their small share in the footwear composition.

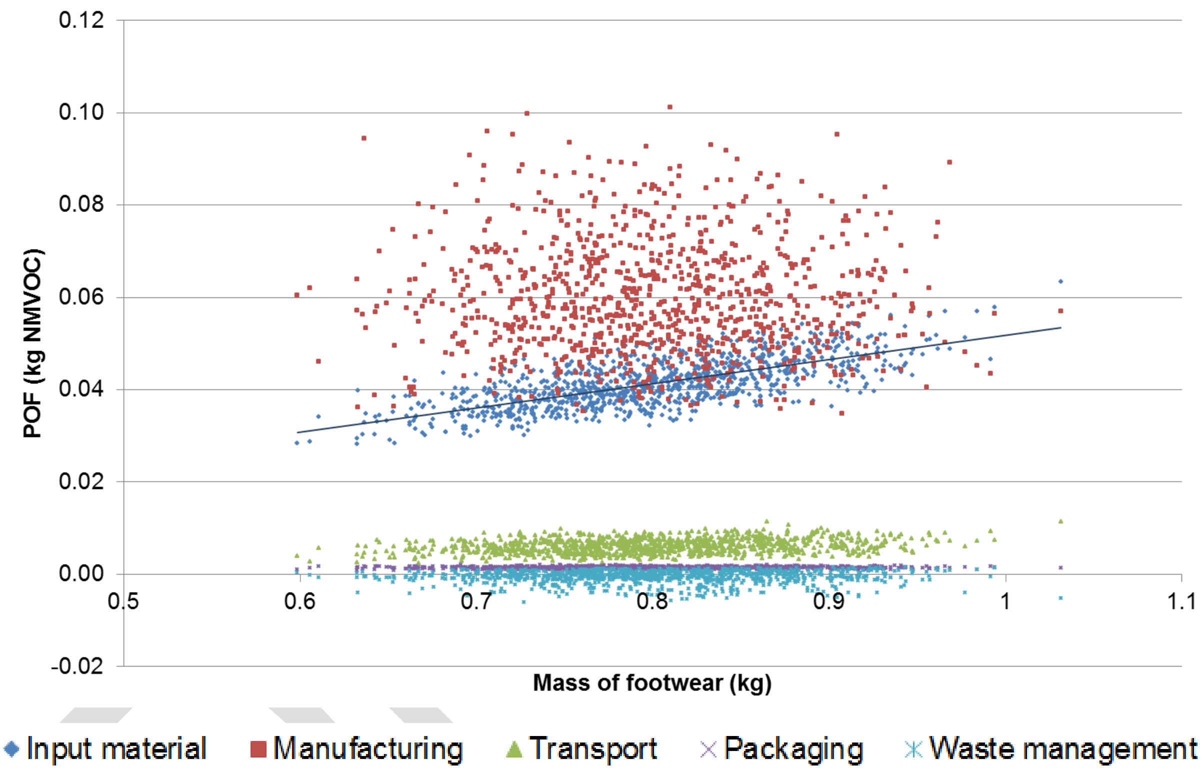


Figure 55: Sensitivity of mass of footwear – Photochemical ozone formation

Figure 55 shows that even for a category where mass of footwear is not the most significant parameter, it still has an important influences on the results. However, when referring to ozone depletion, the plot of input materials is less scattered, and the manufacturing stage remains the most important one.

For other impact categories, interpretations are close to the ones drawn here (see Annex VIII).

<u>Share of airplane for intercontinental distribution</u>

Figure 56 presents the variation of acidification results with respect to the airplane share of intercontinental transport. Airplane transport has a much bigger impact on the environment than boat or truck transport. However, this difference remains relatively small compared to the variation associated with manufacturing and input materials.

Manufacturing data vary broadly because the Chinese electricity grid mix has almost 5 times more impact on acidification than the European grid mix.

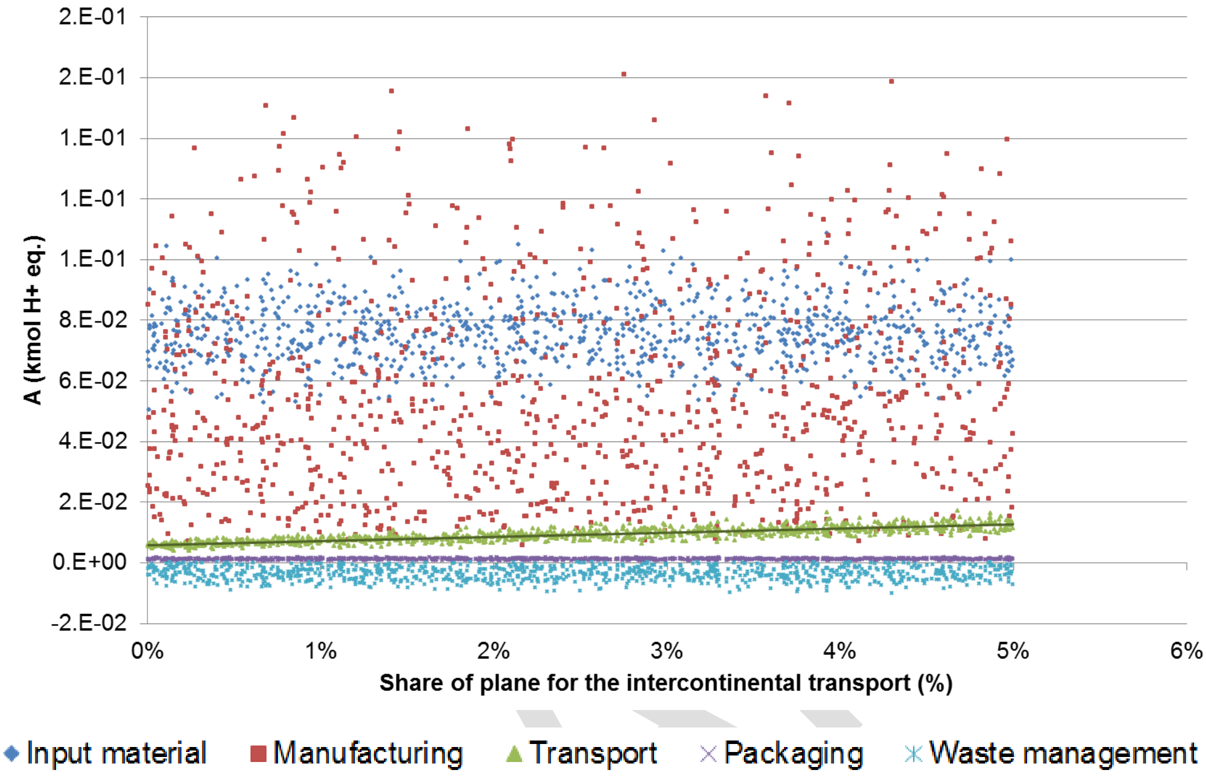


Figure 56: Sensitivity of share of airplane – Acidification

Graphs for other categories of influence are presented in Annex VIII.

<u>Incineration rate</u>

Figure 57 presents the variation of resource depletion results as a function of incineration rate at the end of life. The incineration rate is inversely proportional to the impacts on resource depletion, i.e., more incineration results in lower resource depletion, mainly due to the energy recovery at incineration plants. However, this diminution has relatively little importance compared to the impacts of manufacturing and input materials.

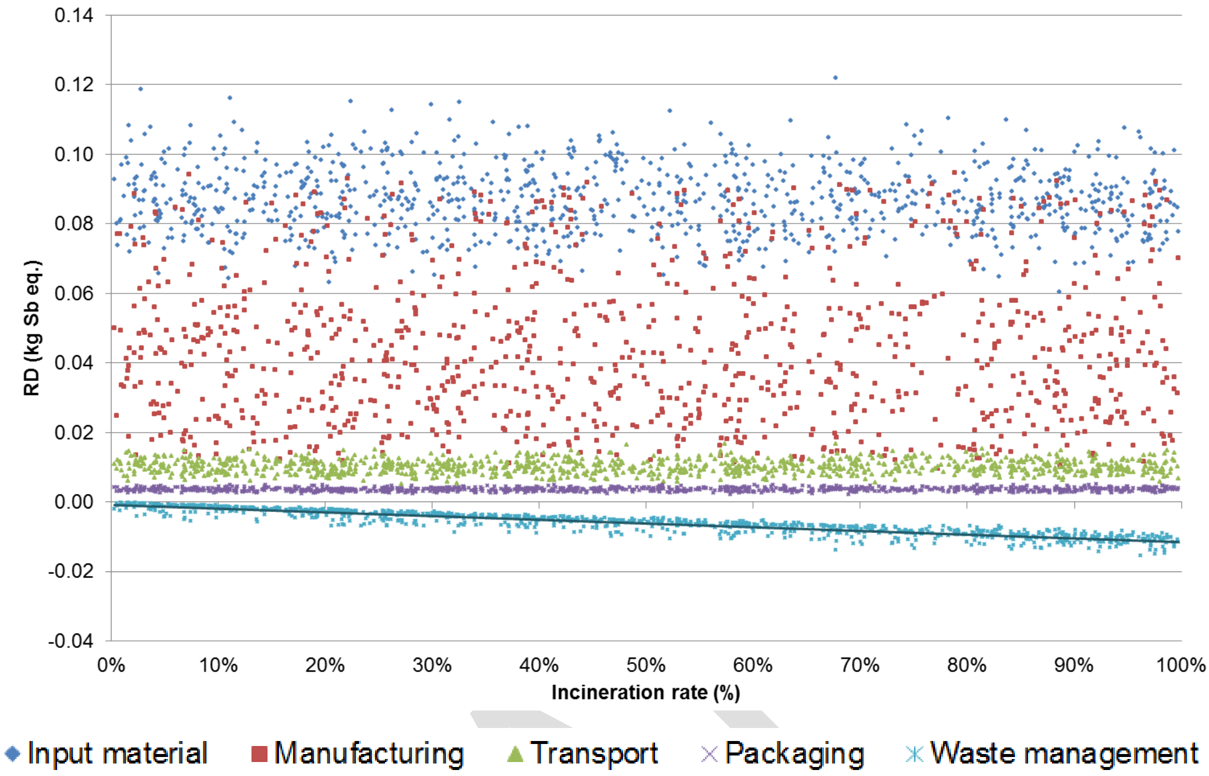


Figure 57: Sensitivity of incineration rate – Resource depletion

Graphs for other categories influenced are presented in Annex VIII.

<u>VOC emissions</u>

Figure 58 shows the sensitivity of results with respect to the quantity of VOC emissions. When VOC emissions exceed 22 g / pair (0.022 kg/pair), the manufacturing stage generally has greater POF impact than the input materials.

The graphs are not displayed for other impact categories because VOC emissions are not identified as significant.

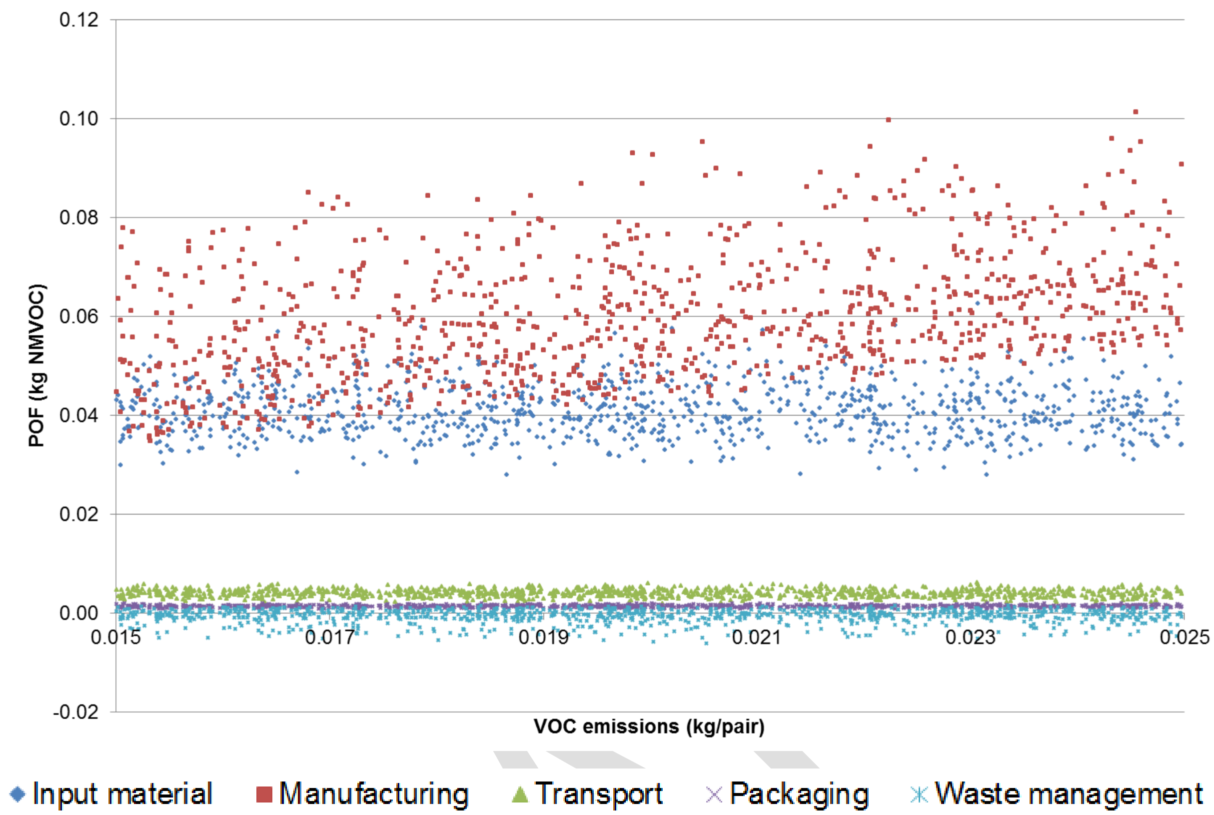


Figure 58: Sensitivity of VOC emissions – Photochemical ozone formation

<u>Durability</u>

The durability of footwear is represented by the reference flow and, therefore, it is the most significant parameter because impact category results vary in direct proportion to the time of use of the product, i.e., it durability. All results are multiplied the reference flow, and the relative results would not change[295]. For instance, if a pair of footwear lasts twice as long as another equivalent one, its environmental impacts will be halved.

3.3.6. Results considering the allocation of agriculture, breeding and slaughtering

Figure 22 shows the results for average footwear for which 10 % of impacts related to agriculture, breeding and slaughtering are allocated to leather. As figure shows, these impacts are significant in the life cycle of footwear and should therefore be analysed carefully, if leather is considered as a co-product of meat and milk industry.

[295] This is true because use phase is not considered in the system boundaries

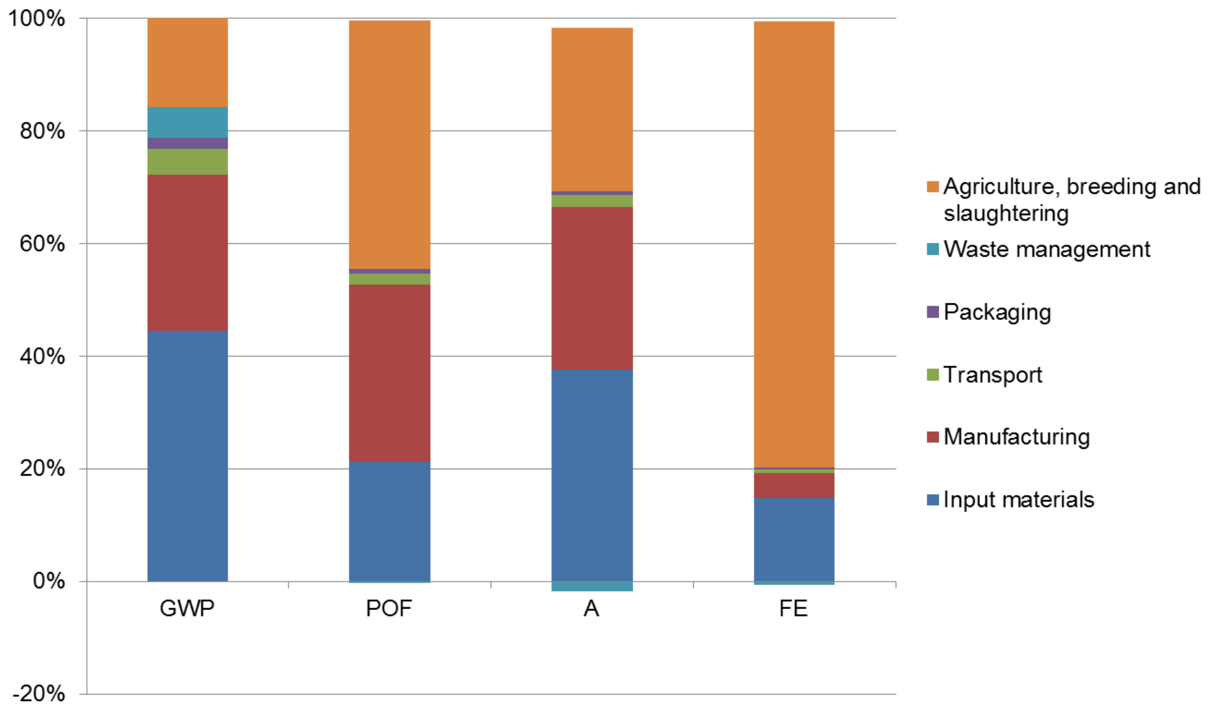


Figure 59: Relative results – Footwear accounting for 10 % allocation[296]

Figure 60 shows the variability of results as a function of the allocation rule, with a greater allocation to leather yielding a proportionate increase in GWP impact. For climate change, results increase by about 30 % between allocation rule 0 % and 10 %, and are 3 times as high for an allocation rule of 50 %, indicating that the allocation rule adopted is the key factor that will influence the distribution of final results.

NB: an allocation rule of 50 % represents an allocation where the impacts of farming and slaughtering are equally shared between the hides and the other co/by-products. As a reminder,

- Milà et al. (2002) used an economic allocation which corresponds to an allocation rule of 7.7 % of cattle impacts to leather;
- The last revision of the EU Ecolabel for footwear considered a mass allocation corresponding to 6 % of the impacts allocated to leather;
- If one considers the hides as a waste or even a by-product, the allocation rule can be assumed as 0 %.

[296] GWP: Climate change, POF: Photochemical Ozone Formation; A: Acidification; FE: Freshwater Eutrophication

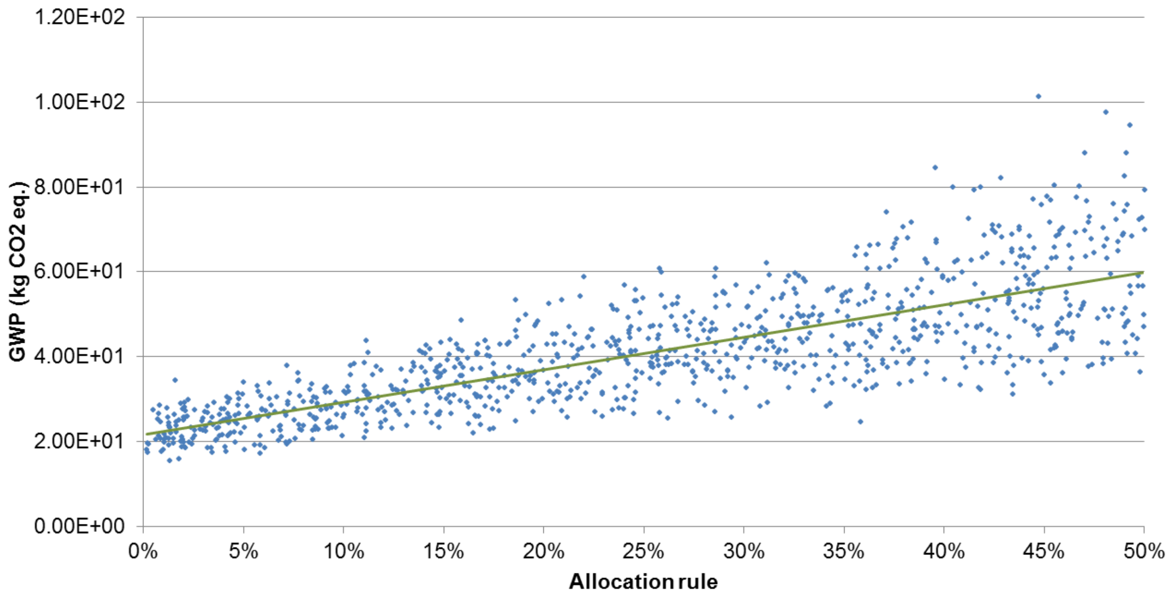


Figure 60: Sensitivity of allocation rule – Climate change

As shown on the Figure 61, the results vary significantly depending on the uncertainty of results from Milà et al. (2002). For more reliable results and firmer conclusions, more reliable data should be collected.

The x-axis is the multiplying coefficient applied on the results of Milà et al. and representing the uncertainty around these results.

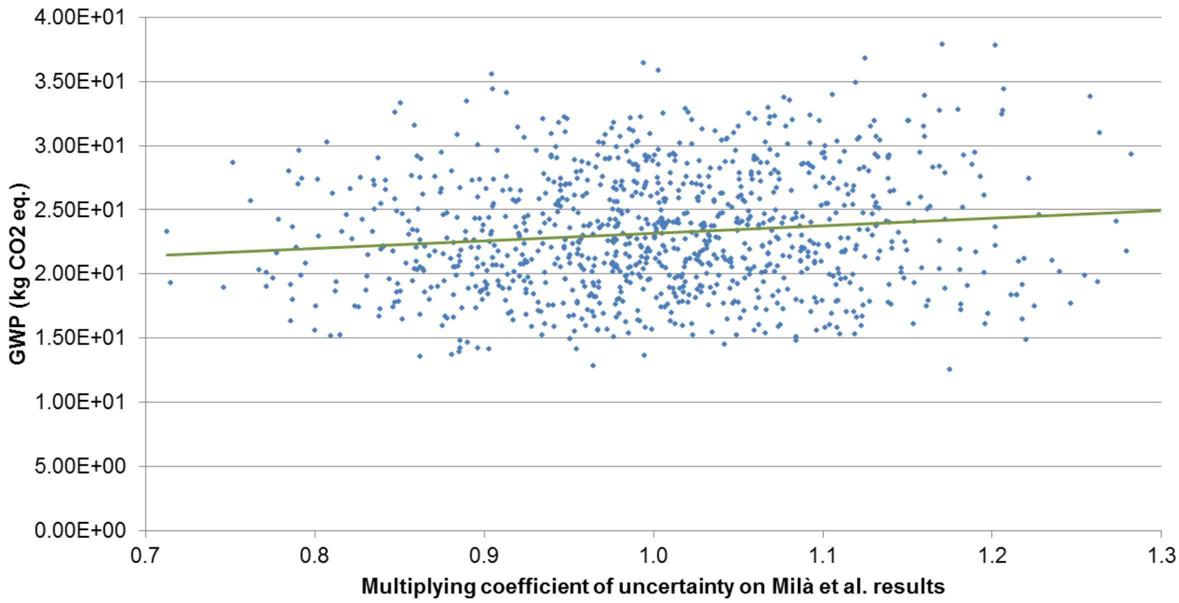


Figure 61: Sensitivity of Milà et al. results – Climate change

Depending on the impact categories and the allocation rule chosen (up to 10 %), the impacts on the environment of agriculture, breeding, and slaughtering can account to as much as 80 % of the whole life cycle of footwear (see Figure 59).

Graphs for the other impact categories analysed are included in Annex VIII.

3.3.7. Quality of the study

According to the same methodology for the quality assessment of the LCA studies (see chapter 3.2.4), the score of the additional LCA has been evaluated. This specific LCA is therefore the second one in terms of quality after Cheah et al. (2012) with a score of 25.8. The weak point is the absence of a peer review process. If a peer review were performed, this additional LCA study would get an overall score of 28.7 and become better in terms of quality than all other studies analysed through literature review.

Table 74: Score of the additional LCA

#	*Item*	*Score*
1	Scope	5
2	Data sources	3.7
3	Impact assessment categories	5
4	Outcomes	5
5	Robustness	5
6	Review	1
Overall score		24.7

3.3.8. General conclusion

As indicated in Table 75, the impacts are mostly due to the production of input materials (40 to 90 %), mainly influenced by the mass of the footwear (i.e., the quantity of input materials required) and the wastage rate. The manufacturing of footwear accounts for 5 to 60 % of overall impact and is generated mainly by the energy consumption and the emissions of VOC. Distribution has an impact of 2 to 15 % on the overall results, mainly due to air transport. Other life cycle stages are of minor importance.

In general, the conclusions are quite similar to the ones drawn from the LCA literature review (see chapter 3.2.6). However, additional special focus is on VOC emissions is necessary due to the use of glues and solvents during footwear assembly, where they are the most significant.

The most sensitive parameters are the following (the most important first):

- Energy consumption (manufacturing);
- Electricity mix (manufacturing);
- Mass of footwear and choice of input materials;
- Wastage rate;
- Share of airplane for intercontinental transport;

- Incineration rate at end of life;
- Quantity of VOC emissions.

The impacts of agriculture, breeding and slaughtering may also be relevant for the life cycle of footwear, depending on the allocation rule chosen. Therefore, careful consideration should be given to whether leather is assumed to be as a co-product of meat and milk production.

Table 75: Highlighted hot spots from additional LCA

Life cycle stages		Environmental relevance[297]
Agriculture, breeding and slaughtering		- to +++
Production of input materials		+++
Manufacturing and assembling	Energy consumption	++
	VOC emissions	+
Transport by plane		+
End of life of footwear		-

Durability of footwear is also a key parameter as it multiplies the results.

Based on the results of the LCA analysis performed and on the outcomes from the current LCA review, the following criteria areas should be addressed in the revision of the EU Ecolabel:

- The footwear should achieve a certain durability considering its resistance to mechanical degradation,
- The input materials should be carefully chosen with a focus on the use of sustainable materials (e.g., recycled materials),
- The mass of footwear should be minimised[298],
- For the production of leather, hides and skins should come from the meat and milk industries in order to ensure that impacts of farming can be mostly attributed to meat and milk,
- The wastage should be minimised during material processing and footwear manufacturing,
- The energy consumption should be minimised for footwear manufacturing (including uppers, soles, and linings manufacturing, and footwear assembly),

[297] +++: proportional to LCA results; ++: very significant on LCA results; +: quite significant on LCA results; -: not significant on LCA results.

[298] This criterion must not be reached at the expense of durability of footwear

- The VOC emissions should be minimised during footwear manufacturing.

3.4 Environmental issues of hazardous substances

3.4.1. Methodology

In this section we explore in greater detail a number of the environmental issues not specifically addressed or highlighted by the LCA studies reviewed in the previous section but identified by the cross-checking of analysed literature, with reference to the Commission Statements and initial stakeholder feedback. Several areas of concern were preliminarily identified as being of significance and requiring addition detail regarding their environmental and human health impacts, considering their implications for the criteria revision in line with Article 6 (Paragraphs 6 and 7) of the Ecolabel Regulation (EC) 66/2010 which established the requirements that no product awarded the Ecolabel should contain:

- Substances or preparations/mixtures that are restricted under Article 57 of the REACH Regulation (EC) No 1907/2006;
- Substances or preparations/mixtures that have been identified according to the procedure described under Article 59 of the REACH Regulation (EC) No 1907/2006 and which have been subsequently classified as Substances of Very High Concern;
- Substances or preparations/mixtures that are classified as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction (CMR), in accordance with Regulation (EC) No 1272/2008.

For each area, additional supporting evidence is introduced in order to inform discussion regarding the possible direction of the criterion revision. The potential for harmonisation with other labelling or certification schemes that address specific environmental issues is also considered. Identification of the additional environmental issues and selection of the most relevant chemicals related to footwear has been cross-checked in different sources of relevance:

- cross-checking of different sources for identification of substance of general concern, such as:
    - Legal requirements in the European Union and Member States
        - REACH Regulation (EC) No 1907/2006
        - SVHC list from ECHA
        - CLP Regulation (EC) No 1272/2008
        - Biocidal products Regulation (EU) No 528/2012
        - Persistent Organic Pollutants Regulation (EU) No 850/2004
        - Commission Decision of 17 March 2009
    - EU Ecolabel regulation and existing ecolabels
        - EU Ecolabel Regulation

        - Current EU Ecolabel for footwear
        - On-going revision of the EU Ecolabel for Textile
        - Existing EU Ecolabels of relevance
        - Restricted Substances lists from 14 companies
    - Commission Statement 19 March 2009/ ENV G2
    - Initial stakeholder feedback
    - Analysis of available scientific literature, reports and publications

The chemical substances used in materials manufacturing, finishing, and footwear assembly might be present in the final product. Some of these substance are classified as hazardous according to the CLP and REACH regulations. The key objective of the screening was to identify the potential use and presence in the final product of these groups of substances from an overall supply chain perspective, focussing mainly on the material and process criteria, i.e., in which material processing or process stage there is a risk of possible involvement of the identified substance(s).

Substances listed in the Restricted Substances List (RSL) may be banned from the finished products or accepted based on the condition that their concentrations in the product are below certain concentration limits Some restrictions follow only the legal restrictions imposed on the substance, but some corporations have stricter limits than regulations because they have to be compliant with the regulations of multiple countries or because they want to obtain certain labels[299].

The results of the analysis are summarized in Table 100 (see Annex X Hazardous substances potentially present in footwear). The main issues of concern identified are discussed further in the following chapters.

[299] Consultation with footwear testing expert from Intertek

3.4.2. Review of legal requirements, literature and stakeholder input

Legal requirements in the European Union and Member States

The Regulation (EC) 1907/2006 (REACH) concerning Registration, Evaluation, Authorisation and Restriction of Chemicals entered into force on 01 June 2007. REACH does not allow marketing substances on their own, in mixtures and, in certain cases, in articles in quantities equal or greater than 1 tonne per year if they have not been registered by every legal entity that manufactures or imports outside the European Union. REACH is gradually being implemented in the European Economic Area through a phased approach with a timeline that extends until June 2018.

Regulation (EC) 1272/2009 on classification, labelling and packaging of substances and mixtures (CLP) and based on the United Nations' Globally Harmonised System (GHS) entered into force on 20 January 2009. The CLP Regulation ensures that the hazards of chemicals are clearly communicated to workers and consumers in the European Union through a common classification and labelling system which uses standard statements and pictograms on labels and safety data sheets. Before placing chemicals on the market, the industry must establish the potential risks to human health and the environment posed by these substances and mixtures, classifying them in line with the identified hazards. The hazardous chemicals also must be labelled according to a standardised system so that workers and consumers know about their effects before they handle them. Similarly to REACH, the requirements in CLP will be gradually implemented and replace the Council Directive 67/548/EEC as well as Directive 1999/45/EEC. The date from which classification and labelling of substances must be consistent with CLP was December 2010; for mixtures the date is June 2015. Accordingly, identification of hazardous substances will focus on the classification specified under CLP regulation.

The main objectives of REACH and CLP are: to ensure a high level of protection of human health and the environment from the risks that can be posed by chemicals, to promote alternative test methods, to ensure free circulation of products on the internal market and to enhance competitiveness and innovation of the EU chemicals industry.

REACH and CLP make industry responsible for assessing and managing the risks posed by chemicals and for providing appropriate safety information to their users via the Safety Data Sheet (SDS) intended to provide workers and emergency personnel with procedures for working with or handling substances in a safe manner. SDS includes key information on toxicity and health effects, in addition to physical data (e.g., melting point, boiling point, flash point, etc.), first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures. Manufacturers and importers will be required to identify and manage risks linked to the substances they manufacture and/or import in quantities of 1 tonne or more per year. In parallel, the European Union can take additional measures for highly dangerous substances, where there is a need for complementing action at EU level.

A number of restricted substances for which marketing or use is controlled, are already listed in Annex XVII of the REACH, but it is expected that this list will increase as REACH progresses.

- Several substances identified as being of relevance for the product group under revision are currently restricted by Annex XVII of REACH, as indicated in the following list.
  - Polychlorinated terphenyls (PCTs);
  - Tris (2,3 dibromopropyl) phosphate;
  - Tris(aziridinyl)phosphinoxide;
  - Arsenic compounds;
  - Pentachlorophenol;
  - Cadmium;
  - Nickel;
  - Azocolorants and Azodyes;
  - Alkanes, C10-C13 (short-chain chlorinated paraffins) (SCCPs);
  - Phthalates: bis (2-ethylhexyl) phthalate (DEHP), dibutyl phthalate (DBP), benzyl butyl phthalate (BBP); di-"isononyl" phthalate (DINP), di-"isodecyl" phthalate (DIDP), di-n-octyl phthalate (DNOP);
  - Nonylphenol and Nonylphenol ethoxylate.
  - Polycyclic aromatic hydrocarbons (PAHs): Benzo[e]pyrene (BeP), Benzo[a]anthracene (BaA), Chrysene (CHR), Benzo[b]fluoranthene (BbFA), Benzo[j]fluoranthene (BjFA), Benzo[k]fluoranthene (BkFA), Dibenzo[a,h]anthracene (DBAhA)
- Substances which appear in Annex I of Directive 67/548/EEC classified as carcinogen category 1 or carcinogen category 2 and labeled at least as "Toxic (T)" with risk phrase R 45: "May cause cancer" or risk phrase R49: "May cause cancer by inhalation";
- Substances which appear in Annex I to Directive 67/548/EEC classified mutagen category 1 or mutagen category 2 and labelled with risk phrase R46: "May cause heritable genetic damage";
- Substances which appear in Annex I to Directive 67/548/EEC classified as toxic to reproduction category 1 or toxic to reproduction category 2 and labeled with risk phrase R60: "May impair fertility" and/or R61: "May cause harm to the unborn child."

<u>SVHC list from ECHA</u>

The European Chemicals Agency (ECHA) is the driving force among regulatory authorities in implementing the EU's ground-breaking chemicals legislation for the benefit of human health and the environment, as well as for enhancing EU innovation and competitiveness. ECHA helps companies to comply with the legislation, advances the safe use of chemicals, provides information on chemicals and addresses chemicals of concern.

Substances recommended for inclusion on the SVHC list are selected by the ECHA from a priority list, the “Candidate List." Once sanctioned by the European Commission, the substances are banned unless an authorization for a certain use is temporarily granted to an individual company. Requests for authorization of banned substances must be submitted to the ECHA and final decisions are made by the European Commission. Consequently, all manufacturers and importers must apply for authorisation of substances included in Annex XIV and it should be granted by the Commission only if the risks arising from their use are adequately controlled or the use can be justified for socio-economic reasons and no suitable alternatives are available. In the case that the risks cannot be managed, authorities can restrict, partially or totally, the use of these substances of concern. The companies that do not undertake this procedure will not be able to manufacture, sell or use their products and, consequently, would be forced to stop their activity.

In accordance with Article 59(10) of the REACH Regulation, ECHA publishes the Candidate List of Substances of Very High Concern (SVHC) for authorisation[300].

Substances with the following hazard properties may be identified as Substances of Very High Concern (**SVHC**s):

- Substances meeting the criteria for classification as carcinogenic, mutagenic or toxic for reproduction category 1A or 1B in accordance with Commission Regulation (EC) No 1272/2008 (CMR substances);
- Substances which are persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) according to REACH (Annex XIII);
- Substances identified on a case-by-case basis for which there is scientific evidence of probable serious effects that cause an equivalent level of concern as with CMR or PBT/vPvB substances.

The authorisation procedure aims to assure that the risks from SVHC are properly controlled and that:

- these substances are progressively replaced by suitable alternatives while ensuring the proper functioning of the EU internal market;
- these substances cannot be placed on the market or used after a given date, unless an authorisation is granted for their specific use or the use is exempted from authorisation.

As previously discussed, substances that form part of the SVHC (Substances of Very High Concern) Candidate List should be excluded from EU Ecolabelled products.

The list is dynamic and is updated twice a year with new substances as candidate substances are identified, testing is conducted and evidence is published.

[300] http://echa.europa.eu/en/candidate-list-table

Currently, the list names 144 substances. The last two updates content are specified below.

- On **December 19 2012**, **54** new substances were added to the Candidate List of Substances of Very High Concern (SVHC) for Authorization. The European Commission has achieved its proposed goal of having 136 SVHCs on the candidate list by the end of 2012, and the list contained 138 substances in total. Among them are four Perfluorinated compounds (PFCs), including Henicosafluoroundecanoic acid, Heptacosafluorotetradecanoic acid, Pentacosafluorotridecanoic acid and Tricosafluorododecanoic acid.
- The last SVHC candidate list update occurred on the **20th of June 2013** by inclusion of **six** more substances. Following the inclusion of 4-nonylphenol (branched and linear) last year, its ethoxylated compounds were also included this time, due to concerns about their influence on the environment. Cadmium compounds, cadmium and cadmium oxide, were included in the list for the first time and are classified as carcinogen category 1B and equivalent level of concern (EQC). The perfluorinated chemicals (PFCs) on the list was increase to six substances by including two more members, ammonium pentadecafluorooctanoate (APFO) and pentadecafluorooctanoic acid (PFOA). The last update of 144 substances placed on the SVHC list is available in Table 101 in Annex XII Candidate list of substances of very high concern.

Around 80 substances have been identified as potentially relevant for the footwear manufacturing processes (Table 100 see Annex X Hazardous substances potentially present in footwear) based on information about the potential uses of substances mentioned in the following sources:

- CEN/TR 16417 published in October 2012
- SGS newsletter n°002/ 13 January 2013 regarding "Hard goods, toys & juvenile products, softlines, electrical & electronics, cosmetics, personal care & household"
- SGS newsletter n°115/ 13 June 2013 regarding "Hard goods, toys & juvenile products, softlines, electrical & electronics, cosmetics, personal care & household"
- http://echa.europa.eu/candidate-list-table

These identified substances need to be further discussed during the stakeholder consultation process.

EU Ecolabel Regulation and existing ecolabels

EU Ecolabel Regulation

Article 6 (Paragraphs 6 and 7) of the Ecolabel Regulation (EC) 66/2010 established the requirements that no product awarded the Ecolabel should contain:

- Substances or preparations/mixtures meeting the criteria for classification as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction (CMR), in accordance with Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labeling and packaging of substances and mixtures;

- Substances referred to in Article 57 of Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) and establishing a European Chemicals Agency;
- Substances or preparations/mixtures that have been identified according to the procedure described under Article 59 of the REACH Regulation No 1907/2006 and which have been subsequently classified as Substances of Very High Concern.

Article 6(7) allows derogations for substances only if it is not technically feasible to substitute them with safer chemicals, or the need for the substance is obviated by using alternative materials, designs or products which have a significantly higher overall environment performance compared with other goods of the same category. However, no derogation shall be given for substances that:

- meet the criteria of Article 57 of Regulation (EC) No 1907/2006;
- are identified according to the procedure described in Article 59(1) of that Regulation
- are present in mixtures, in an article or in any homogeneous part of a complex article in concentrations higher than 0,1 % (weight by weight).

Restricted Substances lists (RSL) from 14 companies

RSLs are developed by companies, government agencies, non-profit organizations and other bodies (such as trade organizations). RSLs list chemicals of concern according to various criteria which may vary but often include acute human toxicity, carcinogenicity, mutagenicity, reproductive toxicity, endocrine disruption, eco-toxicity, and persistence and bioaccumulation.

A substance listed in the RSL may be banned from every final product or accepted on condition that its quantity in the product is below a limited value. Some restrictions only follow the legal status of the substance but some corporations have stricter limits than regulations because they have to be compliant with the regulations of multiple countries or because they want to obtain certain labels[301].

Many retailers begin their efforts to improve product chemicals management with the development and use of an RSL. Some retailers have created RSLs for internal use and some make their RSL publicly available. There are also sector-wide RSLs that list chemicals that are restricted or banned anywhere in the world. An example of this for textile and footwear sector is “Apparel and Footwear International RSL Management Group (AFIRM).

[301] This was stated by experts of footwear testing in Intertek

Commission Statement 19 March 2009/ ENV G2

In conjunction with adoption of the current footwear criteria document on March 2009 (decision No 2009/563/EC), several statements were submitted by Member States relating to issues that should be addressed/investigated further in the next revision. The following concerns related to the possible use of hazardous substances were raised:

- the use and environmental impact of all fluorinated substances (e.g., including PFAS) which might be used for the footwear (e.g., for impregnation) need to be assessed in the revision;
- PFAs and the related environmental problems should be evaluated;
- PVC and the related environmental problems should be evaluated;
- Formaldehyde in leather and the related environmental problems should be evaluated.

Initial stakeholder feedback

During the initial stakeholder consultation process, the following issues were highlighted :

- <u>Regarding exclusion of hazardous substances</u>
    - Stakeholders highlight the importance to restrict the use of PFCs and the Cr(VI)
- <u>Substitution</u>

  Some stakeholders gave examples of hazardous substance(s) substituted by more environmentally friendly alternatives:

    - In the textile industry, phthalates may be used basically for producing fabrics partly made with soft PVC and plastisol prints. The main risk factor associated with the use of phthalates in textile products results from the fact that phthalates are not covalently bound to the polymer molecules. Therefore, they may be transfer to the body of the user, or be released to the environment through washing. However, it is possible to replace phthalates for textile printing. Different options are considered including use of five alternative plasticizers[302]:
        - Substituted substances: Benzyl butyl phthalate (BBP), Dibutyl phthalate (DIP), Di(2-ethylhexyl) phthalate (DIHP)
        - Alternative substances: Tributyl O-acetylcitrate, (2-ethylhexyl) adipate (DEHA), Trioctyl trimellitate, Dioctyl terephthalate, Cyclohexane-1,2-dicarboxylic acid diisononyl ester (DINCH).
    - Substitution of decroline (reducing agent) with sodium dithionite or borohydride in the textile industry
    - Substitution of conventional glues with water-based and hot-melt adhesives,
    - Substitution of nickel-with free metal component

[302] http://www.subsport.eu/case-stories/377-en?lang=

- Substitution of Chemical activated reinforcements with thermo–plastic reinforcements

Scientific literature, reports and publications

Shoes are complex consumer products that encompass a broad variety of materials with very specific characteristics. Footwear may consist of one or a few components, or involve a complex construction, which in the case of an athletic shoe can comprise 65 (or more) distinct parts, often material blends, requiring more than 360 processing steps to finalize its assembly.[303],[304] Nearly 90%[305] of components/materials used along the footwear industry supply chain have a chemical origin or chemistry has been used for their treatment and/or modification. Extra-European import is the dominant source of footwear consumed in Europe (89% in terms of volume and 67% in terms of value of the apparent consumption in 2011[306]). According to an estimate reported by the Nordic Council of Ministers[307], as much as 900 tonnes per annum of SVHC could theoretically be imported into the EU contained in shoes.

Chemical analysis of outsoles materials and released leachates give an indicator on the variety of additives used in rubber and plastics, such as plasticizers, antioxidants, stabilizers and vulcanization agents[308]. Dahlberg (2010) found 31 different organic substances in various footwear parts, among them those classified as SVHCs, as indicated in Table 76[309].

The Swedish Society for Nature Conservation (2009)[310,311] has tested 21 pairs of leather shoes and 27 different pairs of plastic shoes from all over the world for the content of different hazardous chemicals, such as heavy metals, organic compounds, and PAHs. European products were included (even those whose producers claim to be taking environmental friendly actions or employing vegetable tanning technology). Metals in various concentrations were found in analysed shoes, and

303 Lee, J.L. and Rahimifard, S. (2012). An air based automated material recycling system for postconsumer footwear products. Resource, Conservation and recycling 69, pp 90-99

304 Cheah, L., Ciceri, N.D., Olivetti, E., Matsumara, S., Forterre, D., Roth, R., Kirchain, R. (2013), Manufacturing-focused emissions reductions in footwear production. Journal of Cleaner Production 44, pp 18-29

305 Ministerstwo Gospodarki we współpracy z Instytutem Przemysłu Skórzanego w Krakowie. 2009. Przewodnik dla przemysłu skórzanego producentów i użytkowników wyrobów skórzanych i skóropodobnych. Warszawa

306 Estimated based on data available in Eurostat

307 Nordic Council of Ministers. 2010. Assessment of application of the 0.1% limit in REACH triggering information on substances of very high concern (SVHC) in articles. TermNord.

308 Khans-Ingre, E., Rudén, C., Breitholtz, M. 2010. Chemical risks and consumer products: The toxicity of shoe soles. Ecotoxicology and Environmental Safety 73, pp.1633-1640

309 Dahlberg A-K.2010., Chemical Analysis of Organic Compounds in Footwear, Stockholm University

310 The Swedish Society for Nature Conservation. 2009. Bad shoes stinks, Report from The Swedish Society for Nature Conservation

311 Swedish Society for Nature Conservation. 2009. Chemicals – up close Plastic shoes from all over the world http://www.groundwork.org.za/Publications/plastskor_eng.pdf

especially high levels of trivalent chromium (even in footwear for which manufacturer claimed to be employing vegetable tanning technology). The total amount of chromium was measured to be between 42 ppm and 29,000 ppm (which corresponds to 2.9%). Organic compounds (such as chlorinated paraffins, azodyes, ortho-phenylphenol, etc.) were detected in some of the shoes. Two shoes contained azodyes, which are capable of forming carcinogenic amines. A high level of the bactericide/fungicide 2,4,6-trichlorophenol was found in one shoe. The phthalate DEHP was present in various amounts in all 17 of these products. The highest content, 23.2%, was found in a pair of flip-flops from South Africa. The analyses conducted also showed that several shoes contained PAH (polyaromatic hydrocarbons), tin, organic compounds and heavy metals. Two pairs of shoes contained mercury (highest level 0.1 ppm), and several contained lead (highest level 2220 ppm) and cadmium (highest level 117 ppm). 5 of the 27 pair of shoes had a content of lead over 100 ppm,

The Danish EPA investigated five different types of plastic clogs and found phthalates in three of the five products tested: One plastic clog contained 0.08 % DEHP (di-2-ethylhexyl phthalate), one contained 2.5 % DBP (dibutyl phthalate), and one contained 0.09 % DIBP (diisobutyl phthalate) and 1.6 % DEHP[312]. A follow-up investigation released in 2010 tested 60 kids' and adults' sandals/clogs made of plastic and "foam" (i.e., vulcanized rubber or "cross-linked" plastic). Without naming brands, it reports that most of the sandals contained one or more phthalates, and in particular "the majority" of plastic straps and soles in kids shoes contained anywhere from 10 to 46 per cent phthalates[313]. Kalberlah et al.(2011)[314] found in PVC plastic bathshoe, a total content of PAHs of 546 mg/kg.

Recently testing of 15 children sandals from the European market revealed that all products analysed contained certain substances of concern (such as: PAHs, phthalates, chlorophenols, o-phenylphenol, tin compounds, lead, chromium). Only one product was classified as reaching minimum requirements; the overall profile of the rest was assessed as failed[315].

312 Danish EPA No. 103, 2009. Tønning K, Jacobsen E, Pedersen E, Strange M, Poulsen PB, Møller L, Boyd HB. Survey of chemical substances in consumer products No. 103, 2009. Danish EPA. http://images.netdoktor.com/dk/Emnecenter%20om%20Kemi/SAMLET%20Rapport%20DK.pdf

313 Vasil, A. 2011. Ecoholic. 30/45 http://www.nowtoronto.com/columns/ecoholic.cfm?content=181662, last check September, 2013.

314 Kalberlah F, Schwarz M, Bunke D, Augustin R, Oppl R. 2011. Karzinogene, mutagene, reproduktionstoxische (CMR) und andere problematische Stoffe in Produkten - Identifikation relevanter Stoffe und Erzeugnisse, Überprüfung durch Messung, Regelungsbedarf im Chemikalienrecht. UBA Texte 18/2011

315 Der Laud der Dinge. 2013. TEST Kindersandalen. ÖKO-TEST Kinder 6 I 2013

Table 76: Survey of critical substances potentially present in footwear and footwear components and the materials in which they might be found[316]

	leather	coated leather	leather board	PVC	EVA foam	rubber	PU-TPU elasthan	PE-T PP	polyester	polyamide	chloride fibre	polyacrylic	latex	natural textile	wood, cork	adhesives	print for textile	cellulosic material
Acrylonitrile						X										X		
Aromatic amines	X	X	X						X	X	X			X			X	
Chloroorganic carriers									X									
Colophony																X		
Dimethylformamide							X											
Dimethylfumarate	X	X	X			X			X	X	X	X		X	X		X	
Dispersed dyes and dye stuff									X	X	X	X		X				
Flame retardants	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Formaldehyde	X	X	X						X	X	X	X		X	X			X
Mercaptobenzothiazole						X												
N-ethylphenylamine						X							X					
Nitrosamines						X												
Nonylphenol	X	X	X						X	X	X			X				
Alkylphenolethoxylates	X	X	X						X	X	X			X				
Ortho-phenylphenol	X	X	X			X							X					
CFCs									X	X	X	X		X				
pentachlorophenol	X	X	X															
tetrachlorophenol	X	X	X															
trichlorophenol	X	X	X															
Pesticides	X	X	X											X				X
Perfluorooctane sulfonate	X	X	X						X	X	X	X		X				
Perfluorooctanoic acid	X	X	X						X	X	X	X		X				
Phthalates		X		X	X	X	X	X	X	X	X	X		X			X	
PCBs	X	X	X						X	X	X	X		X				
Polychloroprene						X										X		
Paraphenylene diamine	X	X	X						X	X		X		X			X	X
Butyl phenol formaldehyde																X		
Chlorinated paraffins	X	X	X			X			X	X	X	X						
TCMTB	X	X	X															
Thiuram and Thiocarbamate						X												
Vinyl chloride monomer		X		X														
Benzendiaminer						X												
Benzotriazoler														X				

[316] Figure based on *Chemical Analysis of Organic Compounds in Footwear,* Anna-Karin Dahlberg 2010, Stockholm University

Herva et al. (2011)[317] highlighted the high environmental risk related to phthalates used, e.g., for the printing. As discussed above, phthalates (especially DINP) have a high potential to diffuse out of plastic materials, since they are not covalently bound to the polymeric matrix; this may a major concern for children's products because of mouthing (oral pathway of exposure to contaminants). The study also stresses the possible hazard associated with the formaldehyde present in the shoe lining and insole.

3.4.3. Analysis of hazardous substances

Several groups of substances listed in the Table 100 (see Annex X Hazardous substances potentially present in footwear), either because of identified frequency of possible occurrence or supported by analysis of other ecolabels of relevance, are discussed further in the paragraphs below either:

- by function
  - Biocides, preservatives, and antibacterial substances
  - Dyes and pigments
  - Organic solvent
  - Plasticizers and elastomers
  - Flame retardants
  - Impregnation agents
  - Auxiliary
- Or by substance group
  - Nanomaterial
  - PAHs
  - Formaldehyde

I. Biocides, preservatives, and antibacterial substances

Pesticides are used in farm animal husbandry to prevent animal pests, fly infestation, and beetle attacks on the animals. Furthermore, biocides can also be used to preserve the hides before they arrive into the tannery. Hence, it is possible that biocides are introduced to tannery through their main raw materials (hides and skins).

Biocides are applied to prevent hides and skins from deteriorating during transport, storage and treatment. The application of biocide is independent of the type of hides or skins or tanning process applied. As preservatives, they prevent microbial destruction of raw hides and skins, and intermediate and finished products. As disinfectants, they reduce germs in the processing plant. As

[317] Sustainable and safe design of footwear integrating ecological footprint and risk criteria Herva et al., Journal of Hazardous Materials , Volume 192, Issue 3, 15 September 2011, pages 1876-1881

pesticides, they prevent animal pests, fly infection, moth larvae damage, and beetle attack prior to slaughtering and on long transports of hides and skins.

Commercial biocide preparations may contain a mixture of biocides. The quaternary ammonium compound didecyldimethylammonium chloride is one of the most frequently used active ingredients against bacteria. It is added at a rate of between 0.03 and 0.1 % of hide weight. Other compounds used in soaking have a broader activity spectrum, including activity against fungi, such as: Sodium dimethyldithiocarbamate, N-hydroxymethyl-N-methyldithiocarbamate, Tetrahydro-3,5-dimethyl-2H-1,3,5-thiadiazine-2-thione, 2-Thiocyanomethylthiobenzothiazole (TCMTB) (BREF, 2013)

Biocides in the textile industry are used to prevent deterioration by insects, fungi, algae and microorganisms and to impart hygienic finishes for specific applications. Sensitivity of the fibres differs on a case-by-case basis, but textiles made from natural fibres are generally more susceptible to biodeterioration than synthetic man-made fibres. Synthetic fibres are very rarely subject to deterioration by microorganisms or insects; nevertheless, two polymers are more sensitive than others: Polyvinyl chloride (PVC) and Polyurethanes (PUR), and biocides are added to both[318]. Natural man-made fibres, such as rayon, are readily degraded by mildew and bacteria, whereas, acetate is more resistant. Treatment with biocides can take place before textile processing (e.g., during storage and transport of the raw fibres) and at various stages of textile processing[319].

The Biocidal Products Regulation (BPR, Regulation (EU) 528/2012)[320] concerns the marketing and use of biocidal products which are used to protect humans, animals, materials or articles against harmful organisms like pests or bacteria, by the action of the active substances contained in the biocidal product. This will repeal and replace the current directive on biocides (Directive 98/8/EC); it will enter into force on 1 January 2013 and be applicable from 1 September 2013, with a transitional period for certain provisions. According to this, all biocidal products require an authorisation before they can be placed on the market, and the active substances contained in that biocidal product must be previously approved by product type.

Products used for preservation of fibrous or polymerised materials, such as leather, rubber, paper or textile products, by the control of microbiological deterioration are covered under Product type 9 in the BPR Regulation. These are defined as: biocidal products which antagonise the settlement of micro-organisms on the surface of materials and therefore hamper or prevent the development of odour and/or offer other kinds of benefits.

[318] INERIS. 2000. Emission scenario document for biocide used as preservatives in the textile processing industry.http://ihcp.jrc.ec.europa.eu/our_activities/public-health/risk_assessment_of_Biocides/doc/ESD/ESD_PT/PT_18/PT_9_PT_18_Textile_processing_industry.pdf

[319] Lacasse, K, Baumann, W. 2004. Textile Chemicals. Environmental data and facts. Institute fuer Umwelforschung. Dortmund. Springer Verlag

[320] More information available online at: http://echa.europa.eu/regulations/biocidal-products-regulation

European Commission decisions on approval and non-approval of active substances are published in the Official Journal of the European Union. The European Commission keeps the list updated and electronically available to the public[321]. The European Commission includes approved active substances in the Union list of approved active substances (formerly Annex I of Directive 98/8/EC).

The big four fungicides are commonly known by their abbreviations, PCMC (para-chlor-metacresol), OIT (2-n-octylisothiazolin-3-one), OPP (ortho- phenylphenol), TCMTB (2-(thiocyanomethylthiobenzothiazole)[322].

Considering that biocide is not a desirable product in EU Ecolabeled footwear, it is understood that its use as a chemical preservative for raw or semi-finished material during transportation or storage should be avoided to the greatest possible extend. Biocide shall not be incorporated into the final product in order to impart biocidal properties.

Only biocidal products containing biocidal active substances authorized under Biocide Directive 98/8/EC and Biocide Regulation (EC) No 528/2012 shall be allowed for use.

The main chemical groups identified are:

- Phenols: several types of phenols can be found in shoes and protect against bacteria-induced decomposition [323]:
  - Chlorinated phenols, mainly pentachlorophenol and tetrachlorophenol, are used as biocides in leather products[324].
  - Ortho-phenylphenol: broad-spectrum fungicide and anti-bacterial agent
  - 2,4,6-tribromophenol: fungicide and bactericide. *Other uses: increasingly as a flame retardant*
- Dimethylfumarate (DMF) CAS No. 624-49-7 (CH3OCOCH= CHCOOCH3) is a mould inhibitor which is used to protect items from attack by micro-organisms during transportation and storage (used in sachets which disseminate and impregnate the product). Commission Decision 2009/251/EC of 17 March 2009 under the General Product Safety Directive (2001/95/EC) prohibits placing on the market (or being made available) products which contain dimethylfumarate. The decision has been incorporated into REACH (Annex XVII) under entry 61:

[321] Last updated: 12th February 2013

[322] http://www.tfl.com/web/files/eco_gl3_small.pdf

[323] Chemical Analysis of Organic Compounds in Footwear, Anna-Karin Dahlberg 2010, Stockholm University

[324] *Bad shoes stink – product survey focusing on certain hazardous chemicals in leather shoes*, Swedish Society for Nature Conservation 2009

- Organotin compounds are substances that contain the metal tin along with carbon, hydrogen and oxygen. Decision No. 2009/425/EC establishes restrictions on the marketing and use of organotin (also referred to as 'organostannic') compounds.

  The Commission incorporated this Decision into Annex XVII of the REACH Regulation (Regulation 1907/2006) by Regulation (EU) No. 276/2010 under entry no. 20. The Decision (2009/425/EC) focuses on the di- and tri- substituted organotin compounds due to their broad applications in the market; for example, insoles for shoes, anti-microbial finishing in socks and sports clothes, additive added during production of polyurethane foam, as a stabilizer in production of PVC and as a catalyst in production of silicone. As mentioned in Table 2, since end of December 2012, the compound Dibutyltin (DBT) is listed as SVHC by ECHA.

Other labels

Table 2 below shows the restrictions pertaining to the studied preservatives of four different labels.

Table 77: Restrictions of preservatives in four labels

Label	Restriction			
	Formaldehyde	Dimethyl fumarate	Pentachloro-phenol	Organotin compounds
Nordic Swan	• Textile: 20ppm • Leather: 75ppm • banned for colour extraction or depigmentation • must not be added to glue, except as contaminants	Not specified	Banned in the treatment of leather and during the packaging, storage and transportation phases	Banned in elastane the packaging, storage, and transportation phases
The New Zealand Ecolabelling Trust	• Direct contact to skin: 30ppm • No direct contact: 300ppm • Banned for stripping and depigmentation	- Not specified	Cotton and other natural seed fibres: 0.05ppm	Banned in elastane, the storage and transportation phases
Japan Eco Mark	• In adhesives: max 5 μg/(m^2.h) In leather and textile: • Under 36 months: 16mg/kg • Direct skin contact: 75ppm • No direct contact: 300mg/kg	-	In leather: • Newborns: 0.05mg/kg • Adults: 0.5mg/kg	-
Blue Angel	Not permitted in leather and textile. From other sources: •Under 36 months: 20mg/kg • Other materials: 75mg/kg	Banned <0.1 mg/kg	Banned in biocides and biostatic products	• TBT: 0.025mg/kg • DBT,DOT,MBT,TPT: 1mg/kg each

II. Heavy metals

Heavy metals are conventionally defined as elements with metallic properties and an atomic number >20[325]. Metal pollution has harmful effects on biological systems and does not undergo biodegradation. Heavy metals such as Pb, Co, Cd, Hg, As can be accumulated in living organisms, thus, causing various diseases and disorders even in relatively lower concentrations[326].

Metals are toxic for the three following reasons[327]:

- ability to replace other metals normally complexed to and necessary for the activity of enzymes;
- ability to attach themselves to certain chemical groups on amino acids constituting enzymes and proteins, thereby altering the physical shape and activity of the proteins and enzymes;
- ability to enhance formation of free radicals.

Migration of these contaminants into non-contaminated areas as dust or leachates through the soil and spreading of heavy metals-containing sewage sludge are a few examples of events contributing towards contamination of the ecosystems.

Other heavy metals, such as copper and zinc, are essential to bodily functions, but at higher levels they begin to alter metabolic processes and become toxic. Metals such as chromium only fit into this group of contaminants when they change oxidation states, in this case when chromium III changes to the hexavalent oxidation state chromium VI, and becomes carcinogenic. The short-term effects of heavy metal poisoning can range from skin irritation to vomiting, but high-level exposure can cause anything from liver damage to renal failure.[328]

Heavy metals, in particular cadmium, lead, mercury, nickel, copper, arsenic, cobalt and zinc, can be used as tanning agents or dye, and can be found in the final product,.

Three metals are specifically highlighted by ecolabels because they are known to be highly toxic[327]:

- Hexavalent chromium is classified as a human carcinogen (class I) by IARC[329], whereas, trivalent chromium is not classifiable as carcinogen (IARC class III). This means that it has not been confirmed as carcinogen but it has not been excluded. If inhaled, hexavalent chromium

[325] Tangahu,B.V. Sheikh Abdullah,S.R., Basri,H., Idris, M., Anuar, N., , Mukhlisin, M. 2011. A Review on Heavy Metals (As, Pb, and Hg) Uptake by Plants through Phytoremediation. International Journal of Chemical Engineering 2011. 31 pages

[326] Pehlivan, E. Özkan, A. M. Dinç, S., S. Parlayici,s. 2009. Adsorption of Cu2+ and Pb2+ ion on dolomite powder. Journal of Hazardous Materials 167, pp. 1044–1049,

[327] Bad shoes stink – product survey focusing on certain hazardous chemicals in leather shoes, Swedish Society for Nature Conservation 2009

[328] http://www.blcleathertech.com/blog/heavy-metal-testing/2013/02/04/

[329] IARC : International Agency for Research on Cancer

can cause asthma, bronchitis, and pneumonitis. In addition, skin contact may induce allergies, dermatitis, and skin death.

- Lead and Cadmium are particularly toxic: they can provoke an oxidative stress and damage the nervous system respectively. They are regulated by REACH.

The main tanning agent used in the leather industry is chromium III hydroxide sulphate form[330] Cr(OH)SO4.

Globally, Chromium tanning accounts for some 80-85% of all tanning agents. It is considered to produce very good quality leather.

Chromium (VI) is not used intentionally in the production of leather, but may be formed within the leather by oxidation of chromium (III) used for the tanning of the leather, during the different stages of the use phase. Chromium III oxidizes into chromium IV in the presence of oxygen combined with other factors, such as extremes in pH, which occurs during the tanning process[331]. The mechanisms for the formation of chromium (VI) in leather are now well known and measures to prevent formation of chromium (VI) in measureable concentrations have been developed and implemented in most tanneries in the EU.

In Germany, the concentration of Chromium (VI) in leather products with longer skin contact (e.g., shoes, gloves, garments, leather used for toys and bags) is limited by the German "Bedarfsgegenständeverordnung" since August 2010. The concentration of Cr (VI) should be not detectable (Zero tolerance). In January 2012, the Danish EPA submitted a report to the ECHA recommending that: Articles of leather coming into direct and prolonged or repetitive contact with the skin shall not be placed on the market if the leather contains chromium (VI) in concentrations equal to or higher than 3 mg/kg. Around 0.2-0.7% of the population in the EU is allergic to chromium (VI), corresponding to approximately 1-3 million people.

Chromium is commonly listed in the RSLs. The current detection limit according to the commonly accepted test ISO 17075 is 3mg/kg, which is the concentration limit proposed by the Danish authorities to the ECHA in 2012[332].

[330] *Bad shoes stink – product survey focusing on certain hazardous chemicals in leather shoes*, Swedish Society for Nature Conservation 2009

[331] Idem

[332] http://echa.europa.eu/en/view-article/-/journal_content/a19f3846-4158-4351-8304-39de35c35f1b

Other labels

Table 3 below presents the chromium concentration restrictions required by four different labels.

Table 78: Restrictions of chromium in four labels

Label	Restriction
Nordic Swan	Chromium(VI): <3 ppm in finished skins and leather
The New Zealand Ecolabelling Trust	Chromium(VI): <3 ppm in finished skins and leather
Japan Eco Mark	Hexavalent chromium: not detected Total chromium: Newborns:<50 mg/kg Adults: <200 mg/kg
Blue Angel	Shall not be found in leather 200 mg/kg for total chromium

Table 79 below presents the heavy metal restrictions required by four different labels.

Table 79: Restrictions of heavy metals in four labels

Label	Restriction						
	Mercury	Cadmium	Lead	Nickel	Cobalt	Copper	Arsenic
Nordic Swan		Shall not be found	Shall not be found	Shall not be found			
The New Zealand Ecolabelling Trust		Shall not be found	Shall not be found				Shall not be found
Japan Eco Mark	0.2 mg/kg	0.1 mg/kg	Newborns: 0.2mg/kg Adults: 0.8mg/kg	1 mg/kg for babies 4 mg/kg for adults	1 mg/kg for babies 4 mg/kg for adults		
Blue Angel	0.02 mg/kg	50 mg/kg	50 mg/kg	4 mg/kg	4 mg/kg	50 mg/kg	0.2 mg/kg

II. Dyes and pigments

Dyes and pigments are to a large extend regulated by REACH and the criteria for Hazardous substances and mixtures

Around 98 % of leather dyes on the market for drum application are dyes which fix using the ionic interaction between the anionic sulphonate group of the dye and the cationic amine group of the collagen. The main dyes mainly used by leather industry are water-based acid dyes (which account for about 90% of the market), direct dyes, mordant dyes, pre-metalized dyes, and solubilised sulphur dyes. From a chemical perspective, the dyestuffs are predominantly azo dyes or anthraquinone dyes. Triphenylmethane dyes may also be used. Addition of dyestuff may range from 0.05 % of the shaved weight of the leathers for pale shades, up to 10 % for deep shades. Pigments may also be added to aid the build-up of a shade, particularly for white leathers[333].

Most of the colorants used in the textile industry are soluble dyestuffs. The clear majority of these are azo dyes (70-80%).

Most of the pigments on the market are azo pigments, followed by phthalocyanines[334].

Textile dyes include a wide range of chemicals. In general terms, they can be classified into three subfamilies[335]:

- Azo dyes: they are diazotized amines coupled to an amine or phenol, with one or more azo bonds. In a reductive environment, azo dyes (e.g.,: azobenzene) can be cleaved to generate aromatic amines (e.g.,: benzidine and 4-aminodiphenyl). Azo dyes are by volume the largest group of synthetic dyes used in the textile and leather industries. They can supply a complete rainbow of colours[336]. The REACH regulation forbids the use of azo dyes that (by reductive cleavage of one or more azo groups) may release any of 22 aromatic amines specified in Appendix 8 of Annex XVII of the Regulation, as mentioned in Table 100 (see Annex X Hazardous substances potentially present in footwear).
- Allergenic and sensitising dyes: these dyes provoke skin allergic reactions. Allergenic and sensitizing dyes are typically disperse dyes, which are used for colouring textiles. The problem occurs with skin contact to the coloured material. Disperse dyes are not water-soluble, therefore, they are not normally used for dyeing leather[337].

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333 BREF for Tanning of Hides and Skins. 2013.

334 Sedlak.D. 2012. AFIRM Group. Chemical Guidance Document, http://www.afirm-group.com/PDF12/AppendixF-ChemicalGuidance.pdf (last check August 2013)

335 *Azo Dyes and Their Metabolites: Does the Discharge of the Azo Dye into Water Bodies Represent Human and Ecological Risks?* Drumont Chequer and al 2011

336 *Bad shoes stink – product survey focusing on certain hazardous chemicals in leather shoes*, Swedish Society for Nature Conservation 2009

337 TFL Restricted Substance List

- Metal complex dyes: in these dyes, one or two dye molecules are coordinated with a metal ion[338].

Metal complex dyes

Metal complex dyes are pre-metallised dyes that show great affinity towards protein fibres. The dye molecule is typically a monoazo structure containing additional groups such as hydroxyl, carboxyl or amino, which are capable of forming a strong co-ordination complexes with transition metal ions such as chromium, cobalt, nickel and copper.[339] These kinds of dyes are used particularly for wool[340], although they are used in many other applications (leather finishing, colouring plastics…).

The Nordic Swan only allows the use of metal complex dyes for dyeing of wool, wool mixes (i.e., wool mixed with other fibres such as viscose) and polyamide, but specifies limits for emissions to water after cleansing. The New Zealand Ecolabelling Trust also sets a similar requirement.

Mordant dyestuffs

Mordant dyestuffs can be classified as acid dyes, but because of the technology with which they are applied, they are a stand-alone category of dyes. The dyestuff molecules do not contain chromium, however chromium is present in the salt used to fix the dye onto the fibres. Commonly salts used in this process are potassium dichromate, potassium chromate and sodium dichromate.

The Nordic Swan and the New Zealand Ecolabelling Trust forbid the use of chrome mordant dye.

The list of dyes that are restricted by REACH can be found in Annex XI: List of restricted dyes.

[338] http://www.dyes-pigments.com

[339] http://www.dyes-pigments.com/

[340] http://www.ineris.fr/ippc/sites/default/interactive/bref_text/breftext/anglais/bref/BREF_tex_gb48.html

Other labels

Table 5 below presents the restrictions concerning studied dyes of four different labels.

Table 80: Restrictions of dyes in four labels

Label	Restriction		
	Azo dyes	Allergenic dyes	Metal complex dyes
Nordic Swan	Dyes and pigments are subject to a list of criteria concerning their toxicity (based on R phrases)		
	24 azo dyes releasing aromatic amines are banned	-	Only permitted when dyeing wool mixed with viscose
The New Zealand Ecolabelling Trust	List of banned aromatic amines which are released by some azo dyes	List of banned carcinogenic and allergenic dyes	Dyes based on copper, chromium or nickel: regulation on emissions to water
Japan Eco Mark	List of banned dyes		
Blue Angel	List of banned aromatic amines which are released by some azo dyes	No carcinogenic dyes shall be used	Regulation on emissions to water

III. Organic solvent

As mentioned in the AFIRM guidance document, solvents are widely used during the footwear or footwear component manufacturing process, for example solvent use to make adhesive. Some solvents used in adhesive systems are based on toluene or benzene,

These substances may be a concern because of their potential environmental, workplace safety and consumer safety impacts. As highlighted by AFIRM and mentioned in Table 100 (see Annex X Hazardous substances potentially present in footwear), solvents may play a significant role as residuals.

Specific examples are organic solvents used are petroleum distillates, esters and glycol ethers. These compounds (e.g., toluene, phenol, formaldehyde, xylene, ethylbenzene, methyl methacrylate, butyl methacrylate, heptane, ethyl acetate, etc.) are mainly volatile and flammable and mosty often classified according to their effect on human health as harmful if inhaled, irritant to eyes, skin and by inhalation.

The Blue Angel restricts the use of chlorinated benzenes and toluenes in dyed synthetic fibers.

IV. Plasticizers and elastomers

The following substances have been identified as used in the production or improvement of plastic materials in the footwear industry:

- Phthalates: Phthalate esters are plasticizing agents used in the plastic manufacturing. Phthalates are commonly used as softeners in plastic and rubber, but especially to soften polyvinyl chloride (PVC) which may contain up to 50% by weight of plasticizers, which are most commonly phthalates[341]. The four main phthalates found in shoes are the following: diethyl phthalate, diisobutyl phthalate, dibutyl phthalate (DBT) and bis(2-etyhylhexyl)phthalate (DEHP).

  Other possible application: fixing agents and carriers in different textile materials

- Chlorinated paraffins: MCCPs are used as secondary plasticizer for PVC and PVC copolymers. They are subdivided into three families according to the length of their carbon chain: short (SCCPs), medium (MCCPs) and long (LCCPs) chain chlorinated paraffins.

  Other possible application: in the tanning process for assisting removal of fat from raw hide, and after tanning to assist re-fatting of the leather, adhesives, lubricants and flame retardants for plastics and fabrics

- Isocyanates (iso): The iso is mixed with polyol or polyamine resins formed as chemical precursors of polyurethanes used as elastomers (elastic fibers), glues and coatings for furs and textiles (synthetic materials imitating fur/leather)[342]. Isocyanates are usually classified into two groups: aromatic and aliphatic compounds. The most common aromatic isocyanates are methylene diphenylmethane-4,4-diisocyanate (MDI) and toluene diisocyanate (TDI). The most common aliphatic compounds are hexamethylene diisocyanate (HDI) and hydrogenated MDI (HMDI). Other isocyanates that can be found in the footwear industry include:
  - Isophorone diisocyanate (IPDI)
  - Tetramethylxylene diisocyanate (TMXDI)

MCCPs (CAS No: 85535-85-90) cover mixtures of alkanes with 14 to 17 carbon atoms and different degrees of chlorination. The total EU consumption of medium-chain chlorinated paraffins is estimated to be between 56,700 and 65,300 tonnes/year over the period 1994-1997. The main uses are as plasticisers/flame retardants in PVC (~79-83% of use), additives in metal cutting/working fluids (5-9% of use), plasticisers/flame retardants for paints and sealants (4-5% of use), plasticisers/flame retardants for rubber and polymers other than PVC (3-4% of use), components of leather fat liquors

[341] http://www.sustainableproduction.org/downloads/PhthalateAlternatives-January2011.pdf

[342] INDITEX Restricted Substance List

(2-3% of use) and as a carrier solvent in carbonless copy paper (1-2% of use)[343]. Norwegian PoHS (Prohibition on Certain Hazardous Substances in Consumer Products) that became effective in 2008 restricts the content of MCCP in consumer goods (including clothing) to 0.01% w/w in article.

The available empirical and modelled data indicate that SCCPs (Alkanes, C10-13, chloro), are persistent, bioaccumulative and toxic, particularly to aquatic organisms, and they may undergo long-range environmental transport. SCCPs are considered as Persistent Organic Pollutants (POPs) pursuant to decisions taken under the UNECE Aarhus (POPs) Protocol to the Convention on Long Range Transboundary Air Pollution (LRTAP). The Stockholm Convention nomination for listing is directed at SCCP products that contain more than 48% by weight chloride. Use of SCCP is restricted by the REACH Regulation so that they shall not be placed on the market for use as substances or as constituents of other substances or preparations in concentrations higher than 1 % in metalworking and for fat liquoring of leather.

Phthalates pose risk for terrestrial and aquatic ecosystems, particularly in the vicinity of phthalates processing industries. Some phthalates are bio accumulative. The impact of phthalates on the environment depends on the type of phthalate[344]. Phthalates may cause reproductive abnormalities, asthma, thyroid effects, and adverse effects on the lungs, liver and kidneys[344].

Polyurethane polymers are formed by reacting at least two isocyanate functional groups with at least two alcohol groups in the presence of a catalyst (tertiary amines, such as dimethylcyclohexylamine, and organometallic salts, such as dibutyltin dilaurate). The first essential component of a polyurethane polymer is the isocyanate. Molecules that contain two isocyanate groups are called diisocyanates. These are also referred to as monomers or monomer units, since they themselves are used to produce polymeric isocyanates that contain three or more isocyanate functional groups.

Isocyanates can be classed as aromatic, such as diphenylmethane diisocyanate (MDI) or toluene diisocyanate (TDI); or aliphatic, such as hexamethylene diisocyanate (HDI) or isophorone diisocyanate (IPDI).

For footwear production, the main adhesive type is polyurethane, so release of methylene diphenyl diisocyanate (MDI), toluene diisocyanate (TDI), hexamethylene diisocyanate (HDI) and isophorone diisocyanate (IPDI) must be considered.

From these substances, further components, such as aliphatic amines, stabilizers, catalysts, etc.,may be released or transferred to the final product.

As mentioned in **Table 100** (see Annex X Hazardous substances potentially present in footwear), MDI is listed in the EU's REACH Directive (Annex XVII) and identified as SHVC in the current candidate list (June 18, 2012).

[343] European Union. Summary Risk Assessment Report. Existing Substances – 3rd Priority List. ALKANES, C14-17, CHLORO. Part II. Human Health. JRC-IHCP

[344] http://www.sustainableproduction.org/downloads/PhthalateAlternatives-January2011.pdf

According to an RPA for the European Commission 2007[345], some alternatives have been found in the marine industry where isocyanates have been used as a component of coating chemicals (in polyurethane):

- Isocyanate-free polyurethane: it is a hybrid non-isocyanate polyurethane
- Polysiloxane alternatives: blend of epoxy (organic) and siloxane (inorganic) materials.

According to the findings from the EU Ecolabel revision for Bed Matrasses, the organotin compounds used in some plastics are di-organostannic tin-compounds and should not to be confounded with tri-organostannic tin compounds (TBT) which were mainly used in the past as anti-fouling agents for ships with significant impact on the environment. Many organotin stabilizers have food contact approval, an indirect indication that their migration, if any, is extremely low. Furthermore, according to the stakeholders consultation TDI forms a significant share of the market in Europe (80%) and its use of TDI is safe since workers exposure is controlled. Moreover, foams produced from MDI need to have a higher density (+30%), thus requiring more material and being more expensive[346]. The use of isocyanate in PU foams for footwear manufacturing should be further consulted with stakeholders.

Other labels

Table 6 below shows the restrictions concerning plasticisers of four different labels.

Table 81: Restrictions of plasticisers and elastomers in four labels

Label	Restriction		
	Chlorinated paraffins	**Phthalates**	**Isocyanates**
Nordic Swan	SCCP Banned	Phthalates regulated by REACH and listed as SVHC are banned	limit on emissions to the air of aromatic diisocyanates during polymerisation and spinning to 5 mg/kg produced fibre
The New Zealand Ecolabelling Trust	Coatings, laminates and membranes shall not be produced using plasticisers or solvents that are assigned or may be assigned at the time of application any of a list of risks phrases (according to that, short chain chlorinated paraffins are banned).		
Japan Eco Mark	Plastic material shall not use halogen elements for the polymer structure as prescription constituents	-	-
Blue Angel	C10-C13 chloro alkanes may not be used in leather, rubber or textile components	Phthalates regulated by REACH and DIBP are banned	-

[345] Impact Assessment of Potential Restrictions on the Marketing and Use of Certain Organotin Compounds – RPA for the European Commission 2007

[346] http://susproc.jrc.ec.europa.eu/mattresses/docs/Technical%20report_v3.10.pdf

V. Flame retardants

Flame-retardants are a variety of compounds added to materials to reduce their flammability or to delay the propagation of the flame, in order to prevent fires. Flame retardants have been used extensively in the passive protection of wood, plastics, textile and synthetic fibres. Some of the main flame retardants contain halogenated organic compounds, such as polychlorinated polybrominated biphenyls (PBBs), polybrominated diphenyl ethers (PBDEs), tetrabromobisphenol A (TBBPA) and hexabromocyclododecane (HBCDD). Although they have been widely used by industry, recent studies warn of the environmental issues and toxicity of these compounds, or advise using flame retardants containing no halogenated compounds[347,348].

In general, halogenated organic compounds (containing chlorine, bromine, fluorine or iodine) encompass a large number of hazardous substances harmful to human health and the environment. Furthermore, halogenated organic compounds do not degrade readily in the environment which increases the risk to harmful effects. Hexabromocyclododecane (HBCDD) and all major diastereoisomers, and Tris(2-chloroethyl)phosphate (TCEP) are classified as PBT (persistent, bioaccumulative and toxic) and toxic for reproduction, respectively, according to the authorisation list for substances of very high concern. Furthermore, short-chain chlorinated parraffins and Bis(pentabromophenyl)ether (DecaBDE) are included in the candidate list of substances of very high concern because they are classified as PBT (persistent, bioaccumulative and toxic) and vPvB (very persistent, very bioaccumulative), respectively.

Environmental problems associated with the use of flame retardants can arise either during the production process, migration of the material under certain waste water treatment conditions, or during the disposal or recycling stage since the products can generate toxic gases or corrosive decomposition. Flame retardants based on antimony trioxide contain halogenated organic synergists like decabromophenyl ether mentioned in Table 100 (see Annex X Hazardous substances potentially present in footwear).

Various RSL[349] documents currently address textile and footwear as a whole, therefore, it was not possible to identify flame retardants used specifically for footwear. According to the information gathered, flame retardants are not commonly used in footwear, unless specifically required by legal requirements, or protective function (e.g., fireman protective footwear). This point needs to be further discussed during stakeholder's consultation process.

[347] Environment California Research and Policy Center. 2003. GROWING THREATS. Toxic Flame Retardants and Children's Health

[348] D'Silva, K. 2004. Brominated Organic Micropollutants—Igniting the Flame Retardant Issue. Critical Reviews in Environmental Science and Technology 34, pp. 141–207

[349] AFIRM, Nike, Adidas, Esprit, C&A

The Blue Angel, Nordic Swan and the New Zealand Ecolabelling Trust restrict the use of flame retardant substances or flame retardant preparations.

VI. Nanomaterials

On 18 October 2011, the Commission adopted the Recommendation on the definition of a nanomaterial[350]. According to this Recommendation, a "Nanomaterial" means: *A natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm - 100 nm. In specific cases and where warranted by concerns for the environment, health, safety or competitiveness, the number size distribution threshold of 50 % may be replaced by a threshold between 1 and 50 %. By derogation from the above, fullerenes, graphene flakes and single wall carbon nanotubes with one or more external dimensions below 1 nm should be considered as nanomaterials.*

The risks posed to the environment and human health by the nanomaterials should be assessed using the existing risk assessment approach in the EU. Based on the conclusions from the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR)[351], there is still scientific uncertainty about the safety of nanomaterials in many aspects, such as: hazard identification, exposure, uptake, absorption and transport across membranes, accumulation in secondary target organs, possible health effects, translocation of nanoparticles via the placenta to the foetus and in vitro and in vivo test methods validated or optimized for nanomaterials.

The current methods used in REACH to assess the toxicological and ecotoxicological risk may not be adequate to evaluate the risks related to nanomaterials. Consequently, there is lack of knowledge regarding the damage nanomaterials may cause. Therefore, the Commission is considering modifying some of the technical provisions in the REACH Annexes, and has launched a public consultation to this effect which was open for input from 21 June 2013 until 13 September 2013.

On the basis of the precautionary principle, both Blue Angel and Nordic Swan restrict the use of nanomaterials in ecolabelled products.

Due to its antimicrobial activity, nanosilver (nAg) has become the most widely used nanomaterial in an increasing number of products. The most common application of nanosilver is as an antimicrobial agent in products such as wound dressings, textiles, food storage containers and personal care appliances.

Relatively little is known about the potential risks of nanosilver. In particular, the cytotoxicity of nanosilver with respect to mammalian cells remains unclear, because such investigations can be

[350] Commission Recommendation 2011/696/EU

[351] http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_010.pdf

biased by the nanosilver coatings and the lack of particle size control[352]. It is hypothesized that the toxic effects of nanosilver are due to a combination of the specific properties of silver nanoparticles and the generation of ions from them[353].

Several studies investigated nanosilver's toxicity to aquatic organisms[354,355] and effects on human cells *in vitro*[356, 357]. Silver ions are able to block certain key enzymes in some types of cells and create powerful free radicals, which can oxidise and further damage enzymes, other proteins and DNA. Silver ions inhibit the Na+/K+ ATPase transporter in the fish gill leading to hypertension, cardiac failure, and death. Wang et all (2013)[356] demonstrated that nAg treatment in vitro resulted in reduced hemoglobin concentration in erythroid cells; in vivo administration of nAg in mice caused profound reduction of hemoglobin content in embryonic erythrocytes, associated with anemia in the embryos. The combined data highlight the inhibitory effect of nAg on RNA polymerase activity through a direct reciprocal interaction.

Emission to the environment may occur during all life cycle steps. For consumers, use of the product may result in both dermal and inhalation exposure to nanosilver. Workers may also be exposed (during production of nanosilver particles and the formulation of the cleaning product)[358]. Overexposure to silver nano-particles can cause other potentially harmful organisms to rapidly adapt and flourish; that is it to say that exposure to excessive doses of silver ion-releasing nanoparticles actually improved bacterial survival rates[359]. According to Prastnis et al. (2013), the toxicity of small nanosilver (<10 nm) is mostly mediated by the released Ag(+) ions. The influence of such ions on the toxicity of nanosilver decreases with increasing nanosilver size (>10 nm).

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352 Pratsinis A, Hervella P, Leroux J.C., Pratsinis S.E., Sotiriou G.A.2013. Toxicity of silver nanoparticles in macrophages. Small 9 (15), pp 2576-2584

353 Wijnhoven, S.W.P., Peijnenburg, W. J.G.M., Herberts , C.A. et al. 2009. Nano-silver – a review of available data and knowledge gaps in human and environmental risk assessment. Nanotoxicology 3. Pp 109-138

354 Meyera, I.N, Lorda, C.A., Yanga, X.Y., Turnera, E.A., Badireddyb, A.R., Marinakosb,S.M., Chilkotib, A., Wiesnerb, M.R., Auffanb, M. 2010. Intracellular uptake and associated toxicity of silver nanoparticles in Caenorhabditis elegans. Aquatic Toxicology 100, pp 140–150

355 Miao, A-J, Luo, Z, Chen, C-S, Chin, W-C, Santschi, P.H, et al. 2010. Intracellular Uptake: A Possible Mechanism for Silver Engineered Nanoparticle Toxicity to a Freshwater Alga Ochromonas danica. PLoS ONE 5(12): e15196. doi:10.1371/journal.pone.0015196

356 Wang, z.,Liu, S., Juan Ma, J. , Qu , G. , Wang, X., Yu, S., He, J., Liu, J., Xia, T. §, Jiang, G-B. 2013. Silver Nanoparticles Induced RNA Polymerase-Silver Binding and RNA Transcription Inhibition in Erythroid Progenitor Cells. ACS Nano, 2013, 7 (5), pp 4171–4186

357 Powers CM. Developmental neurotoxicity of silver and silver nanoparticles modelled in vitro and in vivo [doctoral thesis]. Durham, NC:Duke University (2010). Available: http://hdl.handle.net/10161/3128 [accessed August 2013].

358 Pronk, M.E.J. et all. 2009. Nanomaterials under REACH. Nanosilver as a case study. RIVM report 601780003/2009

359 Gunawan, Yang Teoh, W., Marquis, C.P., Amal, R. 2013. Induced Adaptation of Bacillus sp. to Antimicrobial Nanosilver. Small, published online 29 APR 2013

On the basis of the toxicology studies reviewed to date and the uncertainty associated with its possible environmental impacts, a precautionary approach is proposed for nanosilver with respect to the EU Ecolabel criteria. The requirement to restrict the use of nanosilver is aligned with the requirement laid down in the on-going revision process of the EU Ecolabel for textile.

VII. PAHs

Polycyclic aromatic hydrocarbons (PAHs) are known for their carcinogenic, mutagenic and teratogenic properties.[360,361] . They form a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic compounds. PAHs can be found in petrochemicals, rubber, plastics, lubricants, antirust oil, paints, varnishes. EU REACH Annex XVII has placed a restriction on the use of 8 PAHs (Table 100). REACH has designated ISO 21461 as standard testing method for 8 PAHs in tyre (see Annex X Hazardous substances potentially present in footwear). The US Environmental Protection Agency listed 16 different PAHs in consumer goods as priority environmental pollutants (EPA-PAH 2008). The German committee' Technische Arbeitsmittel and Verbraucherprodukte(AtAV)' has decided to require mandatory testing of the presence of Polycyclic Aromatic Hydrocarbons (18 PAHs) for the GS-certification process[362]. Below table specifies the comparison between GS Mark, REACH Annex XVII, and US EPA PAHs.

Table 82 The comparison between GS Mark, REACH Annex XVII, and US EPA PAHs

Name	CAS NO	REACH Annex XVII	US EPA	GS MARK
Naphthalene	91-20-3		X	X
Acenaphthylene	208-96-8		X	X
Acenaphthene	83-32-9		X	X
Fluorene	86-73-7		X	X
Phenanthrene	85-1-8		X	X
Anthracene	120-12-7		X	X
Fluoranthene	206-44-0		X	X
Pyrene	129-00-0		X	X
Chrysene	218-01-9	X	X	X

[360] http://monographs.iarc.fr/ENG/Monographs/vol92/mono92.pdf

[361] http://www.umweltdaten.de/publikationen/fpdf-l/4395.pdf

[362] "Geprüfte Sicherheit: any product bearing the GS Mark indicates that it was tested and complies with the minimum requirements of the German Product Safety Act.

Name	CAS NO	REACH Annex XVII	US EPA	GS MARK
Benzo[a]anthracene	56-55-3	X	X	X
Benzo[b]fluoranthene	205-99-2	X	X	X
Benzo[k]fluoranthene	207-08-9	X	X	X
Benzo[a]pyrene	50-32-8	X	X	X
Dibenzo[a,h]anthrancene	53-70-3	X	X	X
Indeno[1,2,3-c,d]pyrene	193-39-5		X	X
Benzo[g,h,i]perylene)	191-24-2		X	X
Benzo[j]fluoranthen	205-82-3	X		X
Benzo[e]pyren	192-97-2	X		X

German authorities recommend that marketing and use of PAH contaminated products should be limited. In particular, the content of each of the eight PAHs legally classified as carcinogens should be restricted in consumer products or limited. According to ZEK 01.4-08, the MCV (Maximum Concentration Values) of PAHs must comply with the following limits[363]:

Parameter	**Category I**	**Category II**	**Category III**
Product	Material in contact with foodstuff, or materials indented to be put in the mouth and toys for children aged<36 months	Materials with foreseeable contact to skin for longer than 30 seconds (long-term skin contact) and toys not covered by category 1	Materials with foreseeable contact to skin up to 30 seconds (short-term skin contact) or without skin contact
BaP	<0.2 mg/kg	1 mg/kg	20 mg/kg
Total of 18 PAHs	<0.2 mg/kg	10 mg/kg	200 mg/kg

The Nordic Swan limits the use of PAHs in the mineral oil part of an auxiliary chemical to less than 3 % of the total weight. The New Zealand Ecolabelling Trust sets this limit at 1 %. The Oeko-Tex standard sets the limit to 5 mg/ kg for the baby product class and to 10 mg/kg for other product classes. The AFIRM global RSL sets the limit at 50 ppm.

VIII. Auxiliary

APEOs (Alkylphenolethoxylates) belong to the group of nonionic surfactants used for scouring wool and leather, and also in dyestuff formulation as an emulsifier or dispersing agent. APEOs were

[363] http://www.zls-muenchen.de/de/left/aktuell/pdf/zek_01_4_08_pak_verbindlich_engl_30112011.pdf

voluntarily phased out by TEGEWA (Industrial Association for Textile and Leather Aids, Tanning Materials, and Raw Materials for Detergents) by the end of 2001. This commitment covers all European TEGEWA members but not necessarily the manufacturers in other parts of the world. Therefore, a ban on APEO is still relevant.

The European Union has regulated the industrial use of nonylphenol ethoxylates and nonylphenol since 2003. As mentioned in Table 100 (see Annex X Hazardous substances potentially present in footwear), the EU's REACH Directive incorporated these regulations in Annex XVII and limits the amount of nonylphenol ethoxylate and nonylphenol as a substance or component in preparations less than or equal to 0.1% by mass. These substances are also mentioned as SHVCs.

Blue Angel restricts the use of alkylphenol etoxylates (APEOs) in footwear, specifically nonylphenols and nonylphenols ethoxylates, and requires specific tesst for assessment and verification. It also sets a specific concentration threshold. This approach is in line with several RSL branch list screened.

Therefore, it should be discussed with stakeholders if the applicant declaration of no use is feasible. According to some feedback from testing experts there are available alternatives.

Other labels

Table 7 shows the restrictions pertaining to APEOs for four different labels.

Table 83: Restrictions of APEOs for four labels

Label	Restriction
Nordic Swan	Banned
The New Zealand Ecolabelling Trust	Banned
Japan Eco Mark	-
Blue Angel	May not be used, especially nonylphenols and nonylphenol ethoxylates

IX. Impregnation agents

Impregnation agents are used to form a repellent coating or waterproof membrane. The impregnation agents used in the footwear industry are mainly manmade perfluorinated and polyfluorinated chemicals (PFCs) of long carbon chain of both lipid- and water-repellent character[364,365]. PFCs are molecules made up of carbon chains to which fluorine atoms are bound. Due to the strength of the carbon/fluorine bond, the molecules are chemically very stable and are highly resistant to biological degradation; therefore, they belong to a class of compounds that tend to persist in the environment[366]. According to the OECD definition, long-chain perfluorinated compounds refers to[367]:

- Perfluorocarboxylic acids with carbon chain lengths C8 and higher, including perfluorooctanoic acid (PFOA);
- Perfluoroalkyl sulfonates with carbon chain lengths C6 and higher, including perfluorohexane sulfonic acid (PFHxS) and perfluorooctane sulfonate (PFOS); and
- Precursors of these substances that may be produced or present in products

[364] Olsen, G.W., J.M. Burris, D.J. Ehresman, J.W. Froehlich, A.M. Seacat, J.L. Butenhoff, and L.R. Zobel. 2007. Half-life of serum elimination of perfluorooctanesulfonate, perfluorohexanesulfonate, and perfluorooctanoate in retired fluorochemical production workers. Environmental Health Perspectives 115 (9):1298-305.

[365] Agency for Toxic Substances and Disease Registry (ATSDR). 2009. Toxicological profile for Perfluoroalkyls. (Draft for Public Comment). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. http://www.atsdr.cdc.gov/toxprofiles/tp200.html#bookmark08.

[366] Stahl, T., Mattern, D. Brunn, H. 2011. Toxicology of perfluorinated compounds. Environmental Sciences Europe 2011, 23:38

[367] http://www.oecd.org/ehs/pfc/

- a substance that has been recognized as having the potential to degrade to perfluorocarboxylic acids with a carbon chain length of C8 and higher (including PFOA) or perfluoroalkyl sulfonates with a carbon chain length of C6 of higher (including PFHxS and PFOS).

PFCs have found broad industrial application as surface coatings and protectant formulations for leather products and textiles to repel water, grease, and soil, and also in fire-fighting foams. The highest production volume of PFCs have been perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorooctane sulfonyl fluoride (PFOSF) which are generally considered the PFCs reference substances. Other high-volume PFCs include perfluorohexane sulfonic acid (PFHxS), which is a member of the same chemical class as PFOS; and perfluorononanoic acid (PFNA), which is a member of the same chemical class as PFOA. Use of PFAS (Perfluorinated Alkylated Substances) for footwear impregnation at manufacturing stage is from one aspect the concern, but shoe treatment by the consumer is also becoming part of the concern (EPA, 2008)[368]. The PFAS environmental problems are currently being evaluated by the European Food Safety Association (2008)[369] and EPA (2012)[370].

PFCs are biologically and chemically stable and persistent in water and soil. They are toxic/harmful to aquatic organisms and may cause long-term adverse effects in the aquatic environment. PFCs are persistent in humans, with most taking years to be cleared from the body. PFOA and PFOS are absorbed after oral exposure and accumulate primarily in the serum, kidney and liver. PFCs may also enter the body by ingestion of dust and dirt particles and by contact with products that have been treated with substances that contain PFCs or its precursor compounds. These may include footwear products. These routes of entry may be of particular importance in regard to children because of possible indirect contact by hand-to-mouth transfer or direct if an infant sucks on the product. Another exposure route that should also be taken into account is inhalation of PFCs from indoor or outdoor air,[371,372] but also from water repellent sprays. Dermal exposure may also occur by skin contact with PFC-treated products[373].

Available evidence suggests that transformation or biodegradation of precursor perfluorinated chemicals occurs by both abiotic and biotic degradation pathways where perfluorooctane sulfonate

[368] Danish EPA (2008) Fluorinated compounds in impregnating agents

[369] The EFSA Journal (2008) 653, 1-131

[370] EPA (2012) Contaminants – Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)

[371] Langer V, Dreyer A, Ebinghaus R. 2011. Polyfluorinated compounds in residential and nonresidential indoor air. Environmental Sciense Technology 44, pp 8075-8081

[372] Huber S, Haug LS, Schlabach M. 2011. Per- and polyfluorinated compounds in house dust and indoor air from northern Norway-a pilot study. Chemosphere 84, pp. 1686-1693.

[373] Bundesinstitut für Risikobewertung (BfR).2008. Gesundheiltiche Risiken durch PFOS und PFOA in Lebensmitteln sind nach dem derzeitigen wissenschaftlichen Kenntnisstand unwahrscheinlich. Stellungnahme Nr. 004/2009

(PFOS) and perfluorooctanoic acid (PFOA) are typical final degradation products[374]. A recent study revealed that PFC in the children's bodies impaired the effect of childhood vaccines, even at normal concentrations/levels[375]. Experimental evidence exists with regard to reproductive toxicity for the two main PFCs, perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (EFSA, 2008)[376]. The use of polyfluorinated compounds has been related to hormonal disturbances in addition to presenting a risk for the development of breast cancer[377].

Dendrimers are used as non-fluorine alternatives to PFOS as water-proofing agents on textiles and leather. There are considerations concerning health since cytotoxicity studies have shown dendrimers are able to cross cell membranes, disrupt platelet function, and cause hemolysis. Perfluorohexane sulfonyl fluoride (PFHxSF) and its derivatives are used as textile finishing agents with waterproof and anti-fouling effects equal with that of PFOS, but its grease-proof is lower than that of PFOS. There are concerns over the persistence of C6 compounds and the increased ability of C6 and C4 compounds to contaminate water[378].

Use of PFAS (Perfluorinated Alkylated Substances) for footwear impregnation at manufacturing stage is one aspect of the problem, but shoe treatment by the consumer[379] is also becoming part of the concern.

The European Union (EU) Directive 2006/122/EC of the European Parliament and of the Council of 12 December 2006 established restrictions on the marketing and use of PFOS for new products in the non-food area, which applied from 27 June 2008 onwards. PFOS shall not be used as a substance or constituent of preparations in products with a concentration equal to or higher than 0.005 % by mass. Otherwise, products will be restricted to be placed on the market. Semi-finished products or articles, or parts shall not be placed on the EU market if the concentration of PFOS is equal to or higher than 0.1 % (1000ppm) by mass; and for textiles or other coated materials, the concentration shall not be higher than 1 µg/m2.

[374] Bonefeld-Jorgensen, E.C., Long, M., Bossi, R, Ayotte, P., Asmund, G., Krüger, T., Ghisari, M., Mulvad, G., Kern, P., Nzulumiki, P., Dewailly, E. 2011. Perfluorinated compounds are related to breast cancer risk in greenlandicinuit: A case control study. Environmental Health 10:88

[375] Hildebrandt, S. Reduce PFC exposure and rescue childhood vaccines. 2013. ScienceNordic. April 28, 2013, http://sciencenordic.com/reduce-pfc-exposure-and-rescue-childhood-vaccines (last check August, 2013)

[376] European Food Safety Authority.2008. Opinion of the scientific panel on contaminants in the food chain on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and their salts. EFSA J 2008;653:, p 1-131.

[377] Bonefeld-Jorgensen, E.C. , Long, M. , Bossi, R, Ayotte, P., Asmund, G., Krüger, T., Ghisari, M., Mulvad, G., , Kern, P., Nzulumiki, P., Dewailly, E. 2011. Perfluorinated compounds are related to breast cancer risk in Greenlandic Inuit: A case control study. Environmental Health 10:88

[378] UNEP.Technical paper on the identification and assessment of alternatives to the use of perfluorooctane sulfonic acid in open applications. 2010. UNEP/POPS/POPRC.8/INF/17

[379] Danish EPA (2008) Fluorinated compounds in impregnating agents

Blue Angel Eco-label for footwear and Nordic Swan Eco-label for textile, hides/skins and leather prohibit use of PFCs substances in the product.

As mentioned in Table 100 (see Annex X Hazardous substances potentially present in footwear), in December 2012 and June 2013, respectively four and one PFCs were identified as SHVC due to their high persistence and high bioaccumulation.

According to contact with testing experts and stakeholders, there are alternatives to PFCs, but they have a higher cost and a lower performance. Thorough consultation with industry must occur in order to evaluate the feasibility of applying substitutes.

X. Formaldehyde

Formaldehyde is chemically the simplest aldehyde with the formula H2CO. Formaldehyde is a gas at room temperature and readily soluble in water. Formaldehyde can be used in many applications and has many functions (preservative, carrier, binding agent, disinfectant…).

It can be used in the tanning, re-tanning and finishing of leather. It is known to prevent growth of bacteria and fungi in a water-based environment. It is used in the production of adhesives and binders for wood, plastic, textiles and leather. It is the most used resin compound for glue used in shoes. It can also be used in the production of tanning resins for leather.

According to testing experts, Formaldehyde is more for the problem for production stage rather than in the final product, even if it is considered as sensitive for baby shoes. Formaldehyde is often restricted or its use quantity has to be minimized to be in line with RSL document developed by company.

4 Task 4: Improvement potential

4.1 Objectives

The aim of this chapter is to translate the main LCA findings into Ecolabel criteria. The analysis performed provides an estimate of the necessary improvement potential to support discussions and consultation related to on-going revision of the EU Ecolabel criteria for the Footwear product group as introduced by the Commission Decision 2009/563/EC. Therefore, the overall goal of this Task is to highlight possible environmental benefits related to the previously identified impacts (see section Task 3: Technical Analysis), and to prioritize them according to:

- The main environmental issues;
- The technical and economical feasibilities.

The potential for improvement of the environmental hot spots is calculated per functional unit[380] and aggregated to the EU27 level on the basis of the market figures gathered under Task 2: Market analysis. When insufficient availability of market data makes direct calculation unfeasible, an exhaustive estimate is performed. The results are then transformed into criteria proposals to be revised or added following the consultation process.

4.2 Conclusions from Task 2 and 3

The objective of this chapter is to perform a qualitative assessment of the potential improvements that may be achieved in the footwear industry. Market diffusion and possible barriers and opportunities within the proposed analysis areas are considered and, whenever possible, are augmented with numerical estimates.

The key life-cycle areas of concern considered in Task 2: Market analysis and Task 3: Technical Analysis analyses and supported by stakeholder feedback are summarized in Table 84.

In general, the available current information suggests that changes are needed. Potential impacts of hazardous substances used along the footwear supply chain are considered as a non-LCA impact; accordingly, related improvement potential in this area is addressed elsewhere.

[380] "To use and wear appropriately footwear in good conditions during one year."

Table 84: Possible improvement areas within the footwear supply chain

Life Cycle stage	Potential improvements
Input materials	Reduction of footwear mass
	Use of organic cotton
	Use of recycled polyester
	Use of bio-based materials
	Use of recycled plastics
	Exclusion of PVC
	Reduction of emissions to water
Chemicals	Restriction on hazardous substances
Manufacturing	Reduction of energy consumption during footwear manufacturing
	Use of renewable energy for footwear manufacturing
	Reduce VOC emissions from solvents and adhesives
	Reduce wastage
	Reduce water consumption
Distribution	Restriction of airplane transport
Fitness for use	Improvement of footwear durability
End of life	Improvement of end of life management

4.3 Analysis of potential improvements

The improvement potentials derived in this chapter are given in percentages obtained through direct comparison with the results of the baseline scenario (based on an average pair of footwear) established for Task 3: Technical Analysis.

In general terms, it is very complicated to quantitatively evaluate the market diffusion of a series of identified best practices at the European level. However, as the results are expressed in percentage of improvement, the results are also valid at European level under assumption that the related improvement is applied uniformly across the EU28. In general terms, the improvement potential at European scale is proportional to the one estimated for one pair of footwear and to the market penetration (e.g., if the improvement potential for one pair of footwear is 10 % on a given impact category and 20 % of the market is projected to use the best practice, then the improvement potential at European level is of 2 % (10 %*20 %)).

4.3.1. Improve durability of footwear

I. Context

Footwear durability is the most important parameter that directly influences the environmental impacts. Maintaining footwear in a good condition extends its usage period, hence, reducing the quantity of footwear required to fulfil the functional unit. Different parameters influence the actual durability of one generic pair of shoes (such as current fashion trends and users' behaviour, among others); however, only mechanical resistance is controlled by the manufacturers[381]. Because of high

[381] being evaluated through normalized tests, e.g. ISO

level of uncertainty, and lack of statistical estimation methods for evaluating the social aspects of footwear lifetime, only product physical characteristic is addressed here.

The potential improvement is related to the use of appropriate materials and assembling processes that increase the lifetime of footwear that are used in appropriate conditions.

The baseline scenario assumed that two pairs of footwear are required to fulfil the functional unit380; that is to say that a consumer needs two pairs of footwear worn during one year (6 months/ pair). Based on this assumption, extension of footwear lifetime by another 6 months (usage of the same pair of footwear during 12 months) would result in the improvement potential of 50 % on all impact categories (the environmental impacts would be halved).

In general terms, the environmental benefits related to the durability parameter are very easy to calculate when the lifetime is known, since these are directly proportional to the improvement of its lifespan[382].

II. Criterion proposal

Considering the relevance of footwear durability to life cycle, it seems crucial to address this area within the on-going revision of the EU Ecolabel criteria

The proposal is to follow the current EU Ecolabel approach: a minimum limit value for each selected ISO, or equivalent, test method should be reached. According to stakeholders' opinion expressed during the stakeholder survey, selected fitness-or-use methods should be reviewed or clarified. Table 85 presents test methods that are required by different schemes to assess or ensure a sufficient durability of footwear. The Blue Angel uses the same tests as the current EU Ecolabel. The ADEME-AFNOR uses other tests. The relevance of including these tests in the criterion could be further discussed with stakeholders together with analysis of possible test redundancies.

Table 85: Test methods required by other schemes related to footwear product group

Test method	ISO norm	Current EU Ecolabel	Blue Angel	ADEME-AFNOR
Upper – Flex resistance	ISO 13512	X	X	
Upper – Tear strength	ISO 13571	X	X	
Outsoles – Flex resistance	ISO 17707	X	X	X
Outsoles – Abrasion resistance	ISO 12770	X	X	
Outsoles – Tear strength	ISO 12771	X	X	
Whole sole – Sole adhesion	ISO 17708	X	X	X
Uppers, linings and insocks – Tear strength	ISO 17696			X
Insoles – Abrasion resistance	ISO 20868			X
For the lining Textiles – Determination of the abrasion resistance of fabrics by the Martindale method – Part 2: Determination of specimen breakdown	ISO 12947-2			X
Test methods for uppers, linings and in socks — Colour	ISO 17700	X	X	

[382] E.g., If a company manages to make its footwear last twice as long, the environmental impacts will be halved

fastness to rubbing

Simultaneously, an alternative approach in line with ADEME-AFNOR PCR for footwear[383] could also be considered. Recent work conducted by the responsible ADEME-AFNOR Working Group (not yet validated) have been made as specified in the box below.

ADEME-AFNOR's approach for durability

The durability of the footwear is based on five tests based on the respective ISO norms, presented in Table 85.

For each test, two limits are set:

- Minimum value representing a very poor resistance of the footwear, supposed to be the lowest possible on the market,
- Maximum value representing a very high resistance; it is assumed that the footwear will never reach the test "breaking point" relative to during its life cycle.

A linear score between 0 and 7.5, and based on the minimum and maximum values is then attributed for each test. Each score is then weighted with respect to its relative importance on the overall durability of footwear, and an overall score is given.

If this approach is used for the EU Ecolabel, the following parameters should be defined:

- Minimum and maximum values for each test,
- Weighting between the different test thresholds on the final score.

4.3.2. Reduce the mass of footwear

I. Context

Almost all life cycle phases are influenced by the mass of footwear, which indirectly influences the life cycle stages, and in particular the intensity of input material production (identified as one of the main hot spots of footwear life cycle). To a lesser extent, transport and the end-of-life management also contribute to the overall environmental performance of footwear when the product is heavier.

II. Improvement potential

The possible environmental savings related to a 10% mass reduction of generic footwear from the base case scenario (from 800 to 720 g) are indicated in the Table 86.

Depending on the environmental category, the possible benefits are estimated to be between 4 and 7 %, subject to the share of input material impacts relative to the other life cycle phases. The

[383] (BP X 30-323-1, 2010)

calculated improvement would increase proportionally as the impact of input materials decreases. For example, photochemical ozone formation is greatly influenced by the manufacturing phase (in particular VOC emissions), which explains why the impact from production of input materials is relatively lower than for other analysed impact categories.

If the mass of all footwear on the European market was reduced by 10 %, the environmental improvements presented in the Table 86 would be valid at European level.

Table 86: Potential improvement – 10% mass reduction (from 800 to 720 g)

Impact category	Environmental improvement for 1 pair of footwear
Climate change	5 %
Ozone depletion	7 %
Photochemical ozone formation	4 %
Freshwater eutrophication	6 %
Marine eutrophication	5 %
Water consumption	7 %
Resource depletion	5 %
Terrestrial eutrophication	5 %
Acidification	4 %

III. Barriers and opportunities

The results presented in Table 86 must be interpreted with caution because reduction of footwear mass may potentially affect product durability. In addition, specific materials may be used in order to achieve a lower mass, and these may have different environmental impacts (higher of lower) than the material they replace.

Several examples have been found in the literature regarding attempts to minimize footwear mass. For example, Nike uses eco-TPU which is 15 % lighter than regular TPU[384]. But the environmental profile and the environmental costs of such an application are unknown. According to the information found, the weight of footwear advertised as minimalist running footwear varies from 62.4 to 280.7 g (2.2 to 9.9 oz.) and midsole/outsole thicknesses range from 4 mm to 20 mm[385].

However, it should be stated that the mass of footwear might differ as a function of its intended use. For example, flip-flops will always be lighter than trekking shoes, which require specific construction and components; therefore, introduction of generic requirements on footwear mass is not recommended.

On the other hand, making lighter footwear may require investment in research and development. Because numerous strategies may be available for achieving this goal, estimating the economic implications of achieving lighter footwear is very complex.

[384] http://www.nike.com/us/en_us/c/better-world/stories/2012/09/nike-gs

[385] Langer, P. 2012. A Closer Look At Minimalist Running Shoes. Podiarty Today 25, www.podiatrytoday.com

IV. Criterion proposal

Although mass is very sensitive from the LCA perspective, it may be controversial to set a quantitative criterion for it, because mass affects the very nature of the footwear. In addition, no information has been found addressing the possible options to be proposed as a mass threshold. For the aforementioned reasons, additional consultation with the stakeholders and feedback from experts will be necessary to evaluate the feasibility of such an approach.

4.3.3. Reduction of energy consumption during manufacturing

I. Context

According to Eurostat, the total electricity consumption[386] within the EU-27 in 2011 was 3,155 thousands of Gigawatt hours, 0.7 % of which is used in the textile and leather industries. According to IEA statistics[387], in 2009 about 13 % of overall electricity used in EU27 comes from hydropower and 5 % comes from other renewable resources, mainly from wind power. The EU as a whole reached just over 18% for the share of renewable energy in the electricity mix in 2010[388].

The European integrated energy and climate change strategy known as the "20-20-20" targets set key objectives for 2020[389]:

- A 20% reduction in EU greenhouse gas emissions from 1990 levels;
- A raising of the share of EU energy consumption produced from renewable resources to 20%;
- A 20% improvement in the EU's energy efficiency.

The European Commission adopted the ‘Energy efficiency plan 2011’ (COM(2011) 109 final) in March 2011. Directive 2009/28/EC on the promotion of the use of energy from renewable sources (the "Renewable Energy Directive") established mandatory targets to be achieved by 2020 for a 20% overall share of renewable energy in the EU and a 10% share for renewable energy in the transport sector. One of the actions proposed to promote the energy efficiency plan set in the ‘Roadmap for moving to a competitive low carbon economy by 2050’ (COM(2011) 112 final) refers to future energy efficiency requirements for industrial equipment, improved information for SMEs, and energy audits and energy management systems for large companies[390].

From the life cycle perspective (see Task 3: Technical Analysis), energy consumption is one of the most relevant “hot spots” identified within the footwear LCA, because it is responsible for up to 35 % of the overall environmental impacts. Therefore, optimisation of energy management, either by reducing energy consumption or by using less impactful renewable energy, appears to be paramount.

[386] Total net production + imports - exports

[387] http://www.iea.org/

[388] Commission Communication on renewable energy. Reference: MEMO/11/54

[389] http://ec.europa.eu/clima/policies/package/index_en.htm

[390] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Consumption_of_energy

II. Improvement potential

A scenario was analysed in which a company used exclusively renewable energy (here assumed to be wind power and hydropower[391]) instead of the European mix, and the estimated electricity consumption was 2 kWh / pair of shoes (sourced from stakeholders' feedback). The environmental improvement results based on this assumption are presented in Table 87.

The estimated improvement potentials for the various impact categories ranged between 5 and 18 %, depending on the impact category. Significant improvement potential is evident for almost all analysed impact categories, (especially freshwater eutrophication, acidification, climate change and resource depletion) due reduction in the use of natural resources and in emissions associated with the production of electricity.

According to the IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation[392], GHG emissions from renewable energy technologies are, in general, significantly lower than those associated with fossil fuel options. The median values for all renewable energy range from 4 to 46 g CO2eq/kWh while those for fossil fuels range from 469 to 1,001 g CO2eq/kWh (excluding land use change emissions).

Table 87: Potential improvement – Use of renewable energy (wind power instead of European average grid mix)

Impact category	Environmental improvement for 1 pair of footwear
Climate change	13 %
Ozone depletion	6 %
Photochemical ozone formation	5 %
Freshwater eutrophication	17 %
Marine eutrophication	7 %
Water consumption	7 %
Resource depletion	13 %
Terrestrial eutrophication	12 %
Acidification	18 %

The second scenario analysed estimates the improvement potential achieved by reducing the overall energy consumption during footwear manufacturing from 2 to 0.5 kWh / pair of shoes, as shown in Table 88. Depending on the impact category, the improvement potential ranges between 2 and 18 %. The quantity of energy that serves as the basis for the analysis has been extracted from the stakeholders' questionnaire[393] and data on an average of Chinese and European electricity mixes. In general terms, the two scenarios presented (use of green energy and reduced energy consumption) have similar benefits on the environment

[391] Assumption made: wind power and hydropower are the most important sources of renewable energy, additionally supported by robust existing LCI data.

[392] IPCC, 2011. IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Schlömer, C. von Stechow (eds). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1075 pp

[393] Information obtained on the maximum and minimum values of energy consumption during manufacturing process

Table 88: Potential improvement – Reduce energy consumption (from 2 to 0.5 kWh / pair)

Impact category	Environmental improvement for 1 pair of footwear
Climate change	12 %
Ozone depletion	2 %
Photochemical ozone formation	6 %
Freshwater eutrophication	8 %
Marine eutrophication	9 %
Water consumption	-
Resource depletion	11 %
Terrestrial eutrophication	10 %
Acidification	18 %

Because accurate electricity consumption rates for all existing processes across the European footwear manufacturing sector are not available, the estimates presented in Table 5 are characterized by a high level of uncertainty,[394] which precludes evaluation of potential improvement at the European scale. Consequently, no European average or BAT data for footwear production are available to use as a reference level.

III. Barriers and opportunities

Renewable sources of energy include wind power (both onshore and offshore), solar power (thermal, photovoltaic and concentrated), hydro-electric power, tidal power, geothermal energy and biomass (including biofuels and bio liquids). As alternatives to fossil fuels, their use targets reductions in pollution and greenhouse gas emissions.

According to EUROSTAT data, renewable energy capacity has denoted the biggest change in the energy mix as their gross inland consumption of primary energy increased by 74 % between 2000 and 2010, reaching 9.8 % of EU-27 share. In 2010, renewable energy sources accounted for more than one third of gross inland consumption of primary energy in Latvia (34.6 %) and Sweden (33.9 %) followed by Austria (26.2 %) and Finland (24.5 %). According to the Renewable Energy roadmap, the projected electricity production scenario[395] from renewables could increase to approximately 34% of overall electricity consumption by 2020. Wind power could contribute 12% of EU electricity by 2020; one third of this amount will most than likely come from offshore installations. This appears feasible, since18% of current electricity consumption in Denmark is from wind sources. In Spain and Germany, wind power provides 8% and 6%, respectively, of the electricity generation capacity. The biomass sector can grow significantly using wood, energy crops and bio-waste in power stations. The remaining novel technologies, i.e. photovoltaic (PV), solar thermal power, wave & tidal power, will grow more rapidly as their costs decrease. PV costs, for example, are expected to fall 50% by 2020.

As identified through consultation with stakeholders, possible constraints on introducing the maximum value energy consumption strategy into the footwear manufacturing process include the following:

[394] Data are set on 3 answers from questionnaire; the level of European representativeness for the noted energy consumption is unknown.

[395] Renewable Energy Road Map. COM (2006) 848 final.

- Contribution of renewable energy to primary energy supply varies substantially by country and region and depends, to a large degree, on the structure of its energy system, the availability of natural resources for primary energy production, and the structure and development of each economy.
- Energy consumption during footwear assembly depends on the types of technology and processes used, which are directly linked to the type of component materials. The footwear industry still often uses old machinery and technologies that are energy intensive. Therefore, it is very challenging to benchmark the energy consumption or to set one common limit value.
- The different steps of footwear manufacturing (manufacturing of soles, manufacturing of uppers, assembly of footwear…) generally occur in many different sites which makes computation of the overall energy consumption complicated.
- The extent of renewable energy use is unknown within the footwear industry. Feedback from stakeholders would be necessary to evaluate the possibility   proposing such a criterion.

Stakeholders have highlighted that energy consumption depends on the factory size, therefore, such a criterion could potentially be biased against low capacity production enterprises. It should also be stressed that electricity consumption is denoted as the ratio between total energy usage and production volume; therefore, it is subject to the specific geographic climate conditions of the factory (e.g., use of a heating system during long winter months in the North European countries; conversely, use of a cooling system during the summer in equatorial regions).

From the economical perspective, it is always beneficial for an enterprise to reduce its energy consumption or to shift towards renewable energy sources, even though substantial investment might be required to achieve this objective.

IV. Criterion proposal

Based on the analysis conducted, two options are proposed for discussion within the consultation process:

1. To introduce a threshold value for annual energy consumption normalized to one pair of footwear. One of the possible approaches to promote use of renewable energy could be discounting its use from the overall quantity of energy used to fulfil the established energy threshold. In this case, the nature of energy should be specified.
2. To maintain the current criterion in its form: the applicant shall record the energy consumption of the assembly site. In this approach, the energy produced from renewable sources should be also declared.

Finally, the criterion proposal could establish a benchmark for energy efficient technologies; stakeholder feedback would be necessary to highlight specific energy-saving processes and technologies used by footwear industry.

4.3.4. Indoor Air Quality: Reduce VOC emissions from solvents and adhesives during footwear manufacturing process

I. Context

Following the classification given by the World Health Organization, organic indoor air pollutants are classified according to their boiling point ranges as indicated in Table 89[396].

Table 89 : Classification of Inorganic Organic Pollutants (adapted from WHO)[396]

Description	Abbreviation	Boiling Point Range (°C)	Example Compounds*
Very volatile (gaseous) organic compounds	VVOC	<0 to 50-100	Propane, butane, methyl chloride
Volatile organic compounds	VOC	50-100 to 240-260	Formaldehyde, d-Limonene, toluene, acetone, ethanol (ethyl alcohol) 2-propanol (isopropyl alcohol), hexanal, perchloroethylene, benzene,
Semi volatile organic compounds	SVOC	240-260 to 380-400	Pesticides (DDT, chlordane, plasticizers (phthalates), fire retardants (PCBs, PBB))

* Examples of compounds given by the original WHO table have been supplemented

Volatile organic compounds (VOCs) are defined as any organic compound having a vapour pressure of 0.01 kPa or more at 293.15 K, or having a corresponding volatility under the particular conditions of use. VOCs play a significant role in the formation of ozone and respirable suspended particulates (RSPs) in the atmosphere. Through a photochemical process caused by sunlight, they react with nitrogen oxides (NOx) to form ground-level ozone which has been proven to contribute in the smog formation.

Volatile Organic Compounds (VOCs) are present in material finishes, dyes, adhesives, cleaners and polishes used both in footwear and for component materials manufacturing. Some chemicals classified as VOCs may still be present in the finished product.

Following the LCA findings, VOC emissions may be responsible for about 35 % of photochemical ozone formation during the manufacturing stage of footwear[397] and of 6 % during the production of leather from the overall life cycle of footwear perspective.

According to BREF for Tanning of Hides and Skins (2013), use of organic solvents in top-coats and special effects finishes is still common in European tanneries. However, the range of BAT organic solvent-free (aqueous-based) and low-solvent finishes is increasing.

The VOC Solvents Emissions Directive 1999/13/EC[398] integrated into Industrial Emissions Directive (IED) 2010/75/EU, is the main European policy instrument for reduction of industrial emissions of

[396] World Health Organization, 1989. Indoor air quality: organic pollutants. Euro Reports and Studies No. 11 I. Copenhagen: WHO, Regional Office for Europe.

[397] Understood here as the manufacturing of uppers, soles, and linings and the final assembly. Therefore, it does not include the production of input materials such as textiles fabric, finished leather, and plastics pellets.

[398] of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations, OJ L 85/1

Volatile Organic Compounds in the Member States of the Union. The Directive covers a wide range of solvent-using activities, including footwear manufacturing, leather, textile and plastic coating[399]. It sets the following solvent use limits:

- Coating of leather
    - 85 g/m² of leather if the total consumption of solvents is between 10 and 25 tons per year,
    - 75 g/m² of leather if the total consumption of solvents exceeds 25 tons per year,
    - 150 g/m² of leather if the total consumption of solvents exceeds 25 tons per year and for leather coating activities in furnishings and particular leather goods used as small consumer goods, such as bags, belts, wallets.
- Wood and plastic lamination (> 5 tons of solvents/year): 30 g/m².
- Coating, including metal, plastic, textile, fabric, film and paper coating (> 5 tons of solvents/year): maximum fugitive emissions are 20 % of solvents input.
- Footwear manufacture (> 5 tons of solvents/year): 25 g per pair. This limit is already considered quite strict by some stakeholders.

At present, the organic solvents-based adhesives most frequently used by the footwear industry are polyurethane and polychloroprene. Task 2 analysis highlighted the following best-practices known to help avoid or reduce VOC emissions:

- Use of solvent-free adhesives and finishes (water-based, hot-melt),
- Use of advanced abatement techniques,
- Use of seams,
- Direct injection of soles.

The Calsindis LIFE02 ENV/E/000242 project assessed different alternative solvent-free adhesives applied in a variety of bonding operations during footwear manufacturing, as indicated in Table 90. Quality tests used to determine the upper-sole bonding strength confirmed the feasibility of using such adhesive replacements.

[400] http://www.calsindis.inescop.es/results.pdf

Table 90: Analysis of possible use of solvent-free adhesives during various footwear binding operation (LIFE02 ENV/E/000242)[400]

Bonding operation	Traditional adhesive	Alternative adhesive
Preparation of uppers (stitching, lining, folding, etc.)	Adhesives such as glue or cement applied with a brush	Polychloroprene water-based adhesives applied with spray. Latex adhesive. Water-based natural rubber applied with spray.
Lasting	Organic solvent-based polychloroprene adhesive applied with a brush or by machine.	Polychloroprene water-based adhesive resistant to temperature, applied with a brush or by machine.
Upper-sole bonding	Organic solvent water-based polychloroprene adhesive applied with a brush.	Polyurethane water-based adhesive, applied with a brush or by machine
Insert placing	Adhesives such as glue or cement applied with a brush.	Polychloroprene water-based adhesive, applied with a brush. Hot-melt adhesive, machine applied.

Complete elimination of solvents from adhesives and the treatment process would reduce solvent use in the footwear manufacturing process[401] by more than 80%. For example, for the average pair of Nike shoes, VOC content decreased from 340 grams of VOC in 1995 to approximately 15 grams in 2006, for a 95% VOC reduction.

However, because insufficient information, the exact data on the footwear sector penetration of such innovations could not be quantitatively evaluated.

II. Improvement potential

The related improvement potential baseline scenario has taken as a starting point assumption[402] that 20 g of VOC were emitted during the manufacture of one pair of footwear, consistent with the current requirement in the EU Ecolabel criteria under revision. It was then estimated that a potential reduction of photochemical ozone formation by 3% and 8% could be potentially achieved by setting the VOC emission threshold at 18 and 15 g / pair, respectively.

III. Barriers and opportunities

According to PPRC[403], the purchase price of water-based adhesives is generally 15%-20% lower than solvent-based adhesive. The choice of bonding system used should not compromise the durability of footwear, which is one of the most important parameters to be met. According to Peter A. Voss[404] and Calsindis LIFE02 ENV/E/000242 project results[400] , water-based adhesives are very viable

[400] http://www.calsindis.inescop.es/results.pdf

[401] ec.europa.eu/environment/life/publications/life/envcompilation02.pdf

[402] Extracted from the stakeholders questionnaire

[403] Pacific Northwest Pollution Prevention Resource Center: http://www.pprc.org/

[404] http://www.pneac.org/sheets/flexo/waterbasedadhesives.pdf

alternatives to conventional solvent-based products. In some cases, they may have properties that exceed the quality of solvent-borne systems.

On the other hand, use of water-based adhesives requires specific investments because specialized technology is necessary to shorten the product drying time. It should be noted that footwear manufacturing in Europe is mainly represented by SMEs which could potentially achieve a stepwise shifting towards water-based adhesives.

IV. Criterion proposal

Phasing out solvent-based adhesives has been suggested by some stakeholders through the dedicated questionnaire. There is sufficient evidence collected from the footwear brand websites about progressive shifting towards solvents-free adhesives, as identified within Task 2: Market analysis. Therefore, we suggest setting a criterion that requires the use of solvent-free adhesive or otherwise restricts the use of solvent-based adhesives by lowering the VOCs emission threshold per pair of shoe. The exact emission level should be proposed according to stakeholder feedback. However, a limit value of 15 g/pair of footwear could be proposed as the starting point.

4.3.5. Reduce wastage

I. Context

The European Union's approach to waste management is based on an integrated, hierarchical system that considers the following order of prioritization: prevention, re-use, recycling, recovery and disposal[405].

According to the LCA study findings, wastage rate is a significant parameter because it directly affects the mass of input materials needed to produce a pair of shoes. Increase in wastage rate is proportional to the quantity of input materials required, being identified as "hot spot" area.

Footwear manufacturing involves the use of a large range of materials that are processed to achieve the appropriate size and format. Hence, the shapes of the cut components varied greatly; therefore, optimization of material usage in the cutting process should be perceived as one of the key challenges of process management. This is especially essential for leather being neither homogenous nor rectangular. Waste generated during footwear manufacturing along the product supply chain may be divided into three main categories:

- Post–manufacturing waste (e.g., tannery shavings)
- Non-product waste (e.g., packaging, lasts);
- Waste generated during product manufacturing (and because of) footwear assembly process (e.g., waste from material cuttings, shoe samples, process rejects)

Footwear manufacturing involves the use of a large range of materials that are adjusted to the required format and joined together by a series of bonding operation. According to Ferreira et al (2011),[408] residues from footwear roughing and carding operations represent 5–15% (w/w) of the

[405] In line with the Framework Waste Directive (2008/98/EC)

solid wastes generated by shoe-making companies. Following the AFIRM group information, the quantity of waste generated during footwear manufacturing process could be divided as follows[406]:

- Waste from upper = 132.6 tons/ M pairs
- Waste from sole = 118 tons/ M pairs
- Adhesives, oils, solvents = 4.6 tons/ M pairs
- Household type waste = 10.8 tons / M pairs

Considering that no accurate statistical data have been found on the quantity of waste generated during footwear manufacturing, it has been assumed that the sector accounts for approximately 90.000[407] -150.000[408] tonnes of waste. This waste is derived from by-products and process rejects composed of different material mixtures, but mainly chromium tanned leather and sole material. Landfilling used as the principal disposal method for these wastes.

II. Improvement potential

The present analysis and information gathered through the stakeholders survey indicate a wastage reduction of between 15 % and 5%[409] (w/w) (maximum and minimum values according to the stakeholders feedback) is achievable, and this is considered as a base case for quantitative estimation of improvement potential per each impact category considered in the LCA base case scenario, as indicated in the Table 91. Considerable savings for all analysed impact categories could potentially be achieved, especially for water consumption (12%) and ozone depletion (8%) due to reduction of quantity of materials required for production.

Table 91: Potential improvement of reducing wastages (15 % -> 5%)

Impact category	Environmental improvement for 1 pair of footwear
Climate change	5 %
Ozone depletion	8 %
Photochemical ozone formation	3 %
Freshwater eutrophication	6 %
Marine eutrophication	6 %
Water consumption	12 %
Resource depletion	5 %
Terrestrial eutrophication	6 %
Acidification	4 %

406 http://www.afirm-group.com/hongkong/17%20Hengstmann%20Waste%202010.pdf

407 http://www.eco-naturalista.eu

408 Ferreira, M.J., Almeida, M.F., Fernanda Freitas, F. 2011. Formulation and Characterization of Leather and Rubber Wastes Composites. Polymer Engineering and Science 51, pp 1418-1427

409 Wastage rate includes the manufacturing of uppers, soles, and linings and the final assembly. Therefore, it does not include production of input materials such as textiles fabric, finished leather and plastics pellets.

III. Barriers and opportunities

By optimizing the supply chain and material saving principles during the footwear manufacturing processes, considerable decrease in wastage could be achieved.

Because production of footwear occurs in many different sites and geographical locations, the information collection would require an advanced state of control and management of the entire supply chain. Having a criterion only for the assembly site would limit the benefits of such improvement. However, it could however establish the solid base for material management practices in footwear sector, and possibly boost further research and innovation, such as reuse of post-manufacturing rubber and leather cuttings, e.g., for sole-formation of new pair of shoes[410]. The manufacturer, from the long-term perspective, will always benefit from the introduction of a comprehensive waste management system.

IV. Criterion proposal

The relevance of "at source prevention" principle and reduction of the quantity of waste generated, supported by the quantitative estimation of the possible environmental savings indicate that additional use of the consultation process is necessary in order to assess the feasibility of wastage criterion inclusion. Some of the surveyed stakeholders have indicated the relevance of wastage to be analysed within the on-going revision process. Among other things, they proposed use of the ratio of quantity of wastes per pair of shoes produced as an indicator.

One of the proposals to be analysed is the requirement to provide information on the wastage rate at the assembly site. The wastage rate should be calculated as follows: the mass of output products minus the mass of input materials divided by the mass of input materials. It should be assess if the scope of evaluation ought to consider setting a wastage limit value. Beyond the quantitative criteria, it could also be proposed that the applicant provide information on the current waste management scheme, supported by additional planning that it intends to achieve further waste reduction.

4.3.6. Restrict airplane transport

I. Context

According to the LCA study results, the distribution phase is responsible up to 15% of the overall impact. The IMPRO study assumed that long distance shipment is dominated by shipping (92%) and air transportation is assumed to be 8% of the overall impact. According to the ecoinvent inventories, per tonne-kilometre, air transportation has approximately 100 times greater climate change impact than ship transportation (IMPRO-Textiles, 2009).This information is consistent with the information obtained from footwear brands[411].

The magnitude of environmental impacts from airplane transport compared to truck or boat transport, stems mainly from the higher airplane fuel requirement to transport the same quantity of goods.

[410] Information gathered through personal communication

[411] Personal communication with a footwear brand

II. Improvement potential

If airplane transport were to be completely avoided (i.e., from 2.5 % to 0% of intercontinental transport), a reduction in the environmental impact of approximately between 2 and7% could be achieved, as shown in Table 92. Because companies generally do not plan to use the airplane for product transport (it is for "emergency" cases), it would be complicated to evaluate the environmental benefit at European level.

Table 92: Potential improvement – Avoiding airplane (from 2.5 to 0%)

Impact category	Environmental improvement for 1 pair of footwear
Climate change	5 %
Ozone depletion	7 %
Photochemical ozone formation	5 %
Freshwater eutrophication	3 %
Marine eutrophication	7 %
Water consumption	2 %
Resource depletion	5 %
Terrestrial eutrophication	6 %
Acidification	5 %

III. Opportunities and barriers

From the economic perspective, it seems beneficial to avoid airplane transport because it is the most expensive transport mode. According to Rungis[412], the average value of one kilo of goods transported by plane is €114 for imports and €122 for exports, while it is only €1.15 for imports and €1.90 for exports for all the other transport modes combined internationally. This is mainly due to high fuel surcharges which are equivalent to the basic freight tariff. Air freight requires extensive airport infrastructures (logistics platforms handling storage and goods breakdown under controlled temperature for perishable products).

IV. Criterion proposal

Considering the significant impacts of air freight distribution, we propose restricting this transport route by introducing a comprehensive logistic system. Stakeholders have proposed such a criterion. If this criterion is determined to be overly strict, we recommend that empty return trips should be restricted, at a minimum.

4.3.7. Use of organic cotton

I. Context

The LCA emphasizes that input materials have a great impact on the environment, being responsible for 40 to 90 % of impact share. The main areas of eco-innovation related to fabrics used in footwear manufacturing, as identified in the Task 2 analysis, encompass the use of more sustainable raw

[412] http://www.rungismarket.com/en/bleu/enquetesrungisactu/TransportDeMarchandises629.asp

materials, mainly organic cotton. Traditional cotton production requires large quantities of pesticides; cotton covers 2.5% of the world's cultivated land, yet it accounts for 16% of the world's insecticide use, more than any other single major crop.[413]

II. Improvement potential

For the purpose of the LCA analysis in Task 3: Technical Analysis, an average pair of footwear was assumed to contain 19 % of textiles[414], a third of which was cotton[415]. The quantitative assessment of possible improvement potential for one pair of footwear has been excerpted from the on-going revision of the EU Ecolabel for textiles which requires that 50 % of the cotton used in the final product shall be grown using one or a combination of the following three production standards:

(a) Cotton grown without the use of restricted pesticides,

(b) Cotton grown according to IPM principles,

(c) Cotton grown according to Organic standards.

Integrated pest management (IPM)[416] is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant crop varieties. Pesticides are used only after the monitoring indicates that they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and untargeted organisms, and the environment.

For the purposes of this analysis, data for the production of cotton from ecoinvent v2.2 was used to assess the impacts of withdrawing the use of pesticides from cotton fields. Based on this assumption, the improvement potential on the baseline scenario has been estimated as 3 % on freshwater eutrophication. For other impact categories, the improvement potential has been estimated to be lower than 1 %.

III. Barriers and opportunities

Estimates for the global cotton production vary depending on the data source and on how the figure is calculated, but most sources estimate the production to be around 22 million tons in 2009/10[417]. The biggest producers are China, India and the USA, followed by Pakistan and Uzbekistan. The combined production of all West African countries currently accounts for only 4.7 % of the world market. According to (IMPRO-Textiles, 2009), GM cotton has experienced a dramatic increase in cultivation since its introduction, increasing global production by approximately 44 % from 2002 to 2005. Transgenic crops offer the benefit of increased yields and lower costs due to the reduced

[413] EJF. (2007). The deadly chemicals in cotton. Environmental Justice Foundation in collaboration with Pesticide Action Network UK: London, UK

[414] From the EU27 average consumption in 2011

[415] Gross estimation

[416] http://www.ipm.ucdavis.edu/index.html

[417] www.organiccotton.org

application of agrochemicals. Therefore, it seems that GM cotton might be an economical replacement for conventional cotton crops. However, one issue that has come to light in recent years is the decrease in marginal returns from GM crop cultivation due to stagnating, or even decreasing yields, in the long run (Eyhornet al., 2007). In biotechnologically treated cotton, the insecticide is present in the plant rather than applied in periodic spraying sessions which might lead to rapid rates of pest immunities and possibly production of superpests.[418]

The global production of organic cotton increased by 15 % from 2009 to 2010. In a longer perspective, it is worth noting that the global organic cotton market has grown from US$ 240 million in 2001 to US$ 5100 million in 2009. [419,420] In a two-year comparative study in central India covering 170 fields, it was shown that production costs could be lowered by 10–20 %, and a 20 % organic price premium could be achieved when compared with conventional cotton crops (International Trade Centre, 2007). This translates to an income increase of 10–20 % for organic cotton growers, relatively to traditional cotton (International Trade Centre, 2007).

Although organic cotton cultivation has increased in recent years, its uptake has been relatively modest and relatively insignificant in comparison with global cotton production (Baffes, 2004). Some important barriers hinder organic cotton cultivation. Certification and monitoring of organic crop cultivation is a costly procedure, which may ultimately offset the economic benefits associated with less use of chemicals and higher returns from organic crop sales. Concerns over brand, style, colour, quality, care instructions and size may have a greater influence on consumer choice than ecological issues (IMPRO-Textiles, 2009). More importantly, the price of products has a significant effect on consumer decisions. In an age of fast fashion, many companies are competing on price factors by reducing production costs or balancing product quality. However, it is still estimated that the retail market of organic cotton products may grow by about 20% yearly or more depending on the commitment of brands and retailers to support the production of organic cotton.[420]

Organic certification routes vary. GOTS (as discussed in chapter 2.6.4) has emerged as a popular global certification route. According to GOTS, textile product carrying the GOTS label grade 'organic' must contain a minimum of 95% certified organic fibres, whereas, a product with the label grade 'made with organic' must contain a minimum of 70% certified organic fibres.

IV. Criterion proposal

The feasibility of including a minimum requirement on organic cotton content should be discussed further within the on-going revision consultation process.

Currently, we propose to align the proposal with the on-going revision of the EU Ecolabel for textile: 50 % of cotton used in the final product shall be grown using one or a combination of the following three production standards:

(a) Cotton grown without the use of restricted pesticides,

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[418] Chaudhry, M.R., (2007, March 6-8). Biotech applications in cotton: Concerns and challenges. Paper presented at the Regional Consultation on Biotech Cotton for Risk Assessment and Opportunities for Small Scale Cotton Growers (CFC/ICAC 34FT), Faisalabad, Pakistan.

[419] Textile Exchange 2010a. Annual report 2010. Textile Exchange

[420] Textile Exchange 2010b. Market report 2010.Textile Exchange

(b) Cotton grown according to IPM principles,

(c) Cotton grown according to Organic standards.

4.3.8. Water consumption

I. Context

The LCA indicated that the major hotspot for water consumption was input materials production, in particular, for textiles and leather. The main hotspot highlighted is the production of cotton fibres. The baseline scenario assumed the following water consumption rates:

- ~8,000 litres/kg of cotton fibres;
- 130-160 litres/kg of textiles processed;
- 35-55 litres/kg of leather.

About 53 percent of the global cotton fields is irrigated, producing 73 percent of the global cotton production (Institute of Water Education, 2005). Irrigated cotton is mainly grown in the Mediterranean and other warm climatic regions, where freshwater is already in short supply.

For textiles processing, considerable water consumption occurs during dyeing and printing processes, especially relevant for batch dyeing, i.e, for rinsing the batches (BREF Textiles Industry, 2003).

Most of the steps of a tannery's operations are performed in water. Consumption of water during tanning process consists of two main components: process water and technical water needed for cleaning, energy generation, waste water treatment, and sanitary purposes (BREF Tanning of Hides and Skins, 2013). The technical water is estimated to account for about a fifth of the total water consumption (Buljan et al. 1998). Process water consumption varies greatly between tanneries, depending on the processes involved, the raw material used, and the manufactured products.

More than 80 % of tanneries in Europe discharge their effluent to public sewers. The main exceptions are those in parts of Italy and Spain, where the tanneries are in clusters and connected to common effluent treatment plants (BREF Tanning of Hides and Skins, 2013).

Assessment of water consumption considering scarcity

The LCIA method used only accounts for direct flows, so it does not consider the water scarcity as a function of geography, as required by most reliable LCIA methods, and as required by PEF.

The category « Resource depletion – water » accounting for water scarcity could not have been assessed because water is considered as a unique flow in emissions profiles (LCI) used.

II. Improvement potential

BREF for Textiles Industry (2003) and BREF for Tanning of Hides and Skins (2013) present water consumption levels for best available techniques for finishing textiles and processing leather, as indicated in Table 93; water consumption levels are almost halved for the BAT scenario compared to the baseline scenarios. By contrasting best practices data with the baseline scenario analysis, it appears that the improvement potential is about 5 % on water consumption. If water consumption is only reduced for leather processing, the improvement potential is 2%; if water consumption is only reduced for textiles finishing, the improvement potential is 3%.

This relatively small improvement (compared to the high water consumption reduction) is due to the fact that water footprint of the baseline scenario is almost completely due to the water consumption for the production of cotton fibres. Indeed, the water consumption assumed in the baseline scenario for production of cotton crops is extremely high. The data come from ecoinvent and is confirmed by several sources:

- The WWF mentions that 1 kg of cotton production may require more than 20,000 litres of water[421],
- The EJF mentions that one cotton T-shirt takes about 2,720 litres of water[422],
- Institute of Water Education (2005) mentions that one kg of cotton seed requires between 2,000 litres and 8,500 litres of water.

[421] http://wwf.panda.org/about_our_earth/about_freshwater/freshwater_problems/thirsty_crops/cotton/

[422] http://ejfoundation.org/cotton/cotton-and-water

Table 93: Water consumption levels - baseline scenario and BAT

Leather		Textiles	
Baseline scenario	BAT consumption level	Baseline scenario	BAT consumption level
35-55 l / kg	16-28 l / kg	130-160 l/kg	70-100 l/kg[423]

III. Barriers and opportunities

The Water Footprint Network[424] provides a tool (called The Water Footprint Assessment Tool) that calculates the water footprint taking into account the scarcity. It could be proposed to record and report the water footprint of a product or a material, in particular the cotton that is used for the production of footwear.

In order to minimise water consumption, BREF Tanning of Hides and Skins (2013) suggests using one or both of the techniques given below:

- Optimization of water use in all wet process steps, including the use of batch washing instead of running water washes. Optimisation of water use is achieved by determining the optimum quantity required for each process step and introducing the correct quantity using measuring equipment. Batch washing involves washing hides and skins during processing by introducing the required quantity of clean water into the processing vessel and using the action of the vessel to achieve the required agitation, as opposed to running water washes which use the inflow and outflow of large quantities of water.
- The use of short floats. Short floats are reduced amounts of process water in proportion to the amount of hides or skins being processed, as compared to traditional practices. There is a lower limit to this reduction because the water also functions as a lubricant and coolant for the hides or skins during processing. The rotation of process vessels containing a limited amount of water requires more robust geared drives because the mass being rotated is uneven.

BREF Textiles Industry (2003) also suggests BAT used in processing textiles. Optimising water consumption in textile operations starts with controlling water consumption levels. The next step is reducing water consumption, through a number of often complementary actions. These include improving working practices, reducing liquor ratio in batch processing, increasing washing efficiency, combining processes (e.g., scouring and desizing) and reusing/recycling water.

Using these BATs, lower water consumption levels can be achieved, as shown in Table 94, Table 95 and Table 96.

[423] BAT emissions levels including the finishing of yarn, knitted fabric, or woven fabric consisting mainly of cellulosic fibres (BREF Textiles Industry, 2003)

[424] http://www.waterfootprint.org/?page=files/waterfootprintassessmenttool

Table 94: BAT water consumption levels – Raw hide[425]

Process stages	Water consumption per tonne of raw hide[426] (m³/t)	
	Unsalted hides	Salted hides
Raw to wet blue/white	10 to 15	13 to 18
Post-tanning processes and finishing	6 to 10	6 to 10
Total	16 to 25	19 to 28

Table 95: BAT water consumption levels – Skin[425]

Processes stages	Specific water consumption[427] (litres/skin)
Raw to pickle	65 to 80
Pickle to wet blue	30 to 55
Post-tanning processes and finishing	15 to 45
Total	110 to 180

Table 96: BAT water consumption levels – Textiles processing[428]

Process stages	Water consumption
Finishing of yarn	70 - 120 l/kg
Finishing of knitted fabric	70 - 120 l/kg
Pigment printing of knitted fabric	0.5 - 3 l/kg
Finishing of woven fabric consisting mainly of cellulosic fibres	50 - 100 l/kg
Finishing of woven fabric consisting mainly of cellulosic fibres (including vat and/or reactive printing)	<200 l/kg
Finishing of woven fabric consisting mainly of wool	<200 l/kg
Finishing of woven fabric consisting mainly of wool (for processes that require high liquor ratio)	<250 l/kg

425 Source: BREF on Tanning of Hides and Skins

426 Monthly average values. Processing of calfskins and vegetable tanning may require a higher water consumption.

427 Monthly average values. Wool-on sheepskins may require a higher water consumption

428 (BREF Textiles Industry, 2003)

IV. Criterion proposal

The analysis of this eco-innovation did not conclude that such a criterion should be reviewed.

However, the water consumption threshold limit should be discussed further during the working group meeting, in order to obtain additional feedback from the stakeholders. Whether the criterion should be updated and include a limit value for water consumption based on BAT values is proposed for consideration.

4.3.9. Use of non-chromium tanned leather

I. Context

In the tanning process, the collagen fibre is stabilised by the tanning agents, such that the hide is no longer susceptible to putrefaction or rotting. In this process, the collagen fibres are stabilised by the cross-linking action of the tanning agents. After tanning, the hides or skins are not subject to putrefaction, and their dimensional stability, resistance to mechanical action and heat resistance increase[429,430].

The most commonly used tanning agent is chromium III hydroxide sulphate, Cr(OH)SO4 (CAS No 12336-95-7; EC No 235-595-8). (A high proportion (80 – 90 %) of all the leather produced today is tanned using chromium (III) salts. The majority of tanning agents fall into one of the following groups: (BREF Tanning of Hides and Skins, 2013).

- mineral tannins,
- vegetable tannins,
- syntans,
- aldehydes,
- oil tannins.

The Task 2: Market analysis revealed that many companies use non-chromium tanned leather in their products. Therefore, we decided to specifically evaluate the possible environmental benefits that stem from this innovation.

II. Improvement potential

The main environmental concern related to the chromium tanning process is the potential for formation of Chromium (VI) (which is not intentionally used in the production of leather) which may be formed within the leather by oxidation of chromium (III) used for tanning the leather.

According to the baseline scenario assumed for Task 3: Technical Analysis, an average pair of footwear is assumed to contain 24 % leather[431]. Vegetable tanning is an alternative to the chromium-

[429] Andres.1995. Umwelthandbuch für die ledererzeugenden Betriebe, draft version

[430] HMIP, Chief Inspectors' Guidance to Inspectors - Processing of Animal Hides and Skins, Process Guidance, Her Majesty's Inspectorate of Pollution -UK, 1995.

[431] From the EU27 average consumption in 2011

based process. The plant tannins (e.g., oak, chestnut, mimosa, etc.) used in the vegetable tanning process show potential to degrade surface water due to the low biodegradability of the tannins and their toxicity to aquatic life[432].

Aldehyde tanning is another alternative to chromium tanning; glutaraldehyde is the most commonly used compound in this category. Aldehydes react completely with the proteins in both the hides/skins and in the effluents (BREF Tanning of Hides and Skins, 2013). Therefore, this tanning process usually does not create an environmental problem during treatment and discharge of tannery waste water.

According to BLC (Leather Technology Centre) analysis, the improvement potentials of vegetable and aldehyde tanned leather are not significant compared to traditional chromium- tanned leather. The improvement potentials (based on BLC research) is estimated at lower than 1 % for all impact categories.

III. Barriers and opportunities

There is a wide variety of tanning methods and the choice method depends chiefly on the desired properties required of the finished leather, the cost of the materials, the plant tannin available, and the type of raw material. There are several vegetable tanning systems, and the types of leathers produced within each do not have some characteristics that are comparable to chrome-tanned leathers, e.g., resistance to high temperature and flexibility. Conversely, some of the qualities of vegetable tanned leathers, e.g., tooling, burnishing, can only be found in the vegetable-tanned leather (BREF Tanning of Hides and Skins, 2013).

Therefore, chromium tanning requires improvement in the technical performance of the process. In this sense, the BREF Tanning of Hides and Skins (2013) suggests the following best available techniques:

- In order to minimize the emissions of chromium in the waste water during the tanning process, maximise the uptake of chromium tanning agents by optimising the operating parameters (e.g., pH, float, temperature, time, and drum speed) and us chemicals to increase the proportion of the chromium-tanning agent taken up by the hides or skins.
- In order to better treat the waste water, chromium can be precipitated by increasing pH to 8 or above using an alkali,
- In order to reduce the amount of chromium in sludge sent for disposal, the BAT is to use one or a combination of the techniques given below:
    - Recovery of chromium for reuse in the tannery by re-solution of the chromium precipitated from the tanning float using sulphuric acid for use as a partial substitute for fresh chromium salts.
    - Recovery of chromium for reuse in another industry by using the chromium sludge as a raw material for the other industry.

In order to avoid the formation of chromium(VI), the precautions given below can be taken.

[432] (BREF, 2013)

- Use a reducing agent as an auxiliary during the neutralisation of wet blue.
- Avoid using ammonia as a wetting back agent for crust leather before dying.
- Use vegetable retanning agents for chromium-tanned leather or add a small proportion of vegetable tanning agent (e.g. 0.25 – 4 % depending on the agent) in the retanning process step.

III. Criterion proposal

From the LCA perspective it cannot be concluded that such criterion should bring considerable environmental savings. Therefore, it should not be considered within the revised criteria area.

4.3.10. Use of recycled polyester

I. Context

The Task 2: Market analysis revealed that several companies use recycled materials in their products, in particular polyester and nylon. The Polyester has been identified as one of the main textiles used in footwear manufacturing. Consumption of energy for synthetic fibre production was simultaneously assessed as one of the key environmental issues to be addressed within the on-going revision process of the EU Ecolabel for textile product group.

Production of polyester fibres accounts for about 40-45% of total global annual fibre production[433]. Recycled PET fibre accounted for approximately 8% of the world PET fibre production in 2007[434]. In Europe, the amount of post-consumer PET bottle waste collected has increased from 0.2Mt in 1998 to 1.68Mt in 2012[435], showing currently the stable 2% growth in collection in EU 27. In 2011, 39% of all recovered European PET was used to produce polyester fibres.

According to (IMPRO-Textiles, 2009), production of polyester requires large amounts of energy. Therefore, it is an important contributor to energy-related indicators, e.g., climate change and ionising radiation (nuclear energy is mainly used as electricity). The full life cycle of 1 kg of polyester fabric is responsible for the release of more than 30 kg CO2 equivalents to the atmosphere (around 20 kg are associated with cotton). Because no agricultural production is needed for polyester, its impacts on ecosystems are lower than for cotton.

II. Improvement potential

From a life-cycle-thinking perspective, the benefit of recycling is the improvement of the material utilization efficiency by avoiding further resource extraction and waste management. The overall impact can only be assessed when the entire system and the effect of the system are considered. [436] In this sense, Shen et al. (2010)[436] conducted an LCA study aimed at assessing the environmental impact of producing recycled PET fibres contrasted with virgin PET fibre. Environmental performance

[433] http://textileexchange.org

[434] Thiele U. 2009. In: 13th international polyester recycling symposium, pp 22–3.

[435] http://www.petcore-europe.org

[436] Shena, L., Worrellb, E., Martin K. Patela, M.K. 2010. Open-loop recycling: A LCA case study of PET bottle-to-fibre recycling. Resources, Conservation and Recycling 55, pp 34–52

of mechanical recycling, semi-mechanical recycling, back-to-oligomer recycling, and back-to-monomer recycling were assessed. To overpass the possible methodological problem that might occur when LCA includes multi-functional process,[437] three allocation methods have been applied to open-loop[438] PET recycling, such as: "cut-off" method (analysis focuses only on the recycled product), "waste valuation" method (uses economic values to allocate the environmental impacts of the production of virgin polymer), and the "system expansion" method (reflects the overall efficiency of material utilization without distinguishing different players). Depending on the allocation methods applied for open-loop-recycling and/or system boundaries, when contrasted with virgin PET, recycled PET fibres offers 40–85% saving in non-renewable energy use (NREU), and 25–75%saving in global warming potential (GWP). Furthermore, according to the LCA findings, mechanical and semi-mechanical recycling show a better environmental profile than chemical recycling; however, chemically recycled fibres can be used in a wider range of applications.

Table 97: Recycling of polyester - Data

Parameter	Value	Source
Emissions arising from recycling the material	Confidential modeling	Data from a study conducted in 2007 by RDC and representative of an industry in Portugal recycling HDPE
Emissions avoided from the non-use of virgin material	PlasticsEurope LCI	PET process from PlasticsEurope 2005
Qs (quality of secondary material)	RPET flake – colourless: ~1000 Euro / kg	(ICISpricing, 2013)[439]
Qp (quality of primary material)	Polyethylene: ~1500 Euro / kg	(ICISpricing, 2013)
Efficiency of recycling process (mechanical recycling)	95 %	Data from a study conducted in 2007 by RDC and representative of an industry in Portugal recycling HDPE
Allocation rule	50-50	PEF methodology

For the purpose of the on-going EU Ecolabel criteria revision for footwear, an average pair of footwear was assumed to be composed of 19 % of textiles[440], a third of which was polyester[441]. The improvement potential for one pair of footwear is excerpted from the on-going revision the EU Ecolabel criteria for textiles, which requires use of 50 % recycled polyester for standard fibres. The modelling of recycling is based on data indicated in Table 97 and following PEF methodology.

[437] Ekvall T. and Tillmann, A.M. 1997. Open-loop recycling: Criteria for allocation procedures. The International Journal of Life Cycle Assessment 2, pp 155-162

[438] Downcycling or reprocessing: conversion of material from one or more products into a new product.

[439] http://www.icispricing.com/il_shared/Samples/SubPage10100114.asp

[440] From the EU27 average consumption in 2011

[441] Gross estimation

Values of qualities

For the values of qualities (Qs/Qp), we actually used the values of prices (Ps/Pp) recommended in the first PEF draft. The final draft guidance currently recommends using this method when the quality ratio cannot be evaluated, which is the case here.

Based on these assumptions, the potential improvements are less than 1 % for all impact categories except for climate change (1.5 %) and resource depletion (2%).

Allocation rule

A very important parameter of the formula is the allocation rule. PEF sets it at 50 – 50 which means that the benefits of recycling are equally shared between the product incorporating recycled materials (as analysed here) and the product that provides recyclable materials. In additionally to this allocation choice, LCA practices generally use two other types of rules:

- Allocation to the product bringing materials to be recycled on the market (so-called 0-100 or collection-rate based). This allocation applies to markets where demand for secondary material is higher than supply[442]. Additional recycling will only occur if an additional amount of material to be recycled is made available, namely at product end-of-life. Incorporating recycled material in an application corresponds to an increase in demand for secondary materials, which cannot be satisfied without forcing another user to use virgin material. Hence, the incorporation of recycled material has to be modelled by the production of virgin material and the calculated impacts are independent of the recycled content.

  In this case, the improvements potential of using recycled polyester is null.

- Allocation to the product that incorporates recycled material (so-called 100-0 or composition-based). This allocation applies to markets where demand for secondary material is lower than supply.[443] Additional recycling will only occur if an additional amount of secondary material can be incorporated in a product. Increasing the selective collection rate at end-of-life will increase the amount of available material for recycling. However, this material will not find an application. Hence, the end-of-life of the material is modelled as full elimination. The impacts are only dependent on the recycled content and not on the recycling rate of the product.

  In this case, the improvements potential as stated above this frame are doubled.

The 50-50 allocation rule is usually applied to more equilibrated markets where both demand and supply are sensitive to price variations. An additional supply of material to be recycled will partially result in additional recycling. An additional demand of material to be recycled will partially result in additional recycling. Impacts are hence determined by both the recycled content and the recycling rate.

If elasticity values were known precisely (which is hardly available), a more precise repartition of benefit allocation could be determined, rather than 50-50.

[442] Strictly, it corresponds to market situations where elasticity of demand is much higher than elasticity of supply.

[443] Strictly, it corresponds to market situations where elasticity of demand is much lower than elasticity of supply.

III. Barriers and opportunities

According to several sources (Silva, Edmir, 2011[444]; Christopher Intagliata, 2012[445]; IPTS, 2013[446]; and ICISpricing, 2013) the price of recycled polyester is lower than virgin polyester (by about 10 to 30 %), especially considering that increase in virgin PET fibre price is proportional to the petrol price. However, the demand for recycled polyester is higher than the supply, which could potentially limit market ability[447].

IV. Criterion proposal

The inclusion of this criterion should be further discussed during the AdHoc Working Group Meeting in order to gather additional feedbacks from stakeholders. Inclusion of recycling content for other synthetic fibres such as polyamide should also be addressed.

Currently, in line with the EU Ecolabel revision for Textile, we propose a requirement of 50 % recycled polyester content for production of textile uppers made of polyester.

4.3.11. Use of bio-based materials and recycled plastics

I. Context

Overall production of plastics estimated on the basis of crude oil supply is approximately 260 million tons per year worldwide[448]. According to bio-plastic market research overcast[449], the global market for bio-plastics is estimated to reach 1.9 million metric tons by 2017 up from 264 thousand metric tons in 2007. In 2011, 18.5 % of the 1.161.200 tonnes of bioplastics available worldwide was produced in Europe[450].

According to the European Bioplastic definition, the term bioplastics encompasses a whole family of materials which differ from conventional plastics in that they are biobased, biodegradable, or both[451]. Consequently bio-plastics can be classified as[448,449,452]:

1. Biodegradable polymers made from renewable or petroleum-based raw materials (e.g., polyvinyl alcohol or polycaprolactone) meeting criteria of norms for biodegradability and compostability of plastics and plastic products according to the EN 13432 standard.

[444] (Recycled Polyester: Literature Review, 2011)

[445] http://www.livescience.com/32231-does-recycling-plastic-cost-more-than-making-it.html

[446] (End-of-Waste Criteria for Waste Plastic for Conversion - Technical Proposals, 2013)

[447] SETAC Europe 22nd Annual Meeting / SETAC 6th World Congress (2012) – Market-based allocation of recycling benefits

[448] Endres,H.J., Siebert-Raths,A. 2011. Engineering Biopolymers-Markets - Manufacturing, Properties and Applications, Carl Hanser Verlag, München, 2011.

[449] Bioplastics Market Reseach Overview. 2012. Industry Experts. Redifine Business Acumen. http://www.marketresearch.com/Industry-Experts-v3766/Bioplastics-Global-Overview-6838486/ Last check August 2013

[450] European Bioplastics. Institute for Bioplastic and Biocomposits. 2012.

[451] http://en.european-bioplastics.org

[452] Magdalena Rohrbeck, M., Körsten, S., Fischer, C.B. Wehner,S., Kessler,B. 2013. Diamond-like carbon coating of a pure bioplastic foil. Bioresource Technology. In press as to August 2013

2. Bio-based polymers; not all of them are also biodegradable, considering that degradability of biopolymers depends on the molecular structure, not on the raw material from which it was produced (e.g., highly substituted cellulose acetate, polyethylene made of sugar cane),
3. Plastics that are both bio-based and biodegradable because they provide the benefits of both types, in addition to other properties.

Bio-plastics have similar properties to oil-based plastics and in line with their traditional counterparts, the application platform of bioplastics is quite wide. Some bioplastics are already quite successful in a variety of end-use markets, including footwear manufacturing as identified within the Task 2 analysis (see Task 2: Market analysis).

There are several examples of brands that integrate recycled materials (plastics or rubber) into their shoe production, especially for soles (see Task 2: Market analysis). Nonetheless, exact data on the percentage of recycled plastics and rubber used in footwear present on the European market is unknown. According to Plastics Recyclers Europe[453] less than 25% of plastics are recycled in Europe. The unique properties of plastics, such as strength, rigidity and flexibility, combined with affordability and durability make them a perfect alternative to other materials (e.g., glass, metal, wood). They are widely applied in number of sectors and their use is constantly expanding (e.g., from packaging and construction to telecommunications and electronic equipment).

There are two main types of plastics recycling, with mechanical recycling being of interest for the footwear industry:

- Mechanical recycling: Mechanical recycling refers to operations that aim to recover plastics waste via mechanical processes (grinding, washing, separating, drying, re-granulating and compounding) to produce recyclates that can be converted into new plastics products, often substituting virgin plastics. For mechanical recycling, only thermoplastic materials are of interest, i.e., polymeric materials that may be re-melted and re-processed into products via techniques such as injection moulding or extrusion.
- Chemical recycling: Chemical recycling (feedstock recycling) refers to operations that aim to chemically degrade the plastics waste into its monomers or other basic chemicals. The output may be reused for polymerisation into new plastics, for production of other chemicals or as an alternative fuel.

One particular technique for incorporating recycled content into shoes involves producing soles from recycled tyres.

Bio-based materials and recycled plastics may be used as substitutes for synthetic materials, in particular for soles as identified in Task 2: Market analysis.

II. Improvement potential

Accurate evaluation of environmental improvement is hindered by lack of accurate market knowledge as well as miscellaneous nature of substitution materials. In addition, it is quite complicate to quantitatively assess the bio-plastic/recycled plastic market penetration and the types of recycled plastic and bio-plastics used by shoe sector. It is however important to mention that

[453] http://www.plasticsrecyclers.eu/ (last check, August 2013)

there can be trade-offs associated with the use of bioplastics. In addition, bioplastics form about 2% of the European production of plastics[454].

III. Barriers and opportunities

By using data from European Bioplastics and Eurostat on footwear production[455], it can be estimated that the use of bioplastics in footwear is still very low (< 1% of total plastics), thus, meeting the criterion 10-20% of the targeted market would not be feasible.

IV. Criterion proposal

Because of the relatively low market penetration, the analysis performed concludes that criterion on bio-plastic usage in footwear manufacturing should not be covered by the revised the criteria area. As to a requirement on increasing the recycling content or improving material recyclability, additional consultation is necessary to assess the feasibility of such a proposal.

4.3.12. Exclusion of PVC

I. Context

Analysis of PVC usage as a footwear component has been suggested by the Commission Statement 2009/ ENV G2, the EU Ecolabel that supported the Commission Decision 2009/563/EC establishing the EU Ecolabel criteria for footwear. Polyvinyl chloride (PVC) has the third largest thermoplastic market share in the world, with the annual production of around 36 million tonnes in 2011[456], of which around 5.5 million is consumed in Europe[457]. In general terms, the popularity of polyvinyl chloride (PVC) stems mainly from its efficient production costs and it versatility for numerous applications; it can be manipulated by adding additives, stabilizers, and other substances to achieve the precise properties required for specific applications.

The PVC is derived from salt (57%) and oil or gas (43%). Chlorine is produced when salt water is decomposed by electrolysis with ethylene, and ethylene is obtained from oil or gas via a 'cracking' process. After several steps, this leads to the production of another gas: vinyl chloride monomer (VCM). Then, in a further reaction known as polymerization, molecules of VCM link to form a fine white powder (PVC), mixed in subsequent steps with additives, and resulting in PVC granules (compounds), or ready-to-use powders (pre-mixes) are then converted into the final product[457].

II. Improvement potential

Use of chloride compounds is subjected to a longstanding and ongoing environmental debate. This discussion covers a number of points within the life cycle of PVC products, ranging from the production of raw material to the processing of the final product as waste. A number of diverging scientific, technical and economic opinions have been expressed on the question of PVC and its

[454] By comparing figures from European Bioplastics and PlasticsEurope

[455] See Task 2

[456] Stichnothea, H., Azapagica, A.2013. Life cycle assessment of recycling PVC window frames. Resources, Conservation and Recycling 71, pp 40–47

[457] www.plasticeurope.com

possible effects on human health and the environment[458,459,460]. Some Member States have recommended or adopted measures related to specific aspects of the PVC life cycle. However, these measures vary widely[461]. Sweden was the first country to propose general restrictions on the use of PVC in 1995; restrictions have been enforced since 1999, and the country is working toward discontinuing all PVC uses. In order to assess the whole life cycle of PVC and its possible impact on human health and the environment as well as the proper functioning of the internal market, the Commission has carried out several studies and issued a Green Paper on Environment Issues of PVC[461].

The WHO/International Agency for Research on Cancer (IARC) has evaluated Vinyl Chloride (IARC Monographs, 1979, 1987, 1987, 2008) and concluded that sufficient evidence exists for classification of VC as Group 1 (carcinogenic to humans) based on increased risks for angiosarcoma of the liver, and hepatocellular carcinoma[462]. Exposure to PVC dust may cause asthma and affect the lungs. VC also helps form ground-level ozone, which adversely affects breathing and interferes with photosynthesis in plants.

Within the footwear industry, PVC is used in a number of different applications, including whole footwear (for example beach sandals and rain boots can be entirely made of PVC), coatings for upper materials, logos/appliques and outsole units. For the last application, PVC can be in cellular form but is more often seen as a solid material with a specific gravity typically around 1.2 kg/m3[463].

PVC used in footwear does not consist of pure material but of PVC compounds which contain different quantities of additives, such as softeners, filling agents, stabilizers and others; thus, it may contain dangerous chemical additives including phthalates, lead, cadmium, and/or organotins[464]. Additives used in the production process are not covalently bound to the polymeric matrix, and can gradually leach out, or volatilize from the product over its lifetime. PVC plasticizers are used in the amounts ranging up to 50 % w/w.[464] Some phthalate esters, stabilizers, and organotin compounds have been listed as an SVHC[465] by the European Chemical Association (ECHA) under the Article 54 of REACH Regulation.

Because plasticizers are additives that are necessary for PVC production, the need to seek for possible alternatives to restricted phthalates has evolved in a progressive shift from low to high molecular weight phthalates and, to a smaller extent, to some non-phthalate plasticisers. According

458 www.epa.gov/ttn/atw/hlthef/vinylchl.html.

459 http://toxnet.nlm.nih.gov/

460 Huisingh, D (Editor-in Chief). 2011. Special Issue. Improving the health of the public, workers and the environment. Twenty years of toxic use reduction. Journal of Cleaner Production,. Volume 19/5, March 2011. 572 pp. Elsevier

461 http://ec.europa.eu/environment/waste/pvc/

462 IARC Monographs. Vinyl Chloride: http://monographs.iarc.fr/ENG/Monographs/vol100F/mono100F-31.pdf

463 INTERTEK (2011) https://www.wewear.org/assets/1/7/2011January.pdf

464 Lithner, D. Larsson,A. Dave, G. 2011. Environmental and health hazard ranking and assessment of plastic polymers based on chemical composition. Science of the Total Environment 409, pp 3309–3324

465 Substance of Very High Concern

to PlasticsEurope[466] the HMW[467] phthalates (DINP, DIDP, and DPHP) today represent over 70% of the plasticiser market in Europe, the complete phase-out of lead stabilizers is planned by 2015.

However, it should be stressed that the presence of DINP (di-isononyl phthalate), especially in children products, has been the subject of criticism, and the associated risk assessment has been re-analysed. Although these studies concluded that target substances are unlikely to present a health hazard, it is also important to note that the total hazard index is the result of the contribution from different pathways to which human beings may be exposed in daily activities[468]. Considering that in addition to dermal contact, children may also be exposed via oral contact when they insert a portion of the footwear into their mouths; accordingly, it seems reasonable to consider establishment of a precautionary principle.

Following analysis conducted by Stichnotea et al (2013)[469], replacing virgin PVC in plastic windows with PVC from post-consumer waste could save around 2.0 tonnes of CO2 eq./tonne of PVC, while PVC from post-industrial waste saves 1.8 tonnes of CO2 eq./tonne of PVC. According to the Vinyl Report (2010)[470], 260.000 tonnes of PVC waste were recycled in Europe in 2010, mainly into building materials (flooring, roofing, window profile). Footwear were not specifically addressed by report, however, coated fabrics recycling accounted to 6.278 tonnes (2.4% of overall recycled PVC).

However, because of possible differences in the PVC chemical structure, obtaining high-quality recyclates from mechanical recycling of post–consumer waste (i.e., with defined technical parameters of: strength, elasticity, colour) requires input materials with a specified quality[471]. Some papers have addressed the possible adverse effects of PVC on the recycling of mixed plastics, owing to the fact that several different polymers are present in the PVC-rich plastic mixture, and the additives interfere with the recycling process,[472,473] meaning requirement of strict PVC separation[474].

RDC Environment has run a confidential study for a footwear brand. The objective was to assess the environmental impacts of PVC and to compare them with alternative thermoplastics (SBS, SEBS, TPU, TPE-O, EVA, and LDPE). In general terms, from the LCA perspective, it could not be clearly stated that PVC environmental performance is more impactful than that of alternative thermoplastics. The main environmental impacts of PVC life cycle come from the manufacturing phase and from the production of plasticizers. From the LCA perspective, we have concluded that the results and

466 www.plasticeurope.com

467 High Molecular Weight

468 Herva, M., , Álvarez, A., , Roca, E. 2011. Sustainable and safe design of footwear integrating ecological footprint and risk criteria. Journal of Hazardous Materials 192, pp 1876– 1881

469 Stichnothea, H., Azapagica, A.2013. Life cycle assessment of recycling PVC window frames. Resources, Conservation and Recycling 71, pp 40–47

470 Vinyl 2010 Report.The European PVC Industry's Sustainable Development Programme. www.vinyl2010.org

471 Mechanical Recycling of PVC Waste. 2000. Study for DG XI of the European Commission (B4-3040/98/000821/MAR/E3)

472 The issue of hindering was addressed by the Commission Statement.

473 Sadat-Shojai, Bakhshandeh, G.R. 2011 Recycling of PVC wastes. Polymer Degradation and Stability 96, pp 404-415

474 Setting up of a cost effective collection and sorting scheme is a key challenge for post-consumer waste recycling for any material (not only PVC)

magnitude of environmental impact will differ significantly depending on the product disposal method. Burning PVC will strongly contribute to air acidification. A particular issue to be considered is the possible formation of dioxins and furans resulting from an improperly run combustion process. According to EC (2000)[475], reduction of the chloride content in the waste can reduce dioxin formation; PVC was identified as providing considerable chloride input to the MSW stream. It is estimated that about 10% of cadmium found in waste incinerators and landfills originates from PVC. During the incineration of PVC and other wastes, the majority of the lead and cadmium ends up in the bottom and fly ashes of the incinerators. Due to contamination with heavy metals, incinerator residues have to be disposed in controlled landfills. According to (EC, 2000)[476], if PVC is landfilled, related short- and medium term emissions from landfills appear to be lower when contrasting to possible adverse effect of burning.

In case of footwear, it should be stressed that there is no comprehensive and commonly agreed national segregation scheme/recycling infrastructure. Moreover, consumption and end-of-life disposal commonly take place in different countries, subject to varying levels of monitoring and control. The established (most commonly through charity organizations) end-of-life scenario at local levels usually considers collection and reuse of second-hand shoes for either local redistribution or exportation to less-developed countries. According to the estimates of SMART Technology, approximately 15% of post-consumer shoe waste in the UK is collected and re-distributed as second hand shoes, while the rest (85%) is disposed of in landfills. The possible impact of the footwear end-of-life should be carefully analysed. No available data have been found on the main destination countries for footwear distributed through charity networks. In this case, it is not possible to exclude uncontrolled burning of PVC-containing shoes. The potential for dioxin formation and emission of other toxic substances can result from uncontrolled or not appropriately run combustion process.

There is an observable trend to shift towards non-PVC alternatives by many world-known footwear and apparel brands. To promote the EU Ecolabel towards consumers, it is important to consider the current market situation. In this sense, allowing the use of PVC would not enhance the reputation of the EU Ecolabel.

Among the footwear-related ecolabels analysed:

- The Japanese Eco Mark restricts the use of halogen elements for the polymer structure as prescription constituents. If halogen elements are used in footwear plastics parts, 70% or more of these plastic parts shall be collected from the used products. Furthermore, 70% or more of the materials of the collected plastic parts shall be recycled.
- The Nordic Swan label forbids the use of PVC for the production of coatings, laminates or membranes.
- The Blue Angel label forbids the use of PVC in the footwear product group definition.

Recognizing the possible negative environmental impacts of PVC and considering the feasibility of using existing alternatives, many brands are on the way to becoming PVC-free; among others, Nike, Adidas, Esprit, Puma, and Timberland have recently announced these intentions.

[475] Green Paper on Environmental issues of PVC COM(2000) 469 final

[476] The Behaviour of PVC in Landfill

III. Barriers and opportunities

The LCA analysis did not conclude that PVC cause higher environmental impact than other synthetic materials. However, above discussed evidence indicates that PVC may cause environmental problems, especially considering possible risk to hazardous exposures during product life cycle[477]. Because it requires hazardous chemicals in production, it may release harmful additives during use phase and creates potentially toxic wastes. If the end of life treatment is not managed correctly, significant impacts can arise from this life cycle phase. It has potential to become an environmental problem, especially if the footwear is exported or reused in non-European countries where the end of life is not controlled.

The EU Ecolabel Regulation 66/2010 considers the product environmental performance from the life cycle perspective. Therefore, following the evidence found, the stakeholders should be consulted to assess whether a restriction on PVC content should be included in the revised criteria area.

IV. Criterion proposal

Several environmental and consumer NGOs have been advocating phasing out PVC from consumer goods, because of it is suspected of posing environmental and health risks over its life cycle[478]. Following the World Health Organization precautionary principle, whenever a potentially hazardous chemical is identified, if a clearly safer alternative exists, the reasons to accept even a small, highly uncertain risk, should be questionable[479]. From the EU Ecolabel criteria setting perspective when consulting other European Ecolabel relevant for the product group under revision, both Blue Angel and Nordic Swan restrict PVC usage. Japanese Eco-Mark restricts the use of halogen elements. Simultaneously, recognizing the feasibility of existing alternatives, many brands are on the way to becoming PVC-free; such an approach has been announced by Nike, Adidas, Puma, and Timberland, among others. The alternatives are increasingly well known and well developed, and in many cases, they are already cost-competitive with PVC.

The possible restriction of PVC usage in EU Ecolabelled footwear should therefore be further discussed during the AdHoc Working Group Meeting.

4.3.13. Emissions to water

I. Context

Emissions to water that occur during the tanning of hides and skins, processing of textiles, and production of synthetic materials must be minimised in order to limit the impacts on the environment. In the current EU Ecolabel and in other EU Ecolabel, such as for textiles, the main indicator used is the emission of Chemical Oxygen Demand (COD). However, because this indicator is not classified in the LCA impact categories used, the potential improvement related to these emissions cannot be assessed.

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[477] Huisingh, D (Editor-in Chief). 2011. Special Issue. Improving the health of the public, workers and the environment. Twenty years of toxic use reduction. Journal of Cleaner Production,. Volume 19/5, March 2011. 572 pp. Elsevier

[478] Such as: Clean Production Action, Greenpeace, the Centre for Health and Environmental Justice.

[479] Marco Martuzzi, M., Tickner, J.A. (Eds).2004. The precautionary principle: protecting public health, the environment and the future of our children. World Health Organization. Europe.

However, in accordance with the Commission Statement, the emissions levels to water will be updated by using the latest BREF documents available. These emissions levels are further discussed in the technical report.

4.3.14. Management of end of life

I. Context

It is estimated that the amount of waste arising from postconsumer shoes could reach 1.2[480]-1.5[481] million tonnes per year. Approximately 5% of global footwear production is recycled or reused, with most being disposed of in landfill sites[482,483]. One of the primary reasons for the low recycling rate is that most modern footwear products contain a complex mixture of leather, rubber, textile, polymers and metallic materials that make it difficult to perform complete separation and reclamation of material streams in an economically sustainable manner. Many brands have promoted eco-innovations in order to improve the end of life of footwear (see Task 2: Market analysis). However, it is difficult to assess the potential improvement related to these because there is insufficient data regarding:

- The stream statistics,
- The processes of recycling,
- The substituted products.

II. Criterion proposal

It should be discussed during the working group meeting, in order to obtain additional feedback from stakeholders.

It could at least be proposed that the brands report on their post-consumer waste management system, if it exists. It appears complicated to set a quantitative criteria.

4.4 Conclusion

Figure 62 summarizes the improvement potentials that have been quantitatively evaluated in this section. Improvements related to energy consumption clearly appear as the major ones. Reduction of wastage follows, followed by the reduction of VOC emissions, restriction on airplane transport, and reduction of footwear mass. The other improvements are of lesser importance.

[480] Michael James Lee, M.J., Rahimifard, S. 2012. An air-based automated material recycling system for post-consumer footwear products. Resources, Conservation and Recycling 69, pp 90– 99

[481]http://www.eco-naturalista.eu

[482] World Footwear. The future of polyurethane sole in world footwear. Cambridge, MA: Shoe Trades; 2005. p. 18–20.

[483] SATRA. Footwear market predictions: forecasts for global footwear trading to 2009. Kettering: SATRA Technology Centre; 2003.

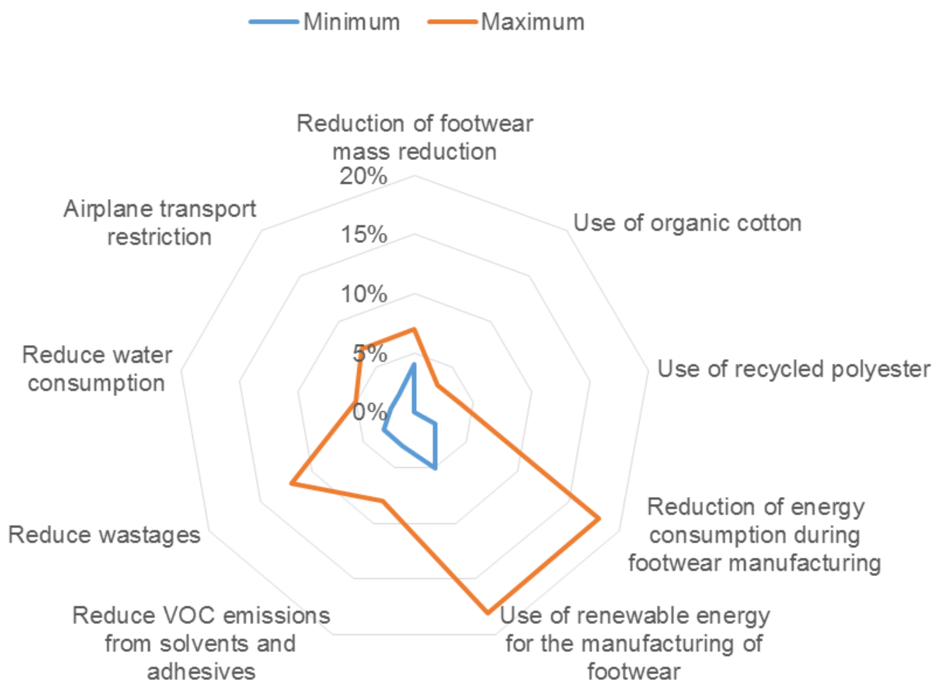

Figure 62: Summary of improvement potentials quantitatively evaluated

Based on the analysis of the potential improvements, the following table summarizes the environmental relevance of possible improvements, the market penetration of these practices, and potential improvements that should, or could be, included in the criteria.

Table 98: Improvement potential – Inclusion in criteria area

Life Cycle stage	Potential improvements	Environmental relevance per functional unit[484]	Market Penetration[485]	Criteria integration/ revision[486]	Feasibility of criteria implementation[487]
Input materials	Reduction of footwear mass reduction	++	-	No	-
	Use of organic cotton	-	+++	Discussion	+
	Use of recycled polyester	-	+++	Discussion	+
	Use of bio-based materials	Not assessed quantitatively	+	Discussion	+
	Use of recycled plastics	Not assessed quantitatively	++	Discussion	+
	Exclusion of PVC	Not assessed quantitatively	+	Discussion	++
	Emissions to water	Not assessed quantitatively	+	Discussion	++
	Limitation of hazardous substances	Not assessed quantitatively	++	Yes	+
Manufacturing	Reduction of energy consumption during footwear manufacturing	++	-	Discussion	+
	Use of renewable energy for the manufacturing of footwear	++	-	Discussion	+
	Reduce VOC emissions from solvents and adhesives	+	+++	Yes	+
	Reduce wastages	+	+	Yes	+
	Reduce water consumption	+	-	Discussion	+
Distribution	Airplane transport restriction	+	-	Yes	++
Fitness for use	Improvement of footwear durability	+++	-	Yes	+
End of life	Improve end of life management	Not assesses quantitatively	++	Discussion	-

[484] +++: LCA results are proportionally related to the parameter; ++: very significant on LCA results; +: quite significant on LCA results; -: not significant on LCA results.

[485] +++: best practice often declared to be used by producers; ++: best practice sometimes declared to be used by producers; +: best practice used by few producers; -: best practice not identified within the chapter 2. Task 2: Market analysis analysis

[486] Yes: the action should be integrated/revised in the criteria area; No: the action must be integrated/revised in the criteria area; Discussion: the action would need feedback from working group to decide whether to include/revise it or not

[487] ++: quite feasible because the criterion is straightforward; +: feasible but needs to set the scope and/or specific limits; -: difficult to set a quantitative criterion.

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Annexes

Annex I NACE for footwear

Prodcom Code	Description	Material segmentation	Use segmentation
15201100	Waterproof footwear, with uppers in rubber or plastics (excluding incorporating a protective metal toecap)	Rubber or plastics	Waterproof
15201210	Sandals with rubber or plastic outer soles and uppers (including thong-type sandals, flip flops)	Rubber or plastics	Sandals
15201231	Town footwear with rubber or plastic uppers	Rubber or plastics	Town
15201237	Slippers and other indoor footwear with rubber or plastic outer soles and plastic uppers (including bedroom and dancing slippers, mules)	Rubber or plastics	Slippers
15201330	Footwear with a wooden base and leather uppers (including clogs) (excluding with an inner sole or a protective metal toe-cap)	Leather uppers	na
15201351	Men's town footwear with leather uppers (including boots and shoes; excluding waterproof footwear, footwear with a protective metal toe-cap)	Leather uppers	Town
15201352	Women's town footwear with leather uppers (including boots and shoes; excluding waterproof footwear, footwear with a protective metal toe-cap)	Leather uppers	Town
15201353	Children's town footwear with leather uppers (including boots and shoes; excluding waterproof footwear, footwear with a protective metal toe-cap)	Leather uppers	Town
15201361	Men's sandals with leather uppers (including thong type sandals, flip flops)	Leather uppers	Sandals
15201362	Women's sandals with leather uppers (including thong type sandals, flip flops)	Leather uppers	Sandals
15201363	Children's sandals with leather uppers (including thong type sandals, flip flops)	Leather uppers	Sandals
15201370	Slippers and other indoor footwear with rubber, plastic or leather outer soles and leather uppers (including dancing and bedroom slippers, mules)	Leather uppers	Slippers
15201380	Footwear with wood, cork or other outer soles and leather uppers (excluding outer soles of rubber, plastics or leather)	Wooden soles	Town
15201444	Slippers and other indoor footwear (including dancing and bedroom slippers, mules)	na	Slippers
15201445	Footwear with rubber, plastic or leather outer soles and textile uppers (excluding slippers and other indoor footwear, sports footwear)	Textile uppers	Town
15201446	Footwear with textile uppers (excluding slippers and other indoor footwear as well as footwear with outer soles of rubber, plastics, leather or composition leather)	Textile uppers	Town
15202100	Sports footwear with rubber or plastic outer soles and textile uppers (including tennis shoes, basketball shoes, gym shoes, training shoes and the like)	Textile uppers	Sports

15202900	Other sports footwear, except snow-ski footwear and skating boots	na	Sports
15203120	Footwear (including waterproof footwear), incorporating a protective metal toecap, with outer soles and uppers of rubber or of plastics	Rubber or plastics	Protective
15203150	Footwear with rubber, plastic or leather outer soles and leather uppers, and with a protective metal toe-cap	Leather	Protective
15203200	Wooden footwear, miscellaneous special footwear and other footwear n.e.c.	Wooden soles	na
15204020	*Leather uppers and parts thereof of footwear (excluding stiffeners)*		
15204050	*Uppers and parts thereof of footwear (excluding stiffeners, of leather)*		
15204080	*Parts of footwear (excluding uppers) other materials*		

Annex II CN for footwear

64 footwear, gaiters and the like; parts of such articles
6401 waterproof footwear with outer soles and uppers of rubber or of plastics, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes (excl. Orthopaedic footwear, toy footwear, skating boots with ice skates attached, shin-guards and similar protective sportswear)
640110 waterproof footwear incorporating a protective metal toecap, with outer soles and uppers of rubber or of plastics, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes (excl. Skating boots with ice or roller skates attached, shin-guards and similar protective sportswear)
64011000 waterproof footwear incorporating a protective metal toecap, with outer soles and uppers of rubber or of plastics, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes (excl. Skating boots with ice or roller skates attached, shin-guards and similar protective sportswear)
64011010 waterproof footwear incorporating a protective metal toecap, with uppers of rubber and outer soles of rubber or of plastics, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes (excl. Skating boots with ice or roller skates attached, shin-guards and similar protective sportswear)
64011090 waterproof footwear incorporating a protective metal toecap, with uppers of plastic and outer soles of rubber or of plastics, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes (excl. Skating boots with ice or roller skates attached, shin-guards and similar protective sportswear)
640191 waterproof footwear covering the knee, with outer soles and uppers of rubber or of plastics, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes (excl. Incorporating a protective metal toecap, skating boots with ice or roller skates attached, shin-guards and similar protective sportswear)
64019100 waterproof footwear covering the knee, with outer soles and uppers of rubber or of plastics, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes (excl. Incorporating a protective metal toecap, skating boots with ice or roller skates attached, shin-guards and similar protective sportswear)
64019110 waterproof footwear with outer soles of rubber or plastics, and uppers of rubber, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes, covering the knee (excl. Footwear incorporating a protective metal toecap, and footwear with fixed attachments for skiing or skating, shin pads and similar protective devices for sports purposes)
64019190 waterproof footwear with outer soles of rubber or plastics, and uppers of rubber, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes, covering the knee (excl. Footwear incorporating a protective metal toecap, and footwear with fixed attachments for skiing or skating, shin pads and similar protective devices for sports purposes)
640192 waterproof footwear covering the ankle, but not the knee, with outer soles and uppers of rubber or of plastics, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes (excl. Incorporating a protective metal toecap, orthopaedic footwear, sports and toy footwear)
64019210 waterproof footwear with uppers of rubber and outer soles of rubber or of plastics, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes, covering only the ankle (excl. Footwear incorporating a protective metal toecap, orthopaedic footwear, footwear with fixed attachments for skiing or skating, and toy footwear)
64019290 waterproof footwear with uppers of plastic and outer soles of rubber or of plastics, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes, covering only the ankle (excl. Footwear incorporating a protective metal toecap, orthopaedic footwear, sports footwear, footwear with fixed attachments for skiing or skating, and toy footwear)
640199 waterproof footwear covering neither the ankle nor the knee, with outer soles and uppers of rubber or of plastics, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes (excl. Incorporating a protective metal toecap, orthopaedic footwear, skating boots with ice or roller skates attached, and toy footwear)
64019900 waterproof footwear covering neither the ankle nor the knee, with outer soles and uppers of rubber or of plastics, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes (excl. Incorporating a protective metal toecap, orthopaedic footwear, skating boots with ice or roller skates attached, and toy footwear)

64019910 waterproof footwear with outer soles of rubber or plastics, and uppers of rubber, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes, covering neither the knee nor the ankle (excl. Footwear incorporating a protective metal toecap, orthopaedic footwear, footwear, skating boots or ski boots, and shoes having the character of toys)
64019990 waterproof footwear with outer soles of rubber or plastics, and uppers of rubber, the uppers of which are neither fixed to the sole nor assembled by stitching, riveting, nailing, screwing, plugging or similar processes, covering neither the knee nor the ankle (excl. Footwear incorporating a protective metal toecap, orthopaedic footwear, footwear, skating boots or ski boots, and shoes having the character of toys)
6402 footwear with outer soles and uppers of rubber or plastics (excl. Waterproof footwear of heading 6401, orthopaedic footwear, skating boots with ice or roller skates attached, and toy footwear)
640211 ski boots and cross-country ski footwear, with outer soles and uppers of rubber or plastics (excl. Waterproof footwear of heading 6401)
64021100 ski-boots and cross-country ski footwear, with outer soles and uppers of rubber or plastics (excl. Waterproof footwear of heading 6401)
640212 ski-boots, cross-country ski footwear and snowboard boots, with outer soles and uppers of rubber or plastics (excl. Waterproof footwear of heading 6401)
64021210 ski-boots and cross-country ski footwear, with outer soles and uppers of rubber or plastics (excl. Waterproof footwear of heading 6401)
64021290 snowboard boots with outer soles and uppers of rubber or plastics (excl. Waterproof footwear of heading 6401)
640219 sports footwear with outer soles and uppers of rubber or plastics (excl. Waterproof footwear of heading 6401, ski-boots, cross-country ski footwear, snowboard boots and skating boots with ice or roller skates attached)
64021900 sports footwear with outer soles and uppers of rubber or plastics (excl. Waterproof footwear of heading 6401, ski-boots, cross-country ski footwear, snowboard boots and skating boots with ice or roller skates attached)
640220 footwear with outer soles and uppers of rubber or plastics, with upper straps or thongs assembled to the sole by means of plugs (excl. Toy footwear)
64022000 footwear with outer soles and uppers of rubber or plastics, with upper straps or thongs assembled to the sole by means of plugs (excl. Toy footwear)
640230 footwear, incorporating a protective metal toecap, with outer soles and uppers of rubber or plastics (excl. Waterproof footwear of heading 6401, sports footwear and orthopaedic footwear)
64023000 footwear, incorporating a protective metal toecap, with outer soles and uppers of rubber or plastics (excl. Waterproof footwear of heading 6401, sports footwear and orthopaedic footwear)
64023010 footwear, incorporating a protective metal toe-cap, with uppers of rubber and outer soles of rubber or plastics (excl. Waterproof footwear of heading 6401, sports footwear and orthopaedic footwear)
64023090 footwear, incorporating a protective metal toe-cap, with uppers of plastics and outer soles of rubber or plastics (excl. Waterproof footwear of heading 6401, sports footwear and orthopaedic footwear)
640291 footwear covering the ankle, with outer soles and uppers of rubber or plastics (excl. Waterproof footwear of heading 6401, sports footwear, orthopaedic footwear and toy footwear)
64029100 footwear covering the ankle, with outer soles and uppers of rubber or plastics (excl. Incorporating a protective metal toecap, waterproof footwear of heading 6401, sports footwear, orthopaedic footwear and toy footwear)
64029110 footwear covering the ankle, with uppers of rubber and outer soles of rubber or plastics (excl. Incorporating a protective metal toe-cap, waterproof footwear of heading 6401, sports footwear, orthopaedic footwear and toy footwear)
64029190 footwear covering the ankle, with uppers of plastics and outer soles of rubber or plastics (excl. Incorporating a protective metal toe-cap, waterproof footwear of heading 6401, sports footwear, orthopaedic footwear and toy footwear)
640299 footwear with outer soles and uppers of rubber or plastics (excl. Covering the ankle or with upper straps or thongs assembled to the sole by means of plugs, waterproof footwear of heading 6401, sports footwear, orthopaedic footwear and toy footwear)
64029905 footwear incorporating a protective metal toecap, with outer soles and uppers of rubber or plastics (excl. Covering the ankle, waterproof footwear of heading 6401, sports footwear and orthopaedic footwear)
64029910 footwear with uppers of rubber and outer soles of rubber or plastics (excl. Covering the ankle or with upper straps or thongs assembled to the sole by means of plugs, waterproof footwear of heading 6401, sports footwear, orthopaedic footwear and toy footwear)
64029931 footwear with uppers of plastic and outer soles of rubber or plastics, with a vamp made of straps or which has one or several pieces cut out, with a maximum sole and heel height of > 3 cm (excl. With upper straps or thongs assembled to the sole by means of plugs)

64029939 footwear with uppers of plastic and outer soles of rubber or plastics, with a vamp made of straps or which has one or several pieces cut out, with a maximum sole and heel height of <= 3 cm (excl. With upper straps or thongs assembled to the sole by means of plugs)
64029950 slippers and other indoor footwear, with outer sole and upper of rubber or plastics (excl. Covering the ankle, footwear with a vamp made of straps or which has one or several pieces cut out, and toy footwear)
64029991 footwear with uppers of plastics and outer soles of rubber or plastics, with in-soles of a length of < 24 cm (excl. Covering the ankle, footwear with a vamp made of straps or which has one or several pieces cut out, footwear incorporating a protective metal toecap, indoor footwear, sports footwear, waterproof footwear of heading 6401, orthopaedic footwear and toy footwear)
64029993 footwear non-identifiable as men's or women's footwear, with uppers of plastics, with outer soles of rubber or plastics, with in-soles of length >= 24 cm (excl. Footwear covering the ankle, with a vamp made of straps or which has one or more pieces cut out, or incorporating a protective metal toecap, indoor or sports footwear, waterproof footwear in heading 6401, and orthopaedic footwear)
64029995 men's footwear with uppers of plastics and outer soles of rubber or plastics, with in-soles of a length of >= 24 cm (excl. Covering the ankle, footwear with a vamp made of straps or which has one or several pieces cut out, footwear incorporating a protective metal toe-cap, indoor footwear, sports footwear, waterproof footwear of heading 6401, and orthopaedic footwear)
64029996 footwear with outer soles of rubber or plastics and uppers of plastics, with in-soles of a length >= 24 cm, for men (excl. Footwear covering the ankle, with a vamp made of straps or which has one or more pieces cut out, or incorporating a protective metal toecap, indoor or sports footwear, waterproof footwear in heading 6401, orthopaedic footwear and footwear which cannot be identified as men's or women's)
64029998 footwear with outer soles of rubber or of plastics and uppers of plastics, with in-soles of a length of >= 24 cm, for women (excl. Footwear covering the ankle, with a vamp made of straps or which has one or more pieces cut out, or incorporating a protective metal toecap, indoor or sports footwear, waterproof footwear in heading 6401, orthopaedic footwear and footwear which cannot be identified as men's or women's)
64029999 women's footwear with uppers of plastics and outer soles of rubber or plastics, with in-soles of a length of >= 24 cm (excl. Covering the ankle, footwear with a vamp made of straps or which has one or several pieces cut out, footwear incorporating a protective metal toe-cap, indoor footwear, sports footwear, waterproof footwear of heading 6401, and orthopaedic footwear)
6403 footwear with outer soles of rubber, plastics, leather or composition leather and uppers of leather (excl. Orthopaedic footwear, skating boots with ice or roller skates attached, and toy footwear)
640311 ski-boots and cross-country ski footwear, with outer soles of rubber, plastics, leather or composition leather and uppers of leather
64031100 ski-boots and cross-country ski footwear, with outer soles of rubber, plastics, leather or composition leather and uppers of leather
640312 ski-boots, cross-country ski footwear and snowboard boots, with outer soles of rubber, plastics, leather or composition leather and uppers of leather
64031200 ski-boots, cross-country ski footwear and snowboard boots, with outer soles of rubber, plastics, leather or composition leather and uppers of leather
640319 sports footwear, with outer soles of rubber, plastics, leather or composition leather and uppers of leather (excl. Ski-boots, cross-country ski footwear, snowboard boots and skating boots with ice or roller skates attached)
64031900 sports footwear, with outer soles of rubber, plastics, leather or composition leather and uppers of leather (excl. Ski-boots, cross-country ski footwear, snowboard boots and skating boots with ice or roller skates attached)
640320 footwear with outer soles of leather, and uppers which consist of leather straps across the instep and around the big toe
64032000 footwear with outer soles of leather, and uppers which consist of leather straps across the instep and around the big toe
640330 footwear with leather uppers, made on a base or platform of wood, with neither an inner sole nor a protective metal toecap
64033000 footwear with leather uppers, made on a base or platform of wood, with neither an inner sole nor a protective metal toecap
640340 footwear, incorporating a protective metal toecap, with outer soles of rubber, plastics, leather or composition leather and uppers of leather (excl. Sports footwear and orthopaedic footwear)
64034000 footwear, incorporating a protective metal toecap, with outer soles of rubber, plastics, leather or composition

leather and uppers of leather (excl. Sports footwear and orthopaedic footwear)
640351 footwear with outer soles and uppers of leather, covering the ankle (excl. Incorporating a protective metal toecap, sports footwear, orthopaedic footwear and toy footwear)
64035105 footwear with outer soles and uppers of leather, made on a base or platform of wood, covering the ankle, with neither an inner sole nor a protective metal toecap
64035111 footwear with outer soles and uppers of leather, covering the ankle but not the calf, with in-soles of < 24 cm in length (excl. Incorporating a protective metal toecap, sports footwear, orthopaedic footwear and toy footwear)
64035115 men's footwear with outer soles and uppers of leather, covering the ankle but not the calf, with in-soles of >= 24 cm in length (excl. Incorporating a protective metal toecap, sports footwear, and orthopaedic footwear)
64035119 women's footwear with outer soles and uppers of leather, covering the ankle but not the calf, with in-soles of >= 24 cm in length (excl. Incorporating a protective metal toecap, sports footwear, and orthopaedic footwear)
64035191 footwear with outer soles and uppers of leather, covering the ankle and calf, with in-soles of < 24 cm in length (excl. Incorporating a protective metal toecap, sports footwear, orthopaedic footwear and toy footwear)
64035195 men's footwear with outer soles and uppers of leather, covering the ankle and calf, with in-soles of >= 24 cm in length (excl. Incorporating a protective metal toecap, sports footwear, and orthopaedic footwear)
64035199 women's footwear with outer soles and uppers of leather, covering the ankle and calf, with in-soles of >= 24 cm in length (excl. Incorporating a protective metal toecap, sports footwear, and orthopaedic footwear)
640359 footwear with outer soles and uppers of leather (excl. Covering the ankle, incorporating a protective metal toecap, with uppers which consist of leather straps across the instep and around the big toe, sports footwear, orthopaedic footwear and toy footwear)
64035905 footwear with outer soles and uppers of leather, made on a base or platform of wood, with neither an inner sole nor a protective metal toecap (excl. Covering the ankle)
64035911 footwear with outer soles and uppers of leather, with a vamp made of straps or which has one or several pieces cut out, with a maximum sole and heel height of > 3 cm (excl. With uppers which consist of leather straps across the instep and around the big toe)
64035931 footwear with outer soles and uppers of leather, with a vamp made of straps or which has one or several pieces cut out, with a maximum sole and heel height of <= 3 cm, with in-soles of < 24 cm in length (excl. With uppers which consist of leather straps across the instep and around the big toe, and toy footwear)
64035935 men's footwear with outer soles and uppers of leather, with a vamp made of straps or which has one or several pieces cut out, with a maximum sole and heel height of <= 3 cm, with in-soles of >= 24 cm in length (excl. With uppers which consist of leather straps across the instep and around the big toe)
64035939 women's footwear with outer soles and uppers of leather, with a vamp made of straps or which has one or several pieces cut out, with a maximum sole and heel height of <= 3 cm, with in-soles of >= 24 cm in length (excl. With uppers which consist of leather straps across the instep and around the big toe)
64035950 slippers and other indoor footwear, with outer soles and uppers of leather (excl. Covering the ankle, with a vamp or upper made of straps, and toy footwear)
64035991 footwear with outer soles and uppers of leather, with in-soles of < 24 cm in length (excl. Covering the ankle, incorporating a protective metal toecap, made on a base or platform of wood, without in-soles, with a vamp or upper made of straps, indoor footwear, sports footwear, orthopaedic footwear, and toy footwear)
64035995 men's footwear with outer soles and uppers of leather, with in-soles of >= 24 cm in length (excl. Covering the ankle, incorporating a protective metal toecap, made on a base or platform of wood, without in-soles, with a vamp or upper made of straps, indoor footwear, sports footwear, and orthopaedic footwear)
64035999 women's footwear with outer soles and uppers of leather, with in-soles of >= 24 cm in length (excl. Covering the ankle, incorporating a protective metal toecap, made on a base or platform of wood, without in-soles, with a vamp or upper made of straps, indoor footwear, sports footwear, and orthopaedic footwear)
640391 footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle (excl. Incorporating a protective metal toecap, sports footwear, orthopaedic footwear and toy footwear)
64039105 footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, made on a base or platform of wood, covering the ankle with neither an inner sole nor a protective metal toecap
64039111 footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle but not the calf, with in-soles of < 24 cm in length (excl. Incorporating a protective metal toe-cap, sports footwear, orthopaedic footwear and toy footwear)
64039113 footwear (not identifiable as men's or women's footwear), with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle (but not the calf), with in-soles of a length >= 24 cm, (excl. 6403.11-00 to

6403.40-00)
64039115 men's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle but not the calf, with in-soles of >= 24 cm in length (excl. Incorporating a protective metal toe-cap, sports footwear, and orthopaedic footwear)
64039116 men's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle (but not the calf), with in-soles of a length >= 24 cm (excl. 6403.11-00 to 6403.40.00)
64039118 women's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle (but not the calf), with in-soles of a length >= 24 cm (excl. 6403.11-00 to 6403.40.00)
64039119 women's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle but not the calf, with in-soles of >= 24 cm in length (excl. Incorporating a protective metal toe-cap, sports footwear, and orthopaedic footwear)
64039191 footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle and calf, with in-soles of < 24 cm in length (excl. Incorporating a protective metal toecap, sports footwear, orthopaedic footwear and toy footwear)
64039193 footwear non-identifiable as men's or women's footwear, with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle, with in-soles of a length >= 24 cm (excl. 6403.1-00 to 6403.40.00)
64039195 men's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle and calf, with in-soles of >= 24 cm in length (excl. Incorporating a protective metal toe-cap, sports footwear, and orthopaedic footwear)
64039196 men's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle, with in-soles of a length >= 24 cm (excl. 6403.11-00 to 6403.40.00 nor 6403.90-16)
64039198 women's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle, with in-soles of length >= 24 cm (excl. 6403.11-00 to 6403.40.00 nor 6403.91.18)
64039199 women's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, covering the ankle and calf, with in-soles of >= 24 cm in length (excl. Incorporating a protective metal toe-cap, sports footwear, and orthopaedic footwear)
640399 footwear with outer soles of rubber, plastics or composition leather, with uppers of leather (excl. Covering the ankle, incorporating a protective metal toecap, sports footwear, orthopaedic footwear and toy footwear)
64039905 footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, made on a base or platform of wood, with neither an inner sole nor a protective metal toecap (excl. Covering the ankle)
64039911 footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, with a vamp made of straps or which has one or several pieces cut out, with a maximum sole and heel height of > 3 cm
64039931 footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, with a vamp made of straps or which has one or several pieces cut out, with a maximum sole and heel height of <= 3 cm, with in-soles of < 24 cm in length (excl. Toy footwear)
64039933 footwear non-identifiable as men's or women's footwear, with outer soles of rubber, plastics or composition leather, with uppers of leather (not covering the ankle), with a vamp made of straps or which has one or several pieces cut out, with sole and heel height <= 3 cm, with in-soles of a length >= 24 cm (excl. 6403.11-00 to 6403.40.00)
64039935 men's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, with a vamp made of straps or which has one or several pieces cut out, with a maximum sole and heel height of =< 3 cm, with in-soles of >= 24 cm in length
64039936 men's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather (not covering the ankle), with a vamp made of straps or which has one or several pieces cut out, with sole and heel height <= 3 cm, with in-soles of a length >= 24 cm (excl. 6403.11-00 to 6403.40.00)
64039938 women's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather (not covering the ankle), with a vamp made of straps or which has one or several pieces cut out, with sole and heel height <= 3 cm, with in-soles of a length >= 24 cm (excl. 6403.11-00 to 6403.40.00)
64039939 women's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, with a vamp made of straps or which has one or several pieces cut out, with a maximum sole and heel height of =< 3 cm, with in-soles of >= 24 cm in length
64039950 slippers and other indoor footwear, with outer soles of rubber, plastics, or composition leather and uppers of leather (excl. Covering the ankle, with a vamp made of straps or which has one or several pieces cut out, and toy footwear)
64039991 footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, with in-soles of < 24 cm in length (excl. Covering the ankle, incorporating a protective metal toecap, made on a base or platform of wood, without in-

soles, with a vamp made of straps or which has one or several pieces cut out, indoor footwear, sports footwear, orthopaedic footwear and toy footwear)
64039993 footwear non-identifiable as men's or women's footwear, with outer soles of rubber, plastics or composition leather and uppers of leather, with in-soles of a length of >= 24 cm (excl. Footwear covering the ankle; with a protective metal toecap; with a main sole of wood, without in-sole; footwear with a vamp made of straps or which has one or more pieces cut out; indoor, sports or orthopaedic footwear)
64039995 men's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, with in-soles of >= 24 cm in length (excl. Covering the ankle, incorporating a protective metal toe-cap, made on a base or platform of wood, without in-soles, with a vamp made of straps or which has one or several pieces cut out, indoor footwear, sports footwear and orthopaedic footwear)
64039996 men's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather (not covering the ankle), with in-soles of a length >= 24 cm (excl. 6403.11-00 to 6403.40.00, 6403.99.11, 6403.99.36, 6403.99.50)
64039998 footwear with outer soles of rubber, plastics or composition leather and uppers of leather, with in-soles of a length of >= 24 cm, for women (excl. Footwear covering the ankle; with a protective metal toecap; with a main sole of wood, without in-sole; footwear with a vamp made of straps or which has one or more pieces cut out; indoor, sports or orthopaedic footwear; footwear which cannot be identified as men's or women's)
64039999 women's footwear with outer soles of rubber, plastics or composition leather, with uppers of leather, with in-soles of >= 24 cm in length (excl. Covering the ankle, incorporating a protective metal toe-cap, made on a base or platform of wood, without in-soles, with a vamp made of straps or which has one or several pieces cut out, indoor footwear, sports footwear and orthopaedic footwear)
6404 footwear with outer soles of rubber, plastics, leather or composition leather and uppers of textile materials (excl. Toy footwear)
640411 sports footwear, incl. Tennis shoes, basketball shoes, gym shoes, training shoes and the like, with outer soles of rubber or plastics and uppers of textile materials
64041100 sports footwear, incl. Tennis shoes, basketball shoes, gym shoes, training shoes and the like, with outer soles of rubber or plastics and uppers of textile materials
640419 footwear with outer soles of rubber or plastics and uppers of textile materials (excl. Sports footwear, incl. Tennis shoes, basketball shoes, gym shoes, training shoes and the like, and toy footwear)
64041910 slippers and other indoor footwear, with outer soles of rubber or plastics and uppers of textile materials (excl. Tennis shoes, gym shoes, training shoes and the like, and toy footwear)
64041990 footwear with outer soles of rubber or plastics and uppers of textile materials (excl. Indoor footwear, sports footwear, incl. Tennis shoes, basketball shoes, gym shoes, training shoes and the like, and toy footwear)
640420 footwear with outer soles of leather or composition leather and uppers of textile materials (excl. Toy footwear)
64042010 slippers and other indoor footwear with outer soles of leather or composition leather and uppers of textile materials (excl. Toy footwear)
64042090 footwear with outer soles of leather or composition leather and uppers of textile materials (excl. Indoor footwear and toy footwear)
6405 footwear with outer soles of rubber or plastics, with uppers other than rubber, plastics, leather or textile materials; footwear with outer soles of leather or composition leather, with uppers other than leather or textile materials; footwear with outer soles of wood, cork, twine, paperboard, furskin, woven fabrics, felt, nonwovens, linoleum, raffia, straw, loofah, etc and uppers of any type of material, n.e.s.
640510 footwear with uppers of leather or composition leather (excl. With outer soles of rubber, plastics, leather or composition leather and uppers of leather, orthopaedic footwear and toy footwear)
64051000 footwear with uppers of leather or composition leather (excl. With outer soles of rubber, plastics, leather or composition leather and uppers of leather, orthopaedic footwear and toy footwear)
64051010 footwear with uppers of leather or composition leather and outer soles of wood or cork (excl. Orthopaedic footwear and toy footwear)
64051090 footwear with uppers of leather or composition leather (excl. With outer soles of rubber, plastics, leather or composition leather and uppers of leather, or with outer soles of wood or cork, orthopaedic footwear and toy footwear)
640520 footwear with uppers of textile materials (excl. With outer soles of rubber, plastics, leather or composition leather, orthopaedic footwear and toy footwear)
64052010 footwear with uppers of textile materials and outer soles of wood or cork (excl. Orthopaedic footwear and toy footwear)
64052091 slippers and other indoor footwear with uppers of textile materials (excl. With outer soles of rubber, plastics,

leather or composition leather, and toy footwear)
64052099 footwear with uppers of textile materials (excl. With outer soles of rubber, plastics, leather or composition leather, wood or cork, indoor footwear, orthopaedic footwear and toy footwear)
640590 footwear with outer soles of rubber or plastics, with uppers other than rubber, plastics, leather or textile materials; footwear with outer soles of leather or composition leather, with uppers other than leather or textile materials; footwear with outer soles of wood, cork, paperboard, furskin, felt, straw, loofah, etc., with uppers other than leather, composition leather or textile materials, n.e.s.
64059010 footwear with outer soles of rubber, plastics, leather or composition leather and uppers of materials other than leather, composition leather or textile materials (excl. Orthopaedic footwear and toy footwear)
64059090 footwear with outer soles of wood, cork, twine, paperboard, furskin, woven fabrics, felt, nonwovens, linoleum, raffia, straw, loofah, etc. And uppers of materials other than leather, composition leather or textile materials (excl. Orthopaedic footwear and toy footwear)
6406 parts of footwear, incl. Uppers whether or not attached to soles other than outer soles; removable in-soles, heel cushions and similar articles; gaiters, leggings and similar articles, and parts thereof (excl. Articles of asbestos)
640610 uppers and parts thereof (excl. Stiffeners and general parts made of asbestos)
64061010 uppers and parts thereof, of leather (excl. Stiffeners)
64061011 leather uppers, whether or not attached to soles other than outer soles
64061019 parts of leather uppers (excl. Stiffeners)
64061090 uppers, whether or not attached to soles other than outer soles, and parts thereof (excl. Stiffeners and general parts made of leather or asbestos)
640620 outer soles and heels, of rubber or plastics
64062010 outer soles and heels of rubber
64062090 outer soles and heels of plastics
640690 parts of footwear; removable in-soles, heel cushions and similar articles; gaiters, leggings and similar articles, and parts thereof (excl. Outer soles and heels of rubber or plastics, uppers and parts thereof other than stiffeners, and general parts made of asbestos)
64069030 assemblies of uppers affixed to inner soles or to other sole components (excl. Of asbestos or fixed to outer soles)
64069050 removable in-soles, heel cushions and other removable accessories
64069060 outer soles of shoes, of leather or composition leather
64069090 parts of footwear and gaiters, leggings and similar articles, and parts thereof (excl. Outer soles of leather, composition leather, rubber or plastics, heels of rubber or plastics, uppers and parts thereof other than stiffeners, removable accessories, and general parts made of asbestos)
640691 parts of footwear, of wood
64069100 parts of footwear, of wood
640699 parts of footwear (excl. Outer soles and heels of rubber or plastics, uppers and parts thereof, and general parts made of wood or asbestos)
64069910 gaiters, leggings and similar articles and parts thereof
64069930 assemblies of uppers affixed to inner soles or to other sole components (excl. Of asbestos or fixed to outer soles)
64069950 removable in-soles, heel cushions and other removable accessories
64069960 outer soles of shoes, of leather or composition leather,
64069980 parts of footwear (excl. Outer soles of leather, composition leather, rubber or plastics, heels of rubber or plastics, uppers whether or not attached to inner soles or other sole components [excl. Outer soles] and parts thereof, and general parts made of wood or asbestos)
64069985 parts of footwear and gaiters, leggings and similar articles, and parts thereof (excl. Outer soles of leather, composition leather, rubber or plastics, heels of rubber or plastics, uppers whether or not attached to inner soles or other sole components [excl. Outer soles] and parts thereof, and general parts made of wood or asbestos)
64069990 parts of footwear (excl. Outer soles and heels of rubber or plastics, uppers, whether or not affixed to inner soles or sole components other than outer soles, and parts thereof, and general parts made of wood or asbestos)
64cc corrections due to erroneous codes belonging to chapter 64
64ccc0 corrections due to erroneous codes belonging to chapter 64
64ccc000 corrections due to erroneous codes belonging to chapter 64

64mm trade broken down at chapter level only
64mmm0 trade broken down at chapter level only
64mmm000 trade broken down at chapter level only
64pp goods of chapter 64 carried by post
64ppp0 goods of chapter 64 carried by post
64ppp000 goods of chapter 64 carried by post
64ss confidential trade of chapter 64
64sss8 confidential trade of chapter 64 and sitc group 8
64sss851 confidential trade of chapter 64 and sitc group 851
64sss9 confidential trade of chapter 64 and sitc group 9
64sss999 confidential trade of chapter 64 and sitc group 999

Annex III Processes in leather production (from BREF)

Stage	Intermediate product	Chrome tanned leather	Vegetable tanned leather: Strap and russet Upper leather	Vegetable tanned leather: Sole leather
		Raw hides	**Raw hides**	**Raw hides**
Beam house		Soaking	Preliminary soaking Soaking	Soaking
Beam house		Liming	Liming	Liming
Beam house		Fleshing Splitting	Fleshing Splitting	Fleshing
Tanning		Deliming Bating	Deliming, Bating Washing, Dripping	Deliming Bating
Tanning		Pickling Chrome tanning	Vegetable pit Tanning	Vegetable pit Tanning
Tanning		Samming	Dripping, Washing Samming	Washing Samming
	Wet blue	Shaving	Shaving	
		Washing	Fatliquoring (drum)	Fatliquoring
		Neutralisation	Drying	Drying
Wet finishing		Washing	Retanning Dyeing Fatliquoring (drum)	
Wet finishing		Retanning Dyeing, Fatliquoring	Retanning Dyeing Fatliquoring (drum)	
Wet finishing		Washing	Samming, washing	
Wet finishing		Drying	Drying	
Dry finishing	Crust	Buffing Lacquering	Staking Buffing Toggling Ironing	Staking (Rolling)
Dry finishing		Mechanical Finishing		

Sheepskins

Raw material

Soaking
Liming
Fleshing
Washing
Pickling
Chrome(III)-tanning / Tanning
Dyeing
Drying
Degreasing
Finishing:
Buffing
Stretching
Shearing
Ironing

Annex IV Existing data sources of LCIs

The LCI data sources presented hereafter are not exhaustive and only focus on materials and processes specifically relevant to leather-made products. The websites of the different databases are user friendly; the user should consult them for more in-depth and more complete information.

PlasticsEurope

PlasticsEurope is the European Federation for plastics. It developed LCI for the following monomers, polymers, and other substances and systems:

Table 99: PlasticsEurope LCI

	LDPE bottles	Polystyrene thermoform (PS trays)
Acetone	LDPE film	Polystyrene, expandable (EPS)
Acetone cyanohydrin	LDPE resin	Polystyrene, general purpose (GPPS)
Acrylonitrile	LLDPE resin	Polystyrene, high impact (HIPS)
Acrylonitrile-Butadiene-Styrene (ABS)	Methylenediphenyl diisocyanate (MDI)	Polyurethane (PUR, PIR) flexible foam
Ammonia	Methylmethacrylate (MMA)	Polyurethane (PUR, PIR) rigid foam
Benzene	Naphtha	Polyvinylchloride, bulk (B-PVC)
Bisphenol-A	Natural gas	Polyvinylchloride, emulsion (E-PVC)
Brine	Pentane	Polyvinylchloride, suspension (S-PVC)
Butadiene (dehydrogenation)	PET bottles	Polyvinylidene chloride (PVdC)
Butenes	PET film	Propylene
Chlorine (Cl2)	PET film (packed)	Propylene (pipeline)
Crude oil	PET resin (amorphous)	PVC calendered sheet
Electricity	PET resin (bottle grade)	PVC film
Epoxy liquid resins	Phenol	PVC injection moulding
Ethylbenzene	PMMA beads	PVC pipes
Ethylene	PMMA sheet	Pyrolysis gasoline
Ethylene (pipeline)	Polyamide (PA) 6	Sodium hydroxide (NaOH)
Ethylene dichloride (EDC)	Polyamide (PA) 6.6	Steam
HDPE bottles	Polyamide 6 (glass filled)	Styrene
HDPE pipes	Polyamide 6.6 (glass filled)	Styrene-acrylonitrile (SAN)
HDPE resin	Polybutadiene	Terephthalic acid
Hydrogen (H2 electrolytic)	Polycarbonate	Toluene
Hydrogen (H2	Polypropylene (PP)	Toluene diisocyanate (TDI)

reformer)	injection moulding	
Hydrogen (cracker)	Polypropylene (PP) resin	Vinyl chloride (VCM)
Hydrogen chloride (HCl)	Polypropylene oriented (OPP) film	Xylenes
Hydrogen cyanide (HCN)		
Acrylic dispersion	Polyether polyols	Styrene-butadiene dispersion
Polyester polyols	Silicones	Vinyl acetate dispersion
Acrylic dispersion	Polyether polyols	Styrene-butadiene dispersion

More information on: http://www.plasticseurope.org/plastics-sustainability/life-cycle-thinking-1746.aspx

ELCD

ELCD is the database developed by the European Commission and it provides LCI related to:

- Plastics: the data come from PlasticsEurope (see previous section)
- Other more general datasets (electricity production, transport modes…)

More information on: http://elcd.jrc.ec.europa.eu/ELCD3/processList.xhtml

LCA Food

This database was developed by the Danish Institute of Agricultural Sciences. It provides inventories related to:

- Crops and crop based products
- Milk and milk based products
    - Vegetables
    - Meat (pig, cattle, chicken)
    - Fish

By using a proper allocation rule, the impacts of agriculture, cattle breeding, and slaughtering related to the production of hides can be evaluated.

More information on: http://www.lcafood.dk/

Ecoinvent

Ecoinvent is a very broad database and it provides LCI related to:

- Plastics: main data are similar as the ones from PlasticsEurope.
- Textiles
    - Jute
    - Kenaf
    - Cotton
    - Viscose

        - Sheep wool
    - Other more general datasets (electricity production, transport modes…)

More information on: www.ecoinvent.org

ESU

ESU-services are developers closely related to the ecoinvent. This database provides LCI related to:

- Beef
- Lamb
- Leather

More information on: http://www.esu-services.ch/

GaBi

GaBi was developed by PE international and is one of the most used LCI database. It developed lots of LCI for the ELCD database. It provides LCI related to:

- Plastics: some data come from PlasticsEurope but they developed their own as well
    - Carbon fiber
    - Natural rubber
    - Nitrile-Butadiene-Rubber (NBR)
    - Silicon Rubber
    - …
- Textiles
    - Cotton fabric
    - Flax fabric
    - Polyacrylonitrile fabric
    - Polyamid fabric
    - Polyester fabric
    - Polyethylene fabric
    - Polypropylene fabric
    - Viscose fabric
    - Finishing (dyeing, desizing, antistatic agents…)
- Seat cover leather
    - Natural leather (from cattle)
    - PUR synthetic leather
    - PVC synthetic leather
- Other more general datasets (electricity production, transport modes…)

More information on:

http://www.gabi-software.com/support/gabi/gabi-6-lci-documentation/

Annex V LCIA methods recommended by ILCD Handbook and used in additional LCA

Mid-point categories

Impact category	Acronym	Recommended LCIA method	Evaluated in specific LCA	ILCD classification	Reason for exclusion
Climate change	GWP	Baseline model of 100 years of the IPCC	Yes	I	
Ozone depletion	OD	Steady-state ODPs 1999 as in WMO assessment	Yes	I	
Human toxicity (cancer and non-cancer effects)	-	USEtox model (Rosenbaum et al, 2008)	No	II/III	Low reliability
Particulate matter/Respiratory inorganics	-	RiskPoll model (Rabl and Spadaro, 2004) and Greco et al 2007	No	I	Format issues
Ionising radiation, human health	-	Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000)	No	II	Format issues
Ionising radiation, ecosystems	-	No methods recommended	No	interim	
Photochemical ozone formation	POF	LOTOS-EUROS (Van Zelm et al, 2008) as applied in ReCiPe	Yes	II	
Acidification	A	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	Yes	II	
Eutrophication, terrestrial	TE	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	Yes	II	
Eutrophication, aquatic, freshwater	FE	EUTREND model (Struijs et al, 2009b) as implemented in ReCiPe	Yes	II	
Eutrophication, aquatic, marine	ME	EUTREND model (Struijs et al, 2009b) as implemented in ReCiPe	Yes	II	
Ecotoxicity (freshwater)	-	USEtox model, (Rosenbaum et al, 2008)	No	II/III	Low reliability
Ecotoxicity (terrestrial and marine)	-	No methods recommended	No	-	
Land use	-	Model based on Soil Organic Matter (SOM) (Milà i Canals et al, 2007b)	No	III	Format issues
Resource depletion, water	WC	Model for water consumption as in Swiss Ecoscarcity (Frischknecht et al, 2008)	Direct flow	III	Format issues
Resource depletion, fossil and renewable	RD	CML 2002 (Guinée et al., 2002)	Yes	II	

Midpoint to endpoint categories

Impact category	Recommended LCIA method	Indicator	ILCD classification
Climate change	No methods recommended		interim
Ozone depletion	No methods recommended		interim
Human toxicity (cancer effects)	DALY calculation applied to USEtox midpoint (Adapted from Huijbregts et al, 2005a)	Disability Adjusted Life Years (DALY)	II/interim
Human toxicity (non-cancer effects)	No methods recommended		interim
Particulate matter/Respiratory inorganics	DALY calculation applied to midpoint (adapted from van Zelm et al, 2008, Pope et al, 2002)	Disability Adjusted Life Years (DALY)	I/II
Ionising radiation, human health	No methods recommended		interim
Ionising radiation, ecosystems	No methods recommended		
Photochemical ozone formation	Model for damage to human health as developed for ReCiPe (Van Zelm et al, 2008)	Disability Adjusted Life Years (DALY)	II
Acidification	No methods recommended		interim
Eutrophication, terrestrial	No methods recommended		
Eutrophication, aquatic	No methods recommended		interim
Ecotoxicity (freshwater, terrestrial and marine)	No methods recommended		
Land use	No methods recommended		interim
Resource depletion, water	No methods recommended		
Resource depletion, fossil and renewable	No methods recommended		interim

Annex VI Description and documentation of all emissions factors

LCI process	Source	Use in the model
Production and manufacturing of input materials (leather, textiles, plastics, wood/cork, metals)		
Acrylonitrile-butadiene-styrene copolymer (ABS), PlasticsEurope 2005, w/o waste treatment	PlasticsEurope 2005	ABS
Steel, Foil Cold rolled coil	Worldsteel	Steel
copper, at regional storage, RER [#1074]	ecoinvent v2.2	Copper
cotton fibres, at farm, US [#6977]	ecoinvent v2.2	Cotton fibres
cotton fibres, ginned, at farm, CN [#10174]	ecoinvent v2.2	Cotton fibres
yarn production, cotton fibres, GLO [#10195]	ecoinvent v2.2	Spinning of fibres
weeving, cotton, GLO [#10196]	ecoinvent v2.2	Weeving into fabric
acrylonitrile, at plant, RER [#366]	ecoinvent v2.2	Acrylic fibres
methyl methacrylate, at plant, RER [#1806]	ecoinvent v2.2	Acrylic fibres
methyl acrylate, at plant, GLO [#7225]	ecoinvent v2.2	Acrylic fibres
vinyl acetate, at plant, RER [#1812]	ecoinvent v2.2	Acrylic fibres
polymethyl methacrylate, sheet, at plant, RER [#1833]	ecoinvent v2.2	Spinning of acrylic fibres
Polyethylene terephtalate (PET) amorphous, PlasticsEurope 2005, with waste treatment	PlasticsEurope 2005	Polyester
solvents, organic, unspecified, at plant, GLO [#443]	ecoinvent v2.2	Chemicals for tanning
chemicals inorganic, at plant, GLO [#264]	ecoinvent v2.2	Chemicals for tanning
chemicals organic, at plant, GLO [#382]	ecoinvent v2.2	Chemicals for tanning
chromium oxide, flakes, at plant, RER [#270]	ecoinvent v2.2	Chemicals for tanning
biocides, for paper production, unspecified, at plant, RER [#254]	ecoinvent v2.2	Chemicals for tanning
ammonium sulphate, as N, at regional storehouse, RER [#41]	ecoinvent v2.2	Chemicals for tanning
alkylbenzene sulfonate, linear, petrochemical, at plant, RER [#1998]	ecoinvent v2.2	Chemicals for tanning
fatty acids, from vegetarian oil, at plant, RER [#405]	ecoinvent v2.2	Chemicals for tanning
sodium sulphate, powder, production mix, at plant, RER [#343]	ecoinvent v2.2	Chemicals for tanning
pigments, paper production, unspecified, at plant, RER [#314]	ecoinvent v2.2	Chemicals for tanning
acrylic binder, 34% in H2O, at plant, RER [#1666]	ecoinvent v2.2	Chemicals for tanning
fatty alcohol, petrochemical, at plant, RER [#409]	ecoinvent v2.2	Chemicals for tanning
tap water, at user, CH [#5739]	ecoinvent v2.2	Water consumption for tanning
treatment, sewage, from residence, to wastewater treatment, class 2, CH [#2274]	ecoinvent v2.2	Wastewater treatment for tanning

LCI process	Source	Use in the model
Polyurethane rigid foam, PlasticsEurope 2005, with waste treatment	PlasticsEurope 2005	Polyurethane (rigid)
Polyurethane flexible foam, PlasticsEurope 2005, with waste treatment	PlasticsEurope 2005	Polyurethane (flexible)
latex, at plant, RER [#414]	ecoinvent v2.2	Latex for soles
Natural rubber	GaBi	Natural rubber
PVC imitation leather (1 square meter)	GaBi	PVC imitation leather
PUR imitation leather (1 square meter)	GaBi	PUR imitation leather
ethylene vinyl acetate copolymer, at plant, RER [#1818]	ecoinvent v2.2	EVA
cork slab, at plant, RER [#992]	ecoinvent v2.2	Cork
sawn timber, hardwood, raw, air dried, u=20%, at plant, RER [#2502]	ecoinvent v2.2	Wood
polyester resin, unsaturated, at plant, RER [#1674]	ecoinvent v2.2	Polyester
Aluminium primary	EAA	Aluminium
High density polyethylene (HDPE), PlasticsEurope 2005, w/o waste treatment	PlasticsEurope 2005	PE
injection moulding, RER [#1853]	ecoinvent v2.2	Manufacturing process for plastic moulding by injection method
extrusion, plastic film, RER [#1850]	ecoinvent v2.2	Manufacturing process for plastic extrusion
packaging film, LDPE, at plant, RER [#1854]	ecoinvent v2.2	Production of LDPE plastic film for packaging
packaging, corrugated board, mixed fibre, single wall, at plant, RER [#1698]	ecoinvent v2.2	Production and manufacturing of corrugated board box
End of life		
disposal, packaging paper, 13.7% water, to sanitary landfill, CH [#2226]	ecoinvent v2.2	Landfilling of paper
disposal, packaging paper, 13.7% water, to municipal incineration, CH [#2106]	ecoinvent v2.2	Incineration of paper
disposal, polyethylene terephtalate, 0.2% water, to sanitary landfill, CH [#2231]	ecoinvent v2.2	Landfilling of PET
disposal, polystyrene, 0.2% water, to sanitary landfill, CH [#2234]	ecoinvent v2.2	Landfilling of polystyrene and other plastics
disposal, steel, 0% water, to inert material landfill, CH [#2082]	ecoinvent v2.2	Landfilling of steel
disposal, inert material, 0% water, to sanitary landfill, CH [#2221]	ecoinvent v2.2	Landfilling of other inert materials
copper, secondary, from electronic and electric scrap recycling, at refinery, SE [#8140]	ecoinvent v2.2	Benefits of copper recycling
Steel scrap benefits	Wordsteel	Benefits of steel recycling
Aluminium recycling	EAA	Benefits of aluminium recycling
Transport		

LCI process	Source	Use in the model
Truck, Articulated 50t-60t, urban, 87 l/100km, 100 % Euro 3, slope : 0%.	COPERT IV	Transport by lorry for distribution, and material supply
Truck, Articulated 40t-50t, urban, 71 l/100km, 100 % Euro 3, slope : 0%.	COPERT IV	Transport by lorry for distribution, and material supply
Truck, Articulated 40t-50t, urban, 66 l/100km, 100 % Euro 4, slope : 0%.	COPERT IV	Transport by lorry for distribution, and material supply
Truck, Articulated 50t-60t, urban, 81 l/100km, 100 % Euro 4, slope : 0%.	COPERT IV	Transport by lorry for distribution, and material supply
Truck, Articulated 40t-50t, urban, 67 l/100km, 100 % Euro 5, slope : 0%.	COPERT IV	Transport by lorry for distribution, and material supply
Truck, Articulated 50t-60t, urban, 83 l/100km, 100 % Euro 5, slope : 0%.	COPERT IV	Transport by lorry for distribution, and material supply
transport, transoceanic freight ship, OCE [#1968]	ecoinvent v2.2	Transport by container ship for distribution
transport, aircraft, freight, intercontinental, RER [#1894]	ecoinvent v2.2	Transport by airplane for distribution
Manufacturing		
electricity, medium voltage, at grid, CN [#6681]	ecoinvent v2.2	Consumption of electricity at footwear, leather, and textiles manufacturing
electricity, medium voltage, production UCTE, at grid, UCTE [#664]	ecoinvent v2.2	Consumption of electricity at footwear, leather, and textiles manufacturing. Energy recovery at end of life.
hard coal, burned in industrial furnace 1-10MW, RER [#848]	ecoinvent v2.2	Consumption of heat at footwear, leather, and textiles manufacturing. Energy recovery at end of life.
heat, light fuel oil, at boiler 100kW, non-modulating, CH [#1584]	ecoinvent v2.2	Consumption of heat at footwear, leather, and textiles manufacturing. Energy recovery at end of life.
heat, natural gas, at industrial furnace low-NOx >100kW, RER [#1352]	ecoinvent v2.2	Consumption of heat at footwear, leather, and textiles manufacturing. Energy recovery at end of life.
acetone, liquid, at plant, RER [#363]	ecoinvent v2.2	Solvents
methyl ethyl ketone, at plant, RER [#424]	ecoinvent v2.2	Solvents
toluene, liquid, at plant, RER [#451]	ecoinvent v2.2	Solvents
ethylene vinyl acetate copolymer, at plant, RER [#1818]	ecoinvent v2.2	Glues
polyurethane, flexible foam, at plant, RER [#1838]	ecoinvent v2.2	Glues

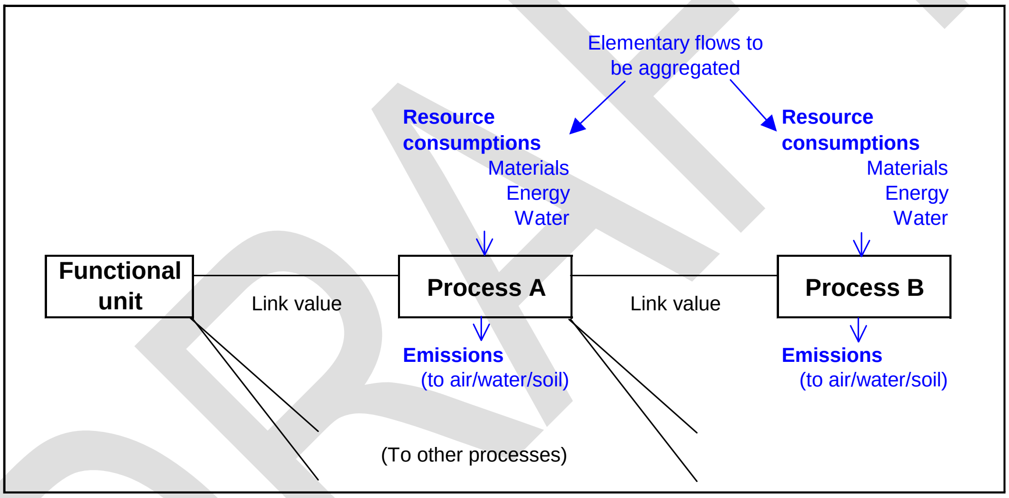
Annex VII Software: RangeLCA

RangeLCA modeling

The software *RangeLCA*, developed by RDC Environment, is used to model the studied functional unit via a process tree, conceived to make it possible to model different systems and to distinguish between the impacts of the different phases of the life cycle. Each process of the process tree is characterized by a unit of output (example: 1 kg of product) and by elementary flows associated with this unit of output, as shown in Figure 63.

Processes are linked directly to the functional unit or to other processes through a formula that expresses the number of process outputs required by the functional unit. It can be a number, a statistical distribution or mathematical operations. In practice, there can be many intermediate processes between process A and the process B terminating this branch of the process tree. Emission factors are mainly from ecoinvent database.

Figure 63: Scheme of the elementary processes and of the process tree



RangeLCA approach

The software *RangeLCA* makes it possible to obtain highly reliable and credible LCA results. The basic concept is that results must represent the diversity of individual cases (rather than a typical case with its few alternative scenarios).

From a mathematical point of view, this concept leads to the use of random variables, rather than fixed "typical values". A range of different values (for which calculations are made with a sufficient number of iterations) are used to produce statistically relevant results.

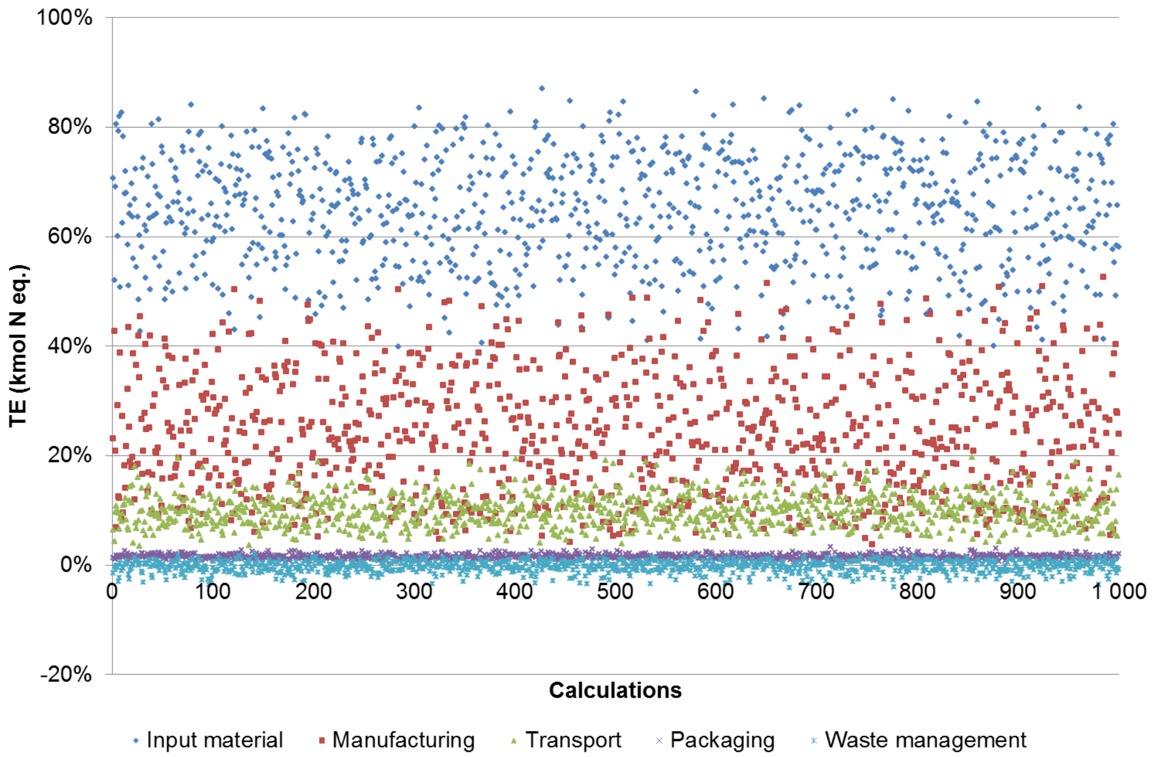
For each parameter for which data vary widely, all values between their extreme values are considered, attributing a certain probability of occurrence and appropriate probability distribution to each value. The results obtained through this method not only provide a wide range of possible combinations for the variability of the different parameters and data, but also the synergetic effects and potential compensations.

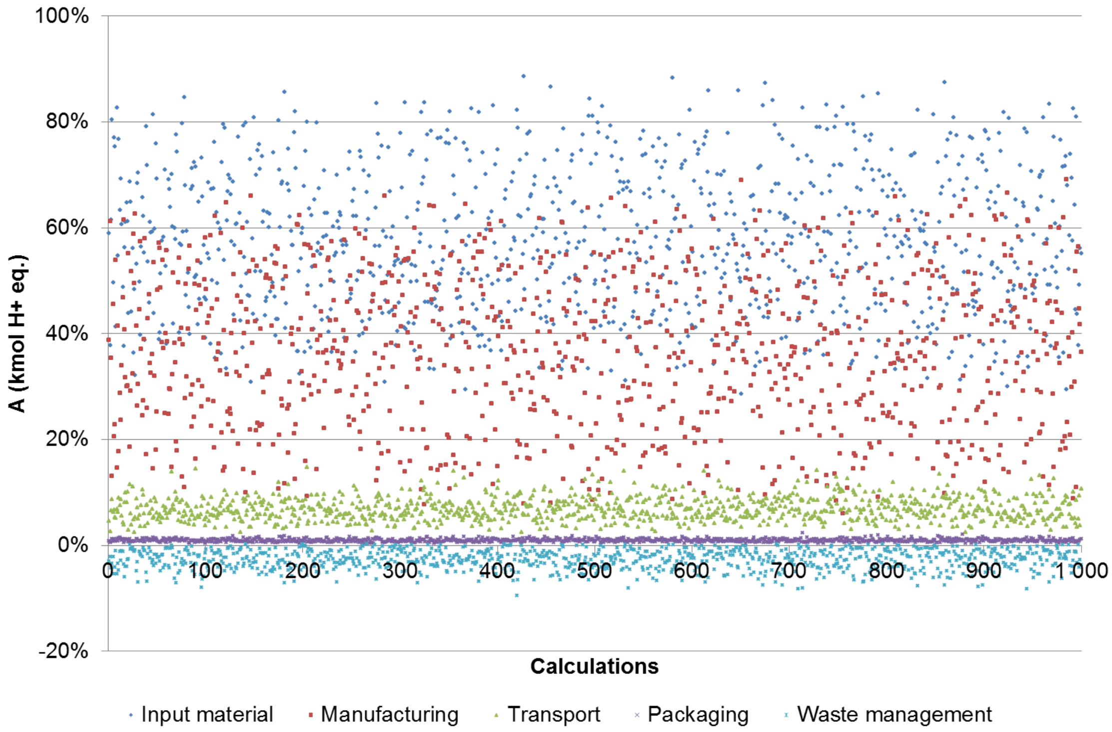
Classification of the results according to the value of a parameter makes it possible to identify the sensitivity of the results according to this parameter. In practice, it is possible to determine the parameters for which the results are most sensitive. The software makes it possible to determine the sensitivity of the different results as a function of each variable parameter in the model.

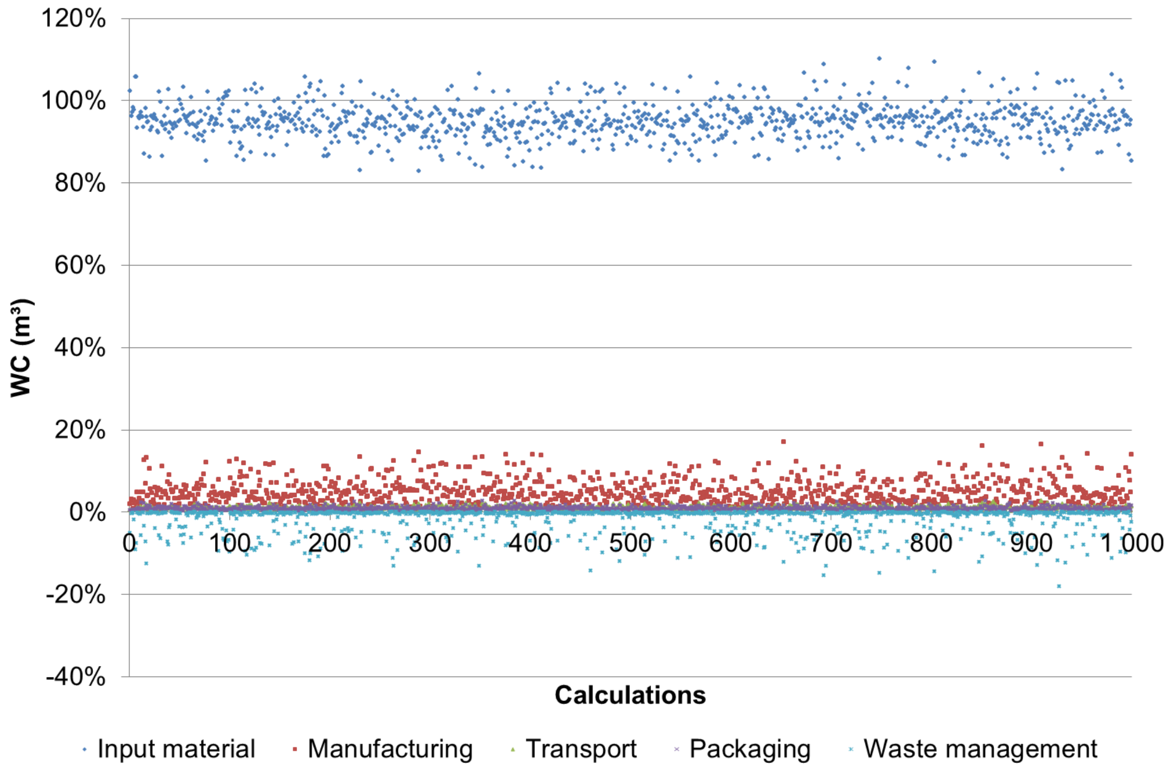
Carrying out a data inventory, this software can automatically calculate the contributions to the different elementary flows (emissions in air, water, soil, etc.). Also, the total impacts can be derived for each process. This makes it possible to focus the research on the key hypotheses and data.

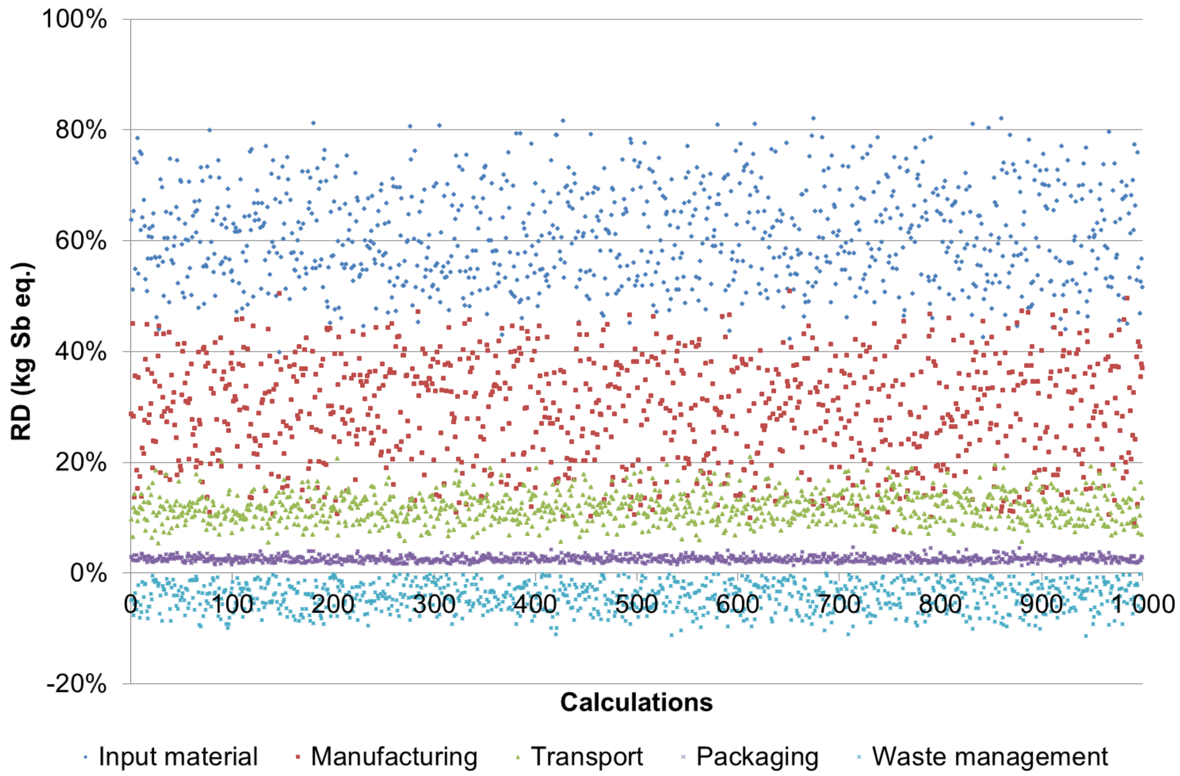
Annex VIII Results of specific LCA

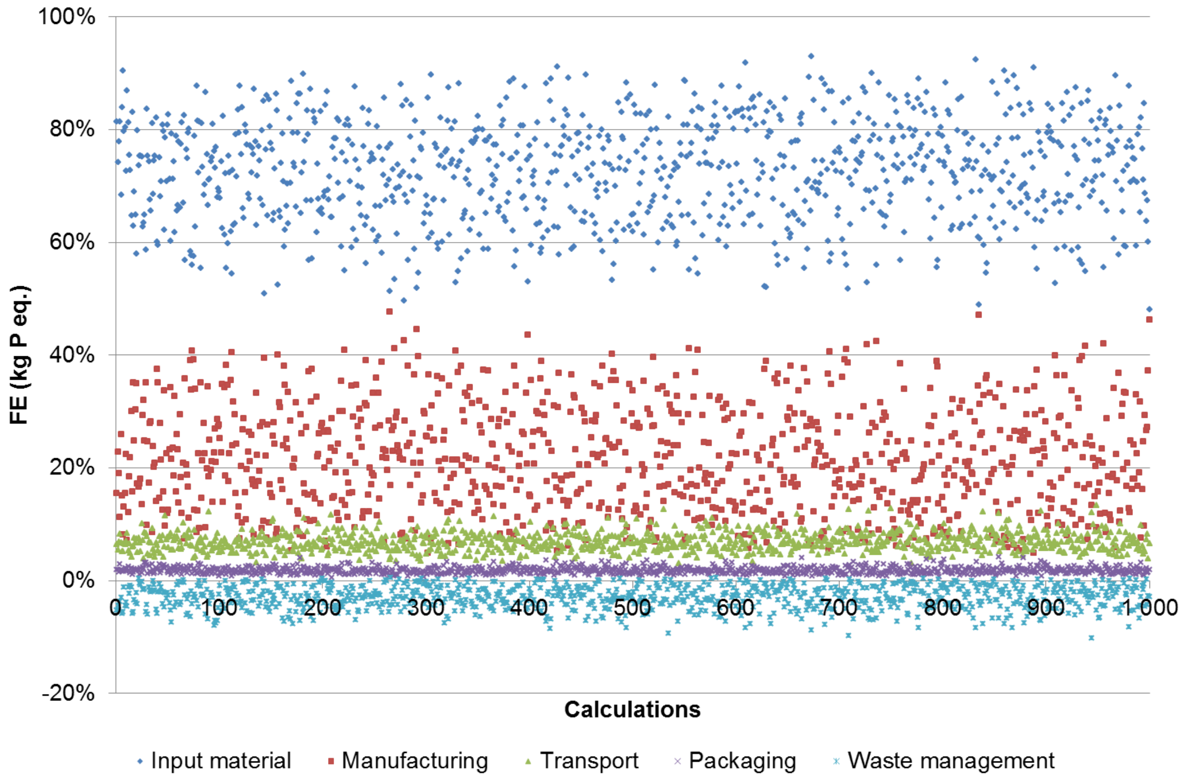
Distribution of phases

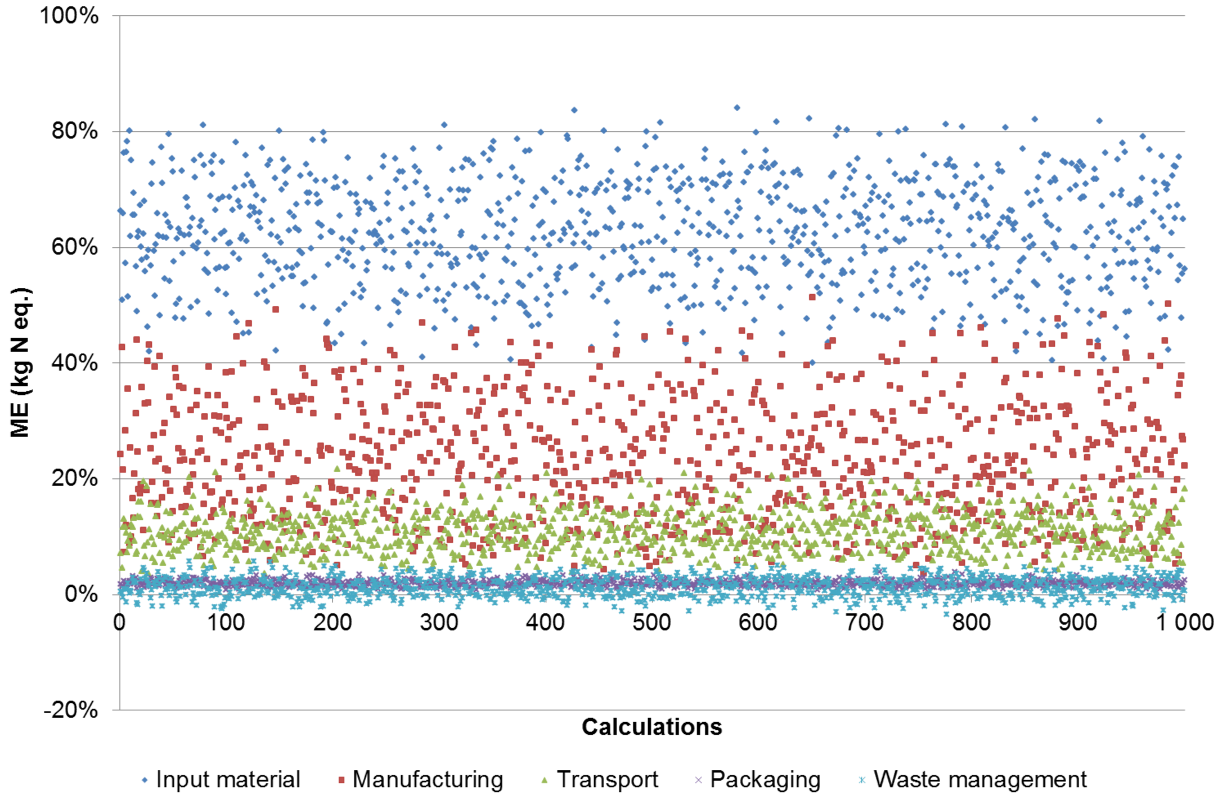




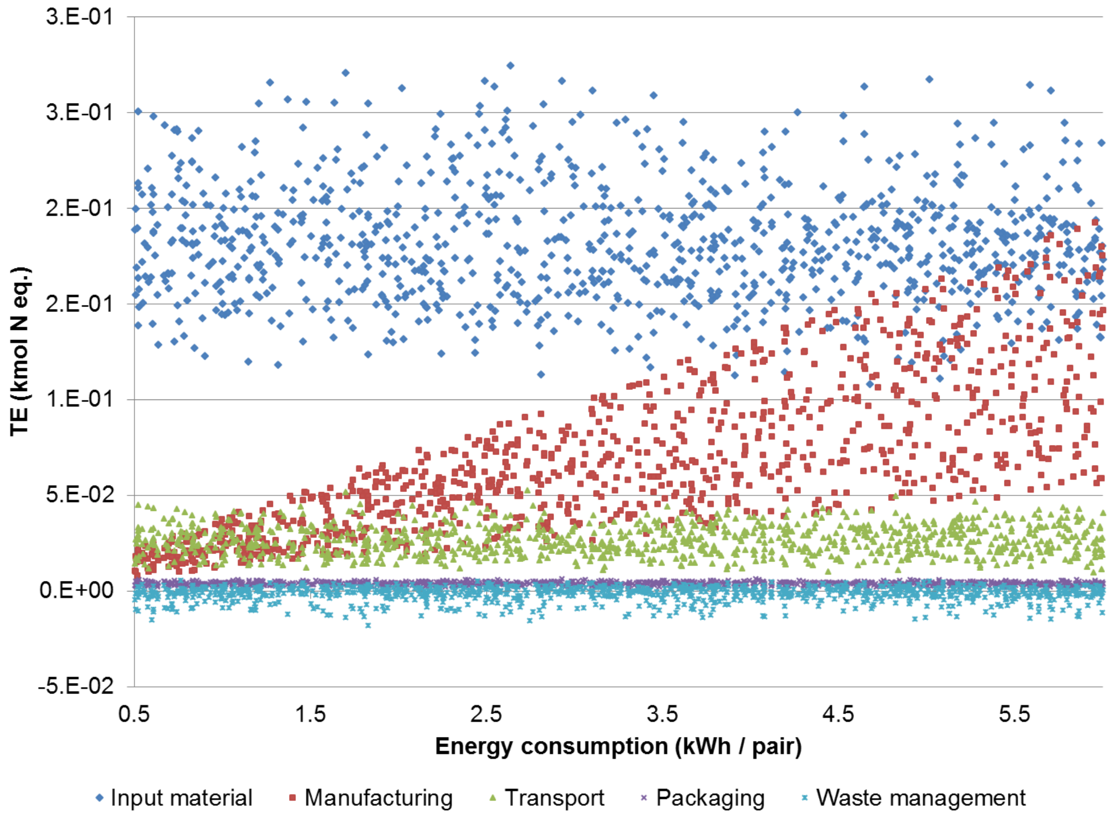

120%
100%
80%
60%
40%
20%
0%
-20%
-40%
WC (m³)
0
100
200
300
400
500
600
700
800
900
1 000
Calculations
Input material
Manufacturing
Transport
Packaging
Waste management

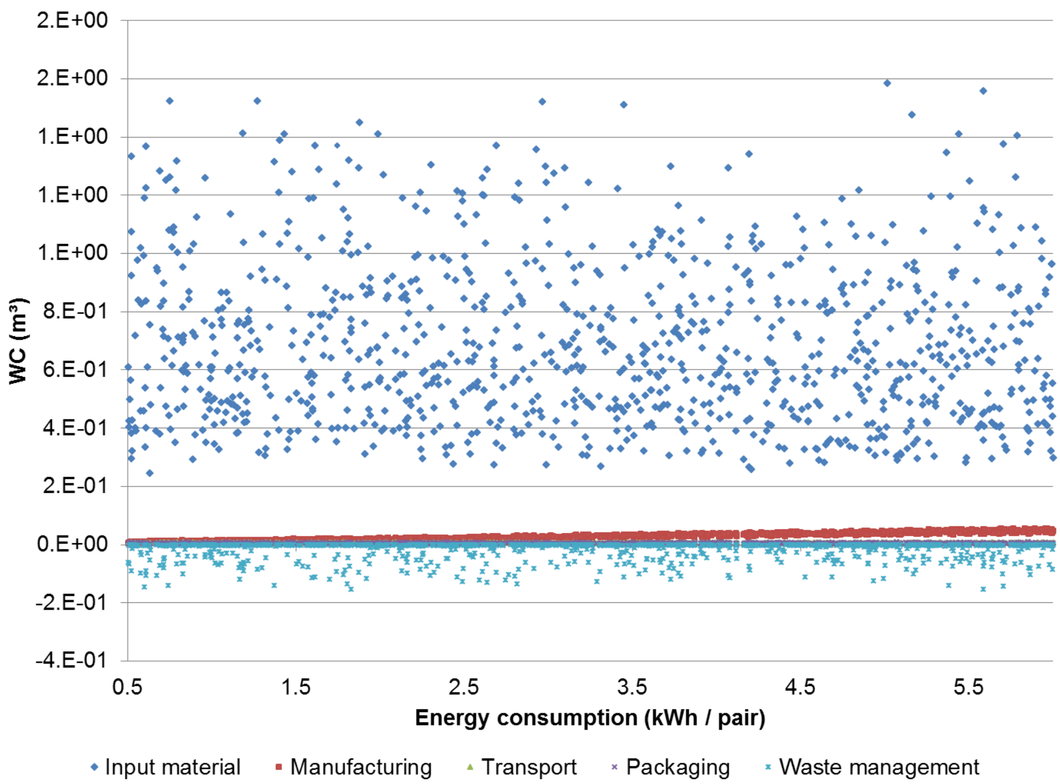

100%
80%
60%
40%
20%
0%
-20%
RD (kg Sb eq.)
0
100
200
300
400
500
600
700
800
900
1 000
Calculations
Input material
Manufacturing
Transport
Packaging
Waste management

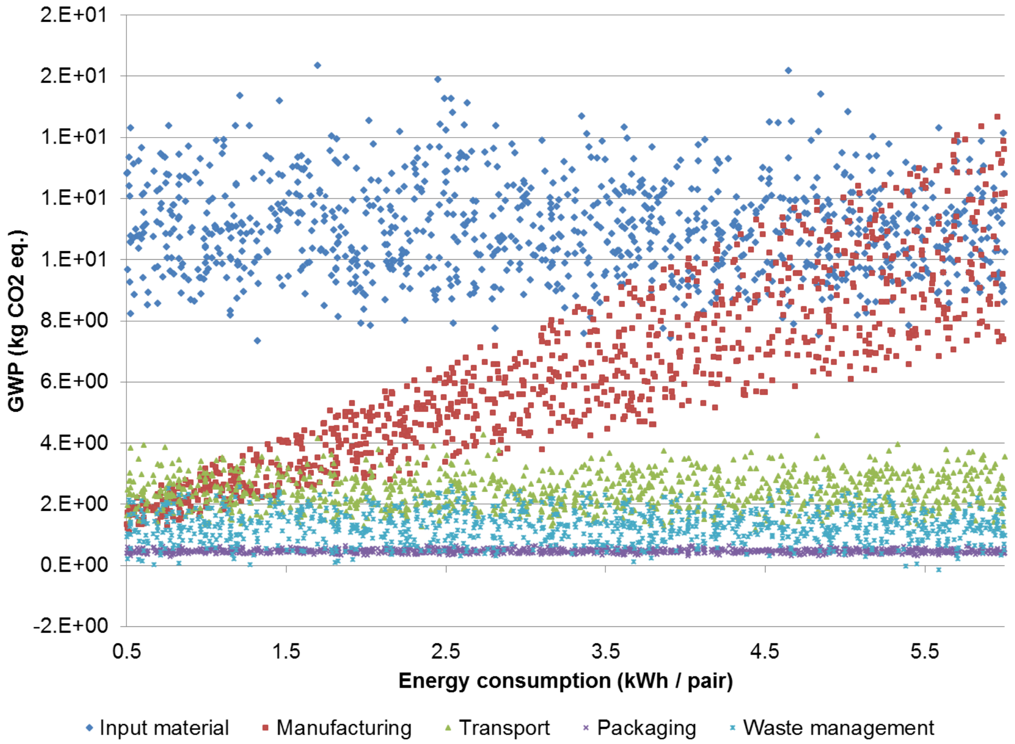


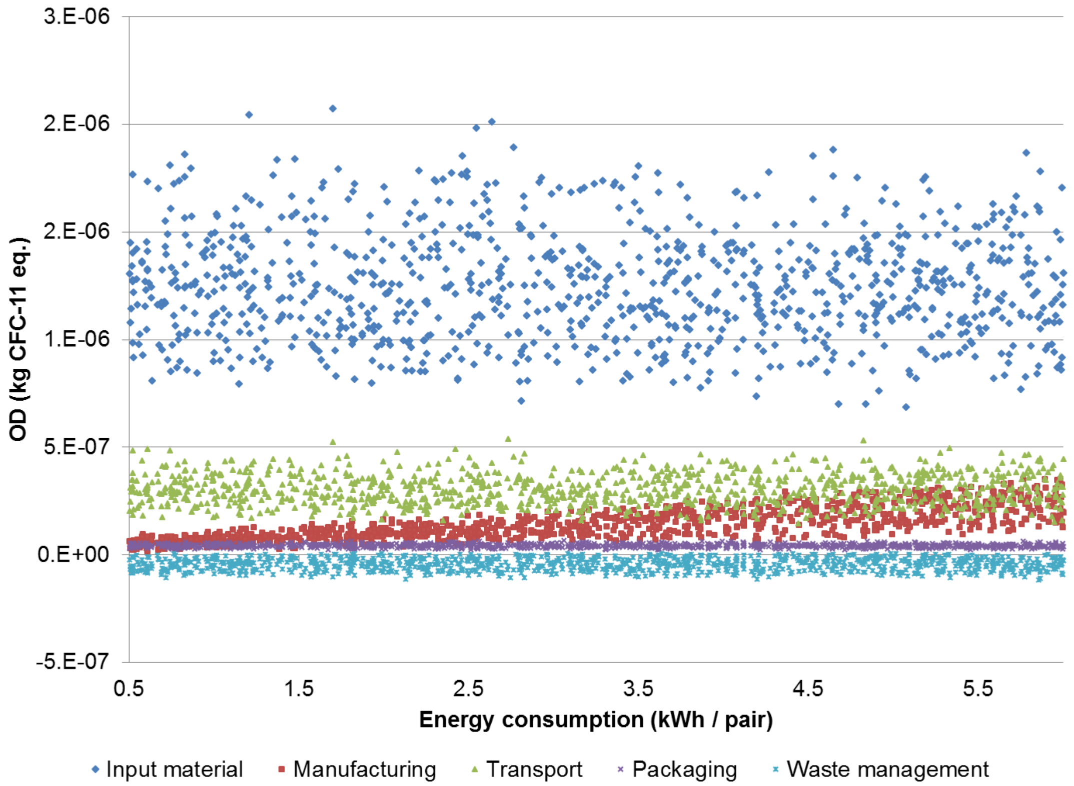


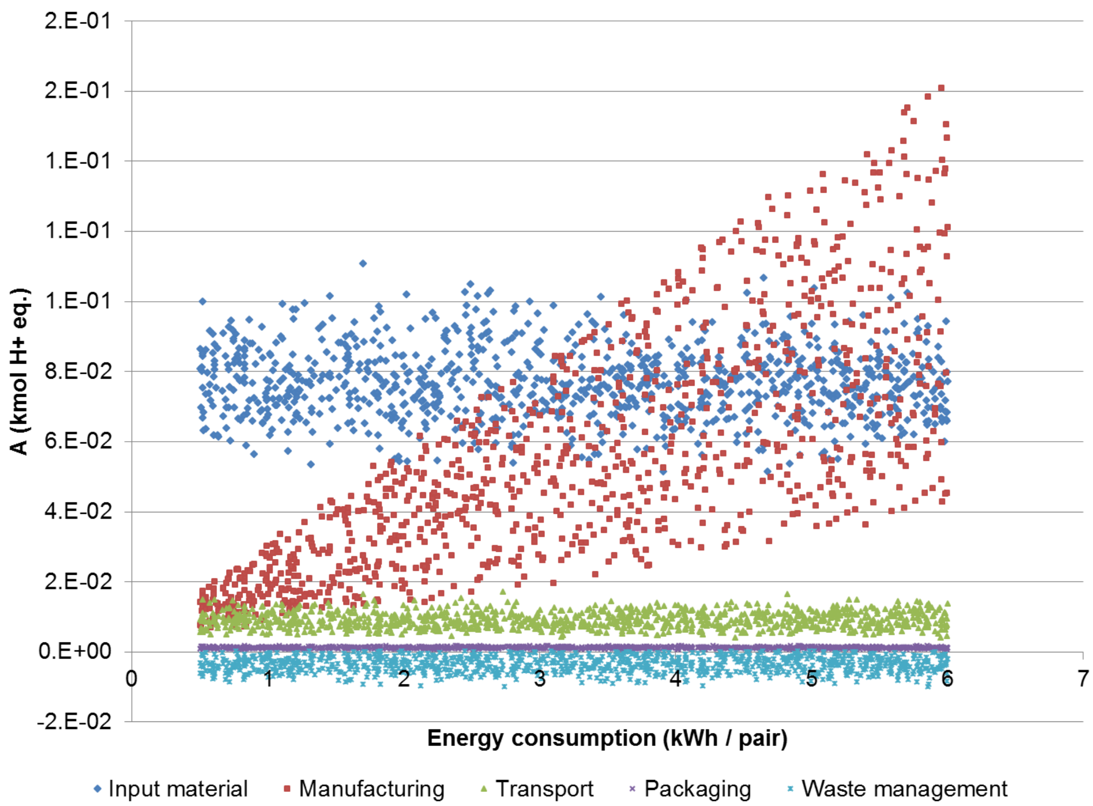
Sensitivity analysis – Energy consumption

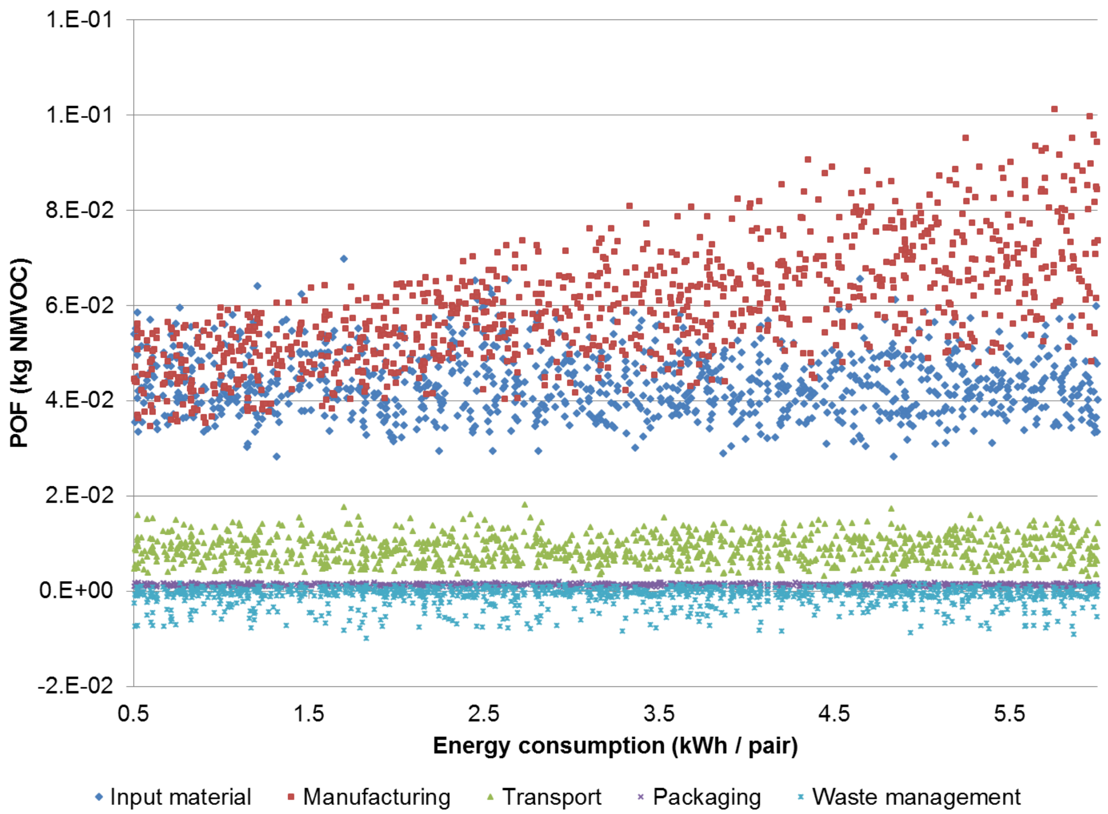

3.E-01
3.E-01
2.E-01
2.E-01
1.E-01
5.E-02
0.E+00
-5.E-02
TE (kmol N eq.)
0.5
1.5
2.5
3.5
4.5
5.5
Energy consumption (kWh / pair)
Input material
Manufacturing
Transport
Packaging
Waste management

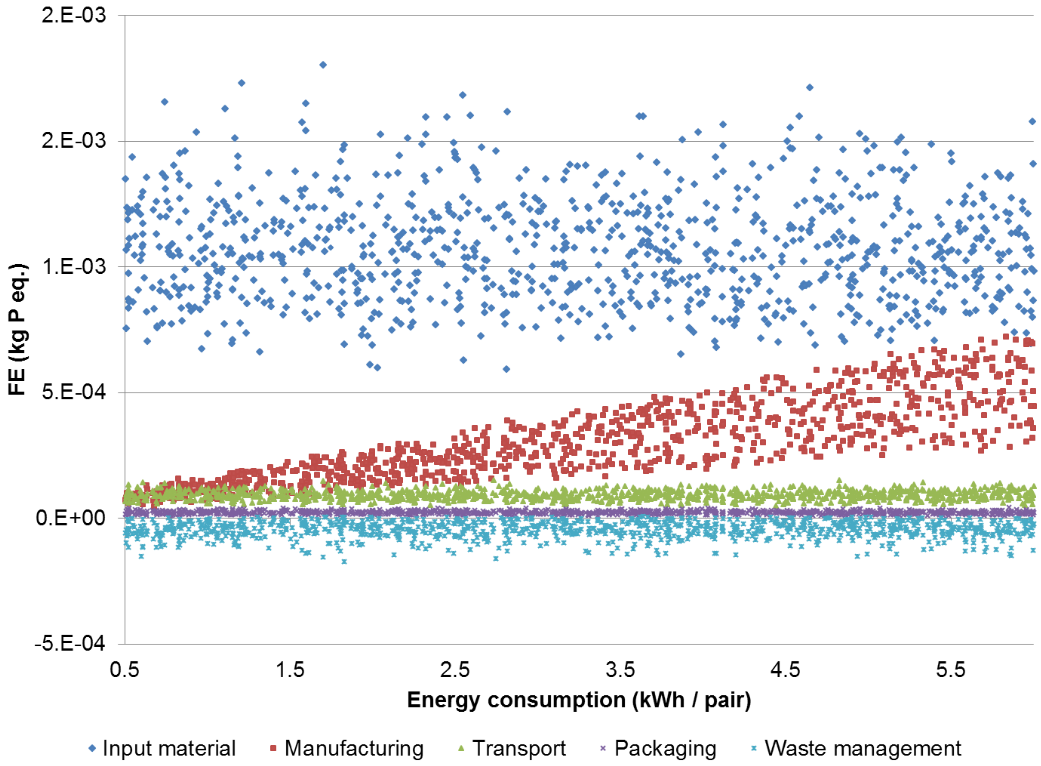

2.E+00
2.E+00
1.E+00
1.E+00
1.E+00
8.E-01
6.E-01
4.E-01
2.E-01
0.E+00
-2.E-01
-4.E-01
WC (m³)
0.5
1.5
2.5
3.5
4.5
5.5
Energy consumption (kWh / pair)
Input material
Manufacturing
Transport
Packaging
Waste management

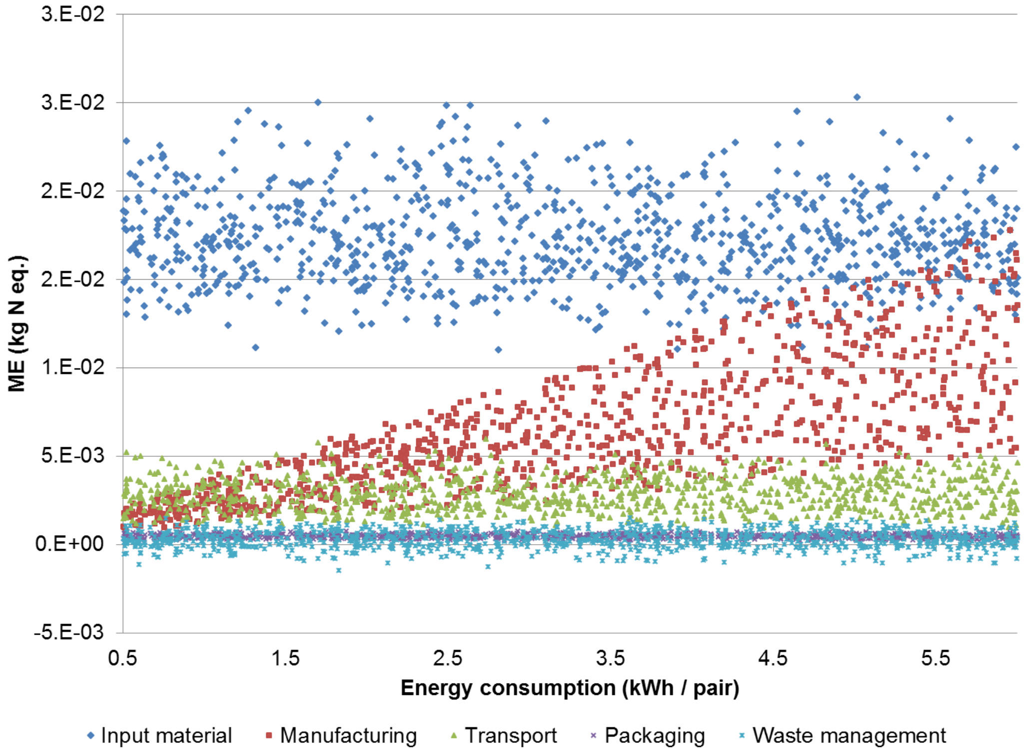

2.E+01
2.E+01
1.E+01
1.E+01
1.E+01
8.E+00
6.E+00
4.E+00
2.E+00
0.E+00
-2.E+00
0.5
1.5
2.5
3.5
4.5
5.5
GWP (kg CO2 eq.)
Energy consumption (kWh / pair)
Input material
Manufacturing
Transport
Packaging
Waste management

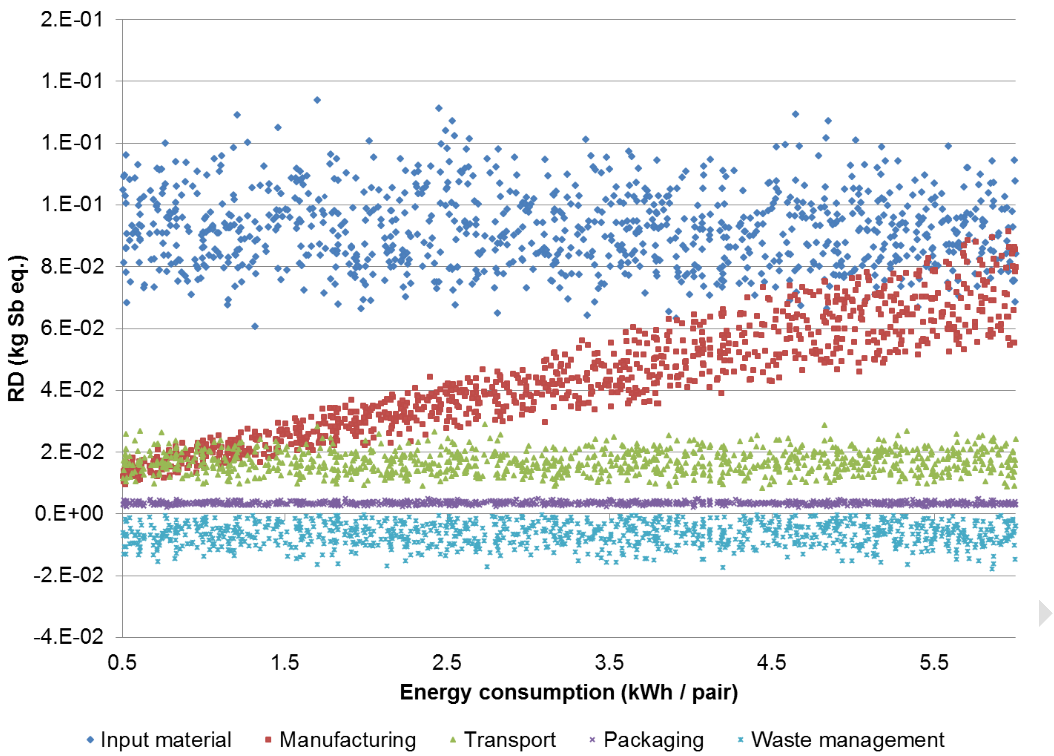

3.E-06
2.E-06
2.E-06
1.E-06
5.E-07
0.E+00
-5.E-07
0.5
1.5
2.5
3.5
4.5
5.5
OD (kg CFC-11 eq.)
Energy consumption (kWh / pair)
Input material
Manufacturing
Transport
Packaging
Waste management


A (kmol H+ eq.)
2.E-01
2.E-01
1.E-01
1.E-01
1.E-01
8.E-02
6.E-02
4.E-02
2.E-02
0.E+00
-2.E-02
0
1
2
3
4
5
6
7
Energy consumption (kWh / pair)
Input material
Manufacturing
Transport
Packaging
Waste management

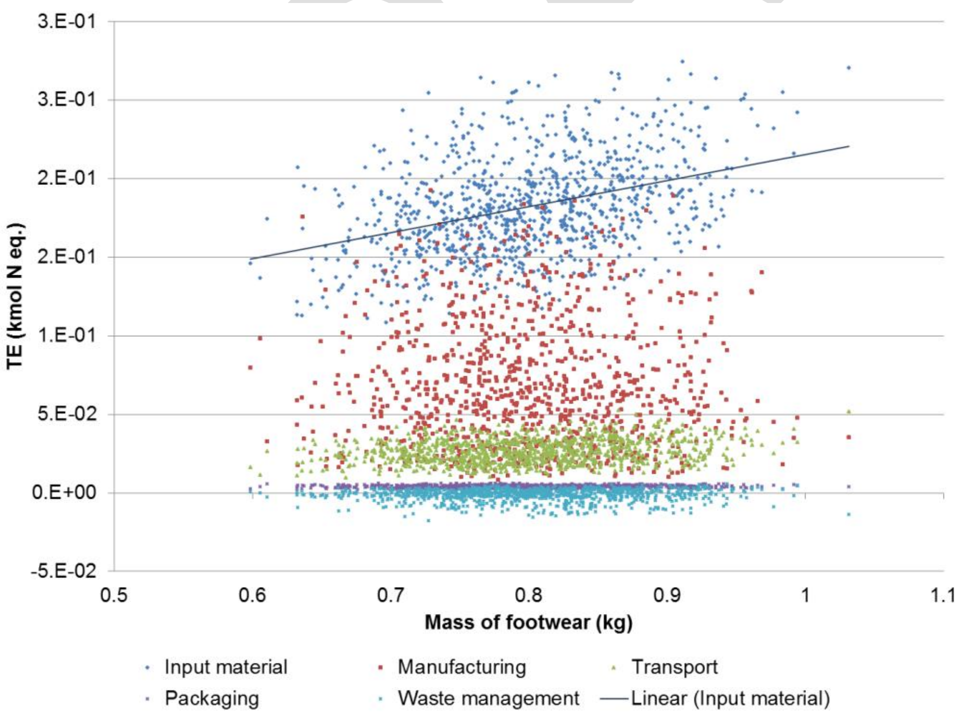

POF (kg NMVOC)
1.E-01
1.E-01
8.E-02
6.E-02
4.E-02
2.E-02
0.E+00
-2.E-02
0.5
1.5
2.5
3.5
4.5
5.5
Energy consumption (kWh / pair)
Input material
Manufacturing
Transport
Packaging
Waste management

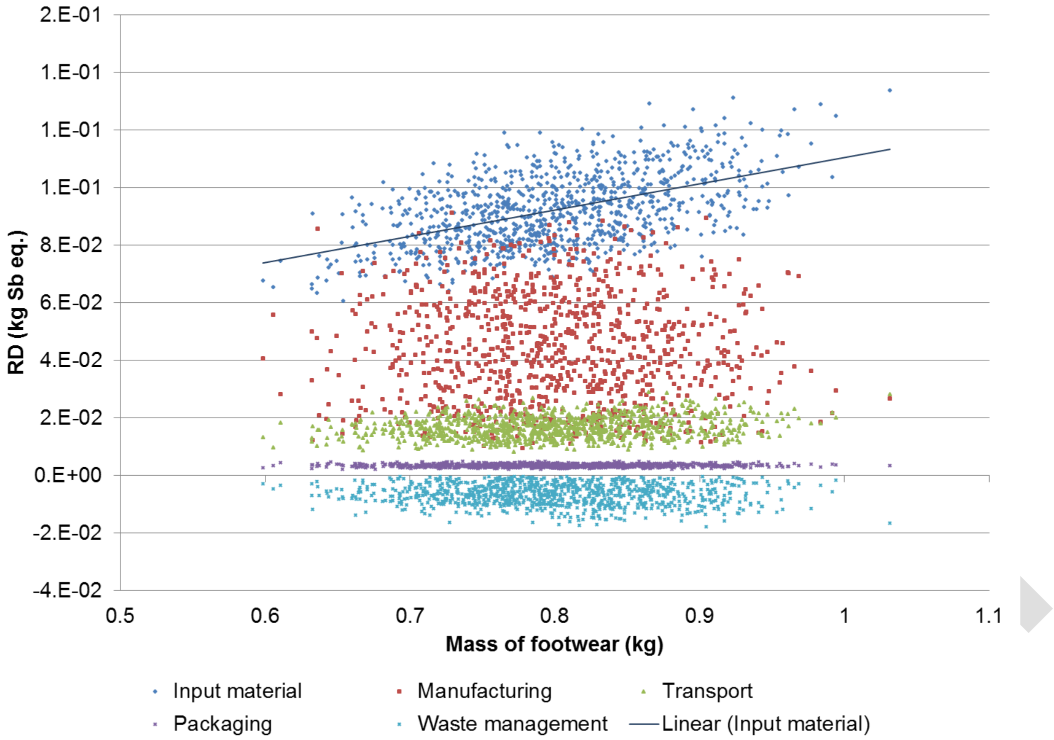

2.E-03
2.E-03
1.E-03
5.E-04
0.E+00
-5.E-04
FE (kg P eq.)
0.5
1.5
2.5
3.5
4.5
5.5
Energy consumption (kWh / pair)
Input material
Manufacturing
Transport
Packaging
Waste management

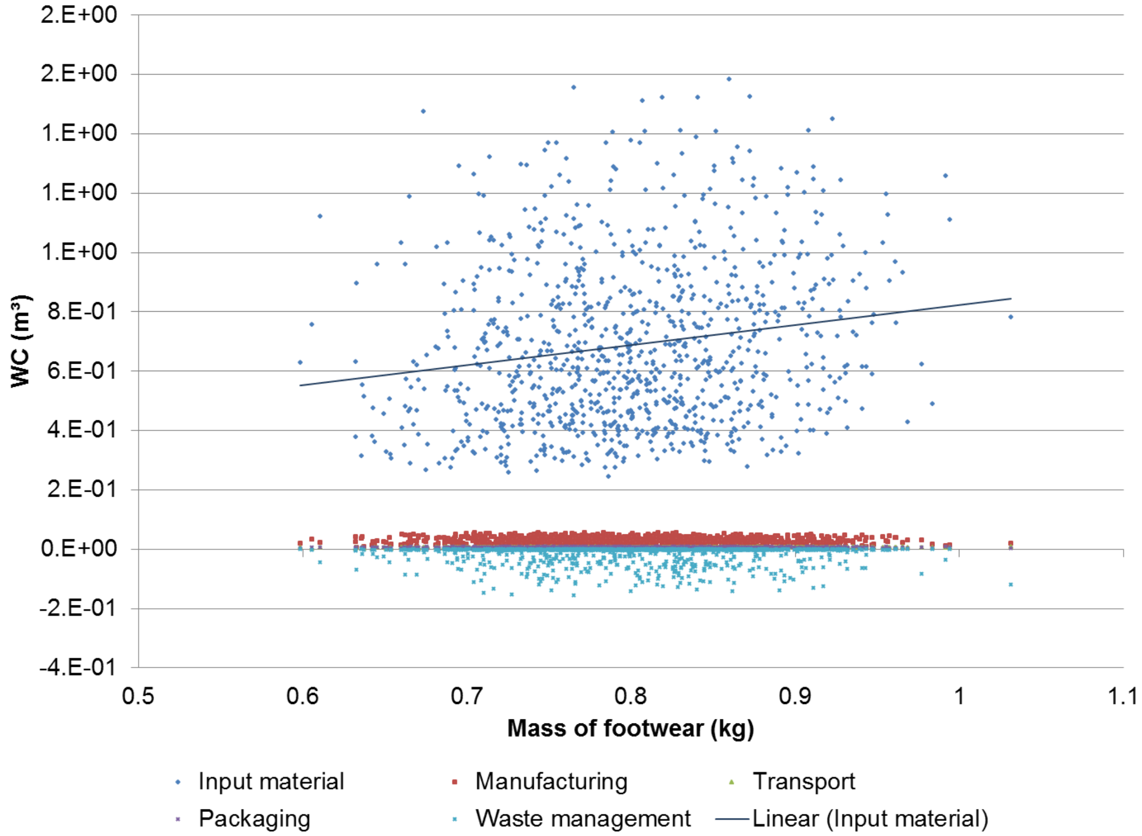

3.E-02
3.E-02
2.E-02
2.E-02
1.E-02
5.E-03
0.E+00
-5.E-03
ME (kg N eq.)
0.5
1.5
2.5
3.5
4.5
5.5
Energy consumption (kWh / pair)
Input material
Manufacturing
Transport
Packaging
Waste management

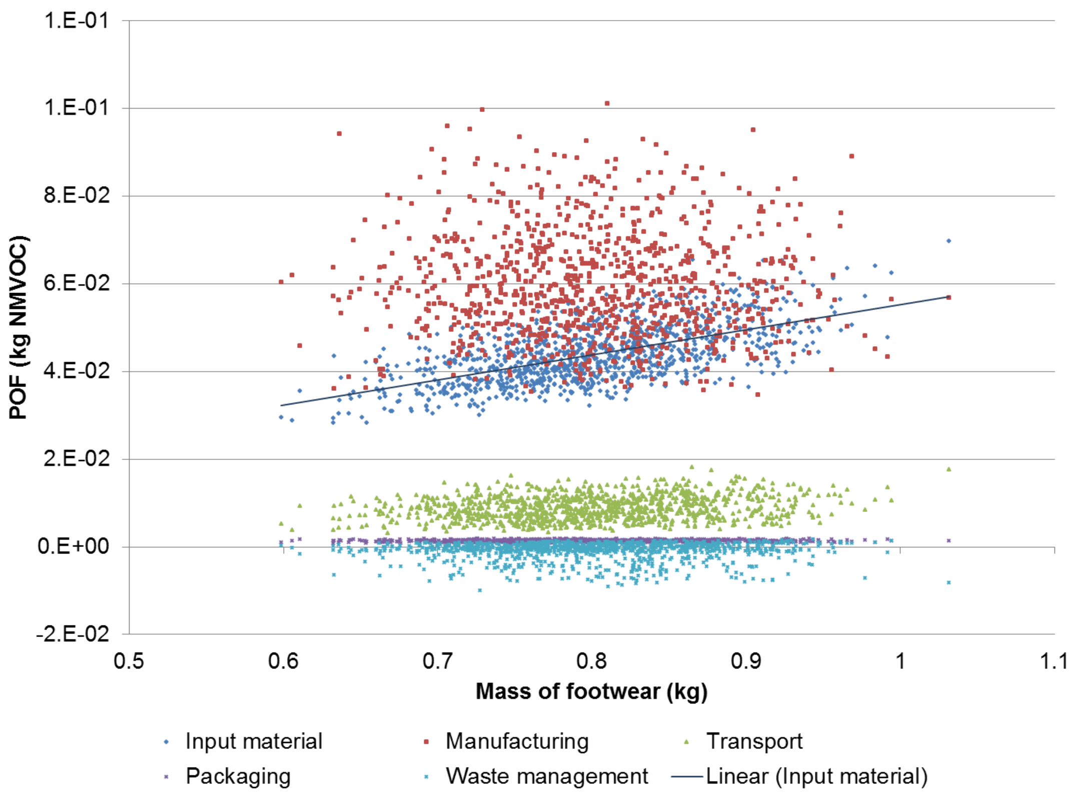


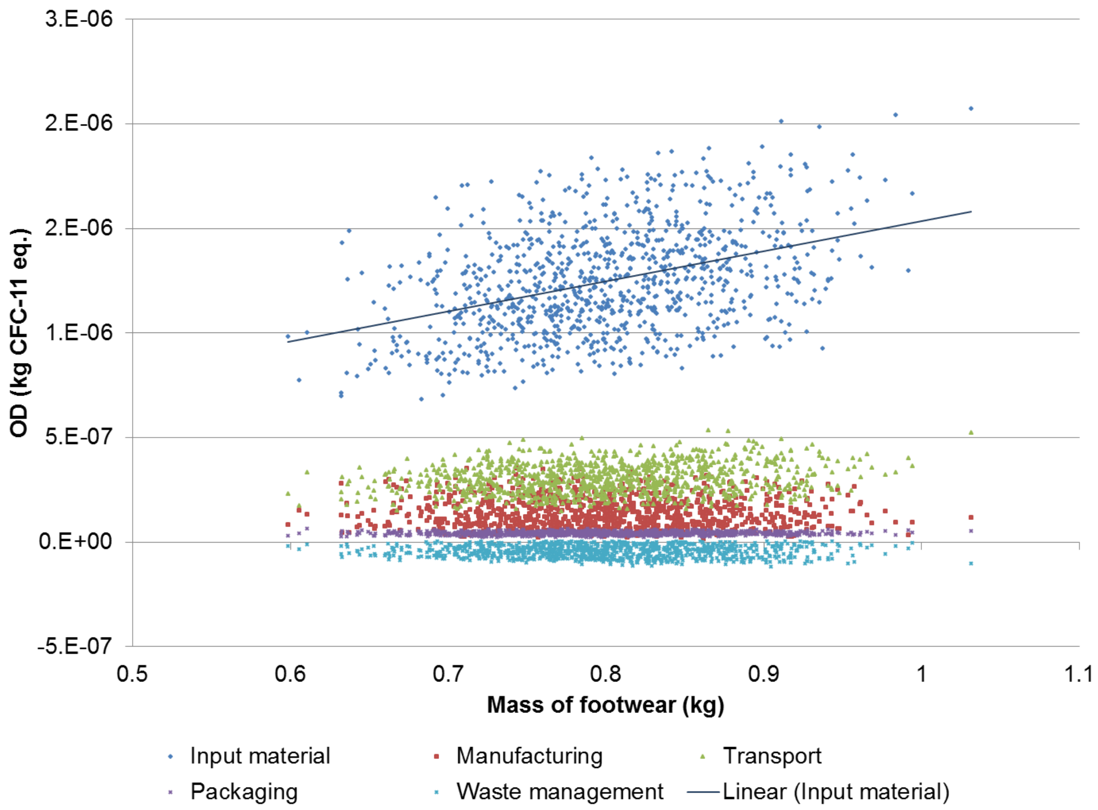
Sensitivity analysis – Mass of footwear and choice of input materials

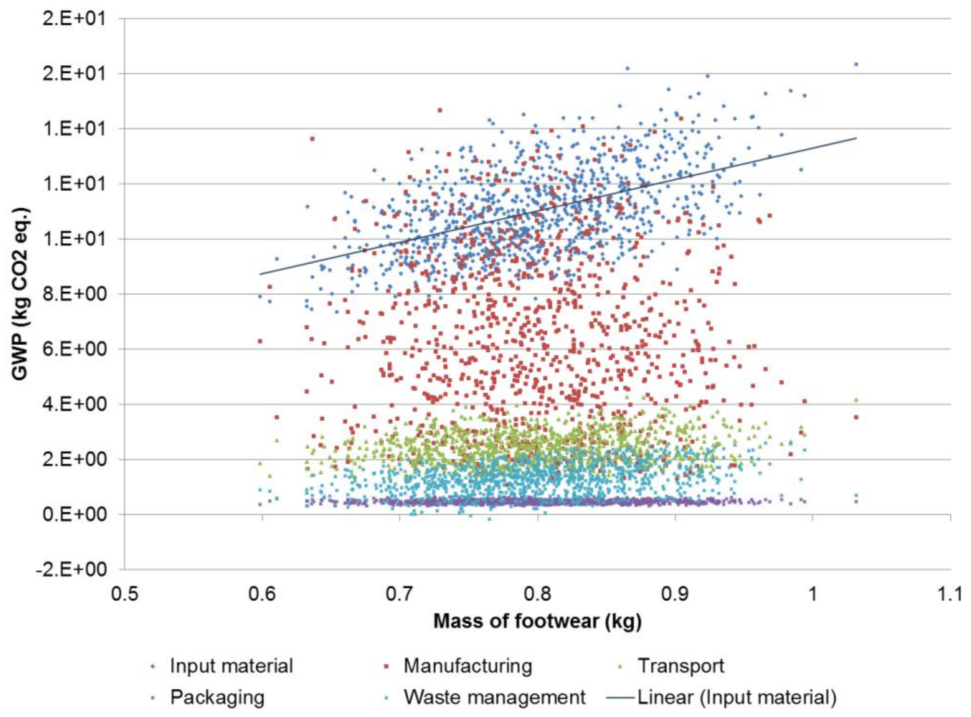



2.E-01
1.E-01
1.E-01
1.E-01
8.E-02
6.E-02
4.E-02
2.E-02
0.E+00
-2.E-02
-4.E-02
RD (kg Sb eq.)
0.5
0.6
0.7
0.8
0.9
1
1.1
Mass of footwear (kg)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Input material)

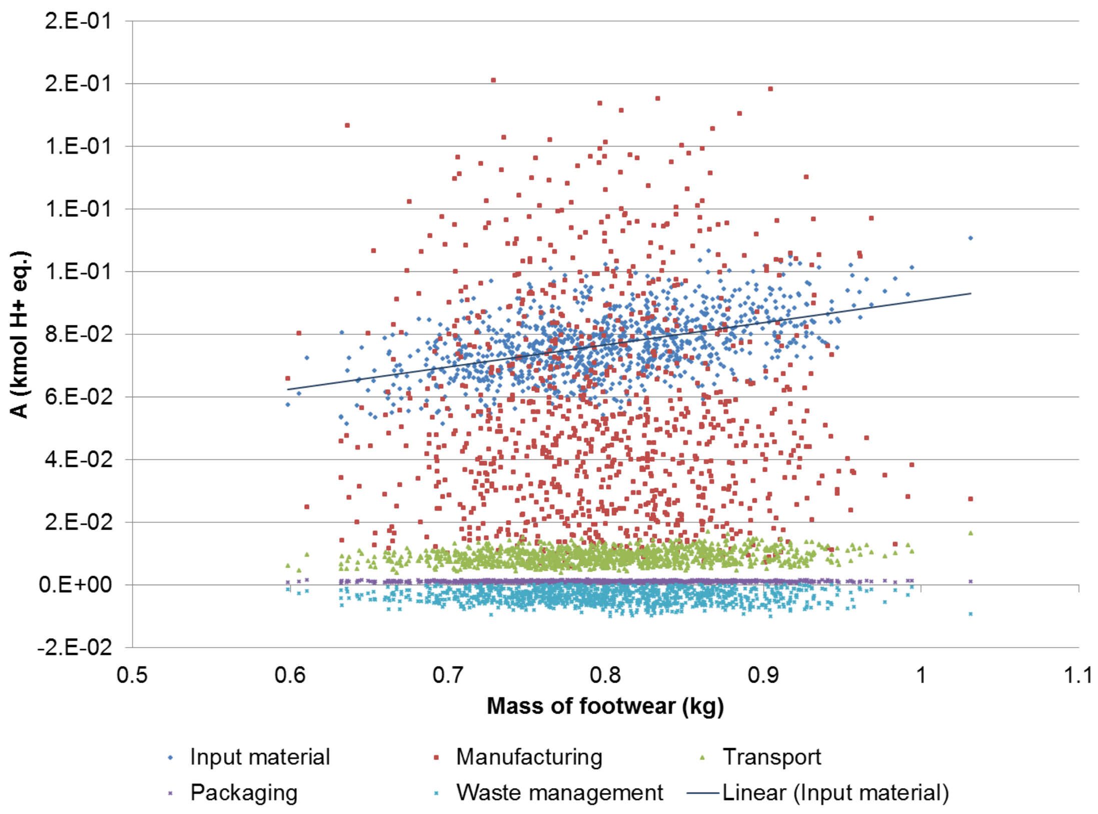

2.E+00
2.E+00
1.E+00
1.E+00
1.E+00
8.E-01
6.E-01
4.E-01
2.E-01
0.E+00
-2.E-01
-4.E-01
WC (m³)
0.5
0.6
0.7
0.8
0.9
1
1.1
Mass of footwear (kg)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Input material)


1.E-01
1.E-01
8.E-02
6.E-02
4.E-02
2.E-02
0.E+00
-2.E-02
POF (kg NMVOC)
0.5
0.6
0.7
0.8
0.9
1
1.1
Mass of footwear (kg)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Input material)

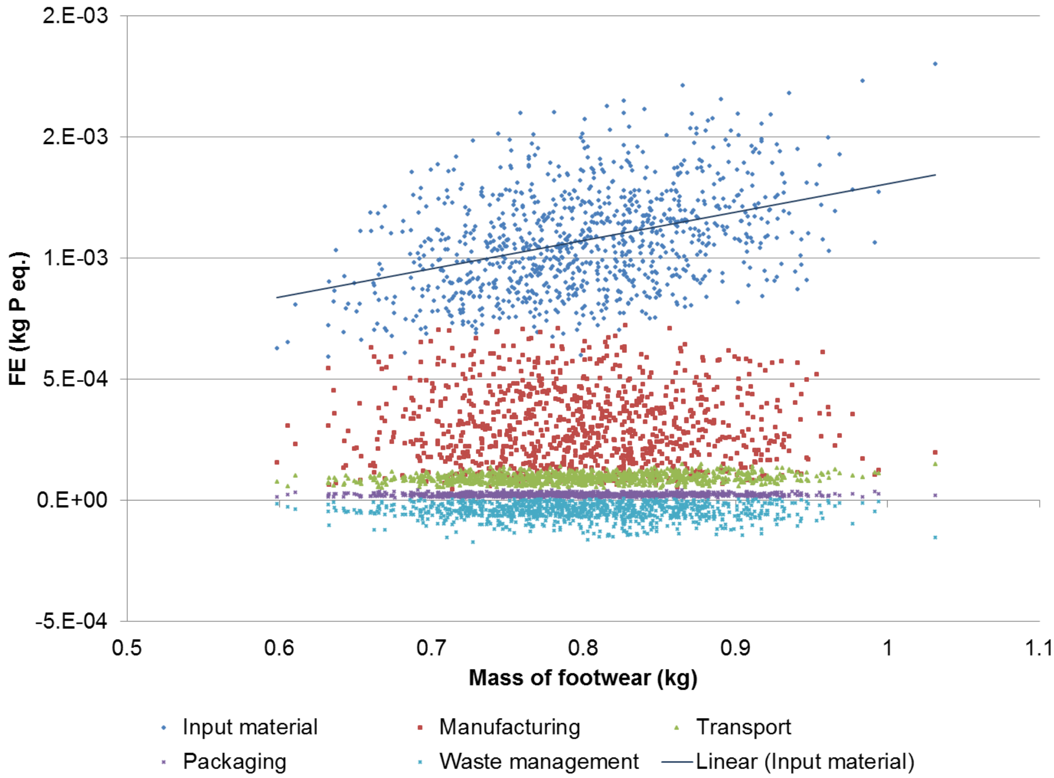

3.E-06
2.E-06
2.E-06
1.E-06
5.E-07
0.E+00
-5.E-07
OD (kg CFC-11 eq.)
0.5
0.6
0.7
0.8
0.9
1
1.1
Mass of footwear (kg)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Input material)

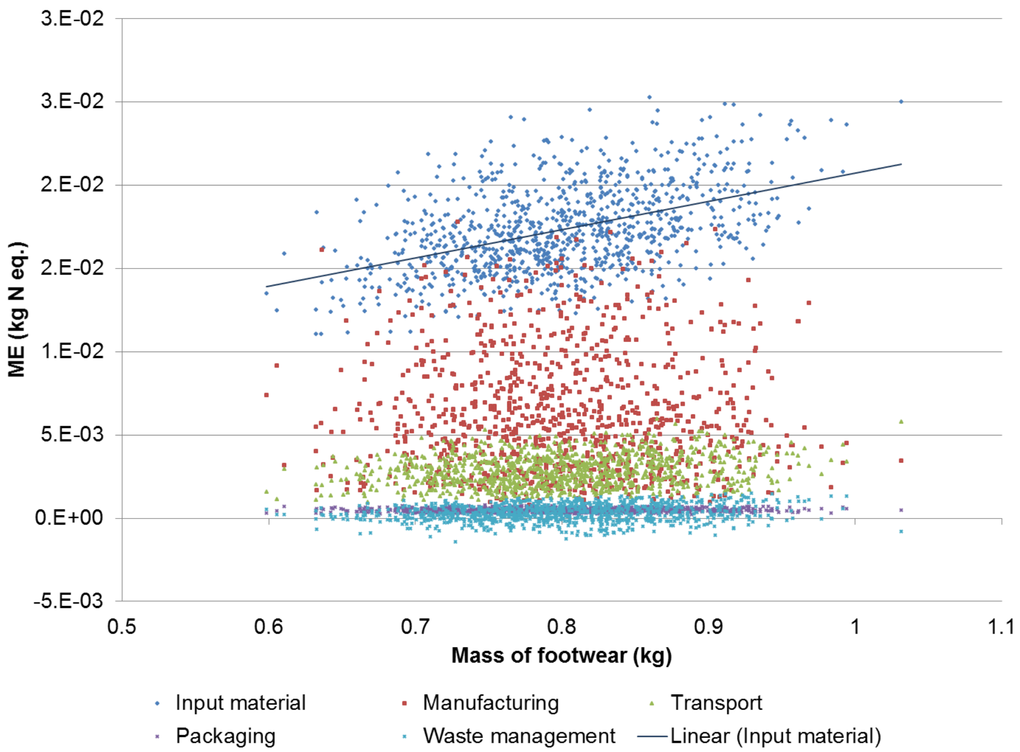


2.E+01
2.E+01
1.E+01
1.E+01
1.E+01
8.E+00
6.E+00
4.E+00
2.E+00
0.E+00
-2.E+00
GWP (kg CO2 eq.)
0.5
0.6
0.7
0.8
0.9
1
1.1
Mass of footwear (kg)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Input material)

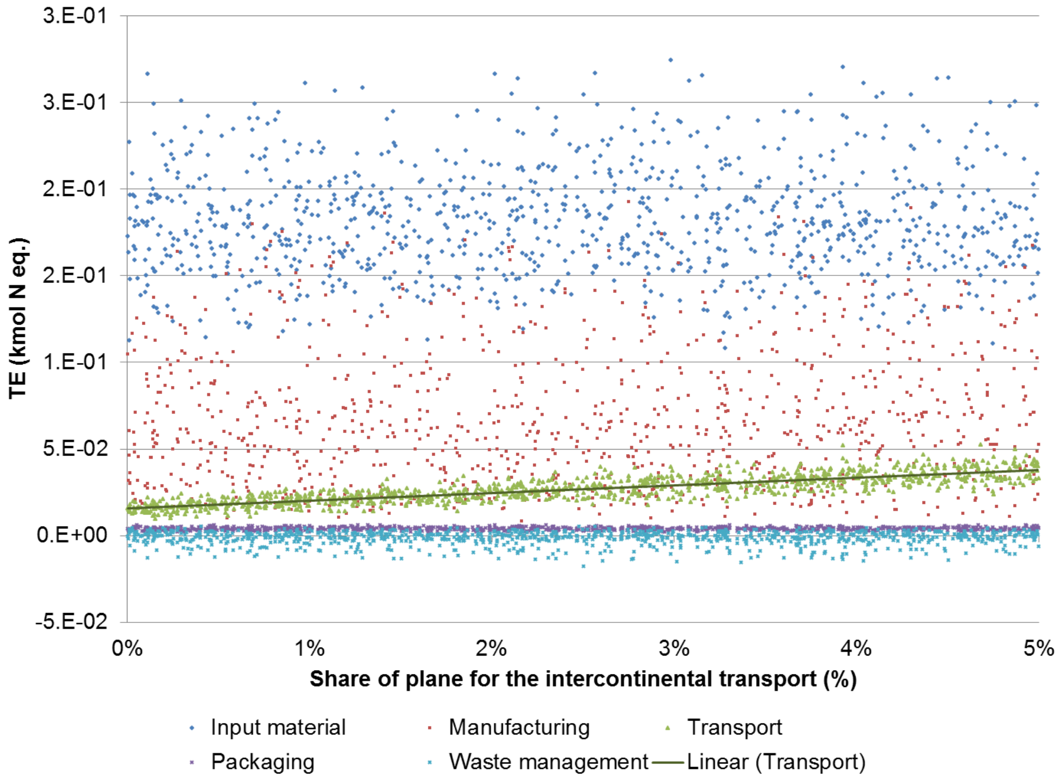


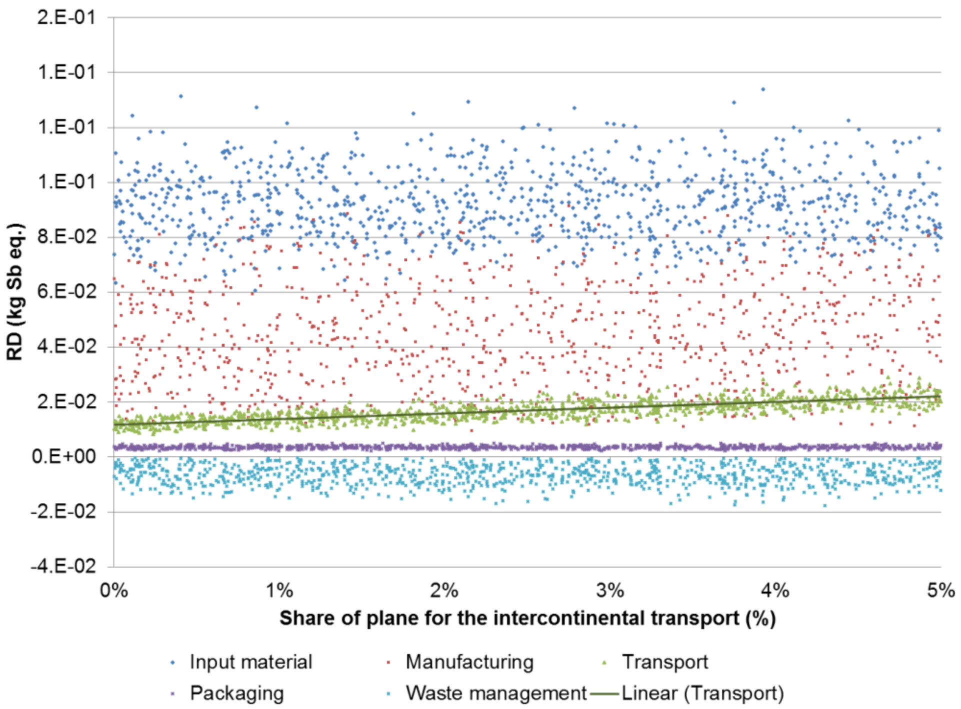
2.E-01
2.E-01
1.E-01
1.E-01
1.E-01
8.E-02
6.E-02
4.E-02
2.E-02
0.E+00
-2.E-02
A (kmol H+ eq.)
0.5
0.6
0.7
0.8
0.9
1
1.1
Mass of footwear (kg)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Input material)

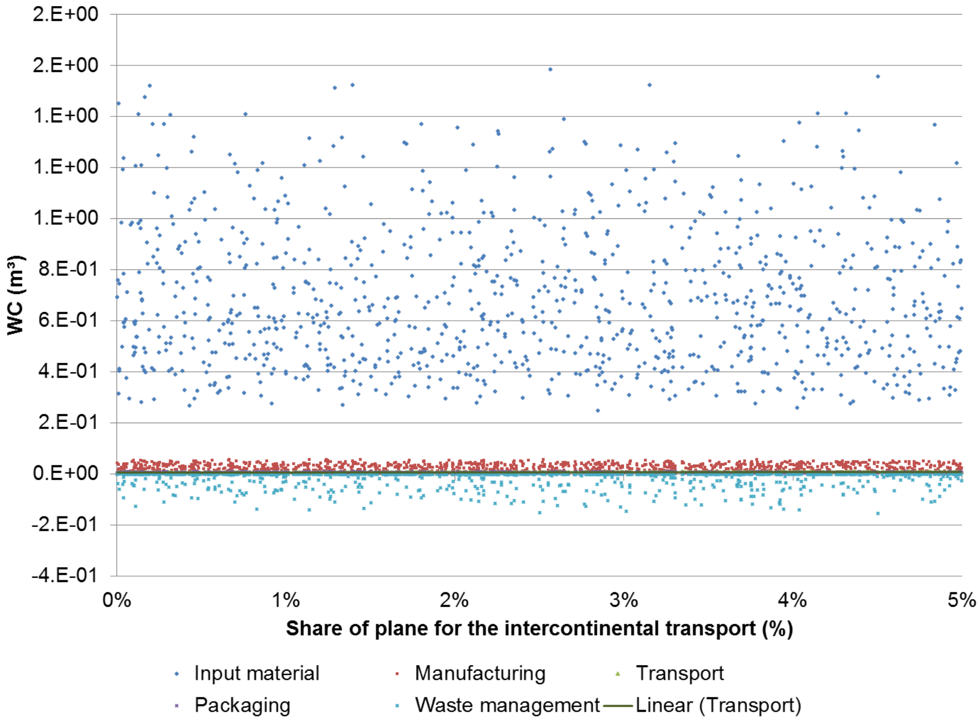




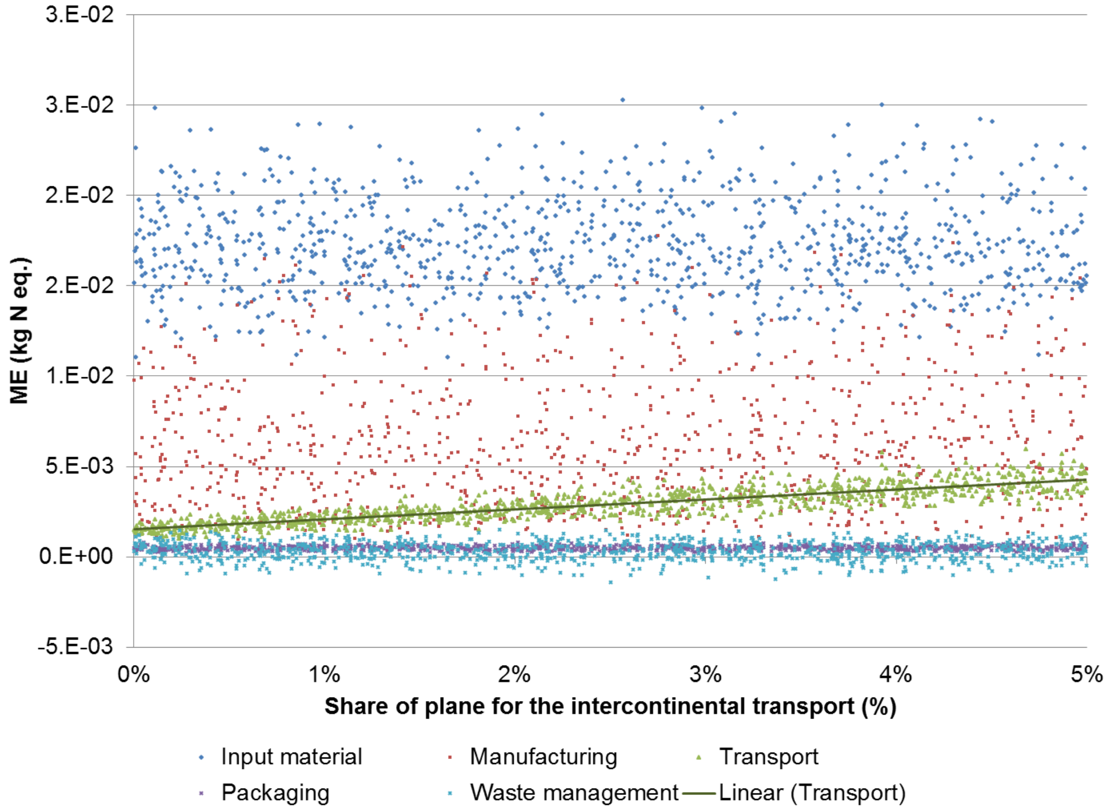
Sensitivity analysis – Airplane


3.E-01
3.E-01
2.E-01
2.E-01
1.E-01
5.E-02
0.E+00
-5.E-02
TE (kmol N eq.)
0%
1%
2%
3%
4%
5%
Share of plane for the intercontinental transport (%)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Transport)

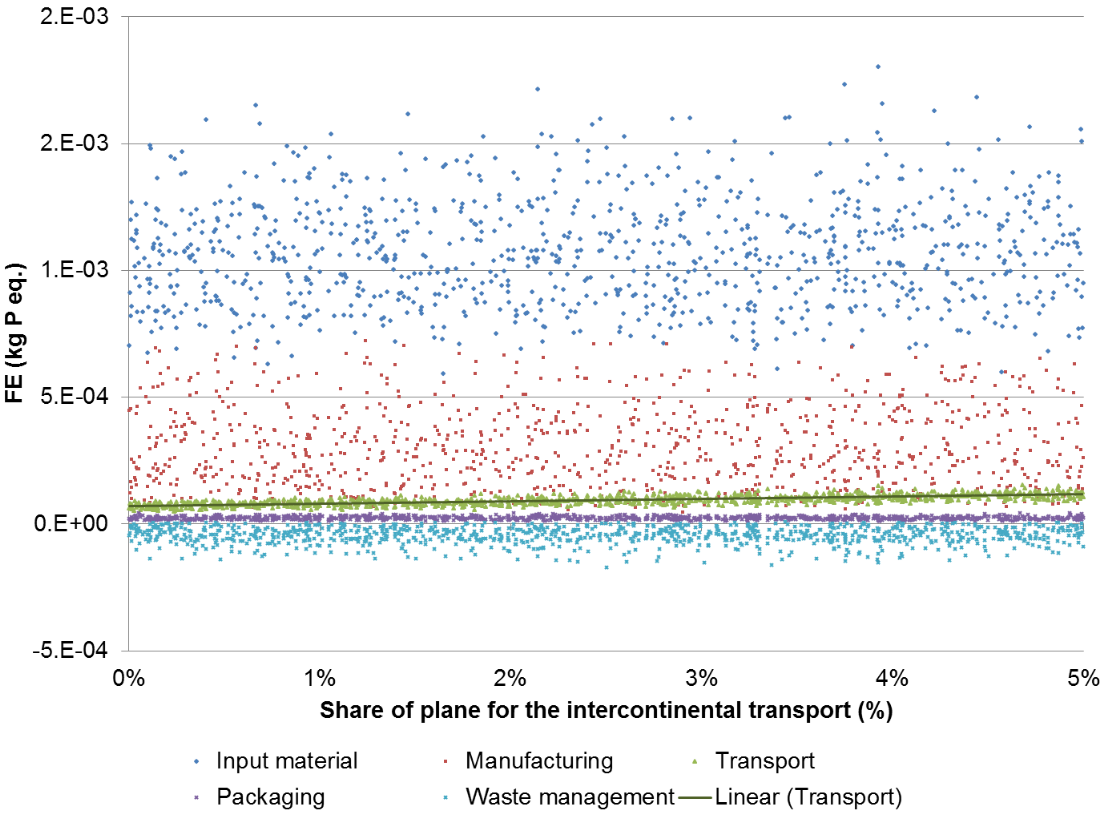

2.E-01
1.E-01
1.E-01
1.E-01
8.E-02
6.E-02
4.E-02
2.E-02
0.E+00
-2.E-02
-4.E-02
RD (kg Sb eq.)
0%
1%
2%
3%
4%
5%
Share of plane for the intercontinental transport (%)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Transport)

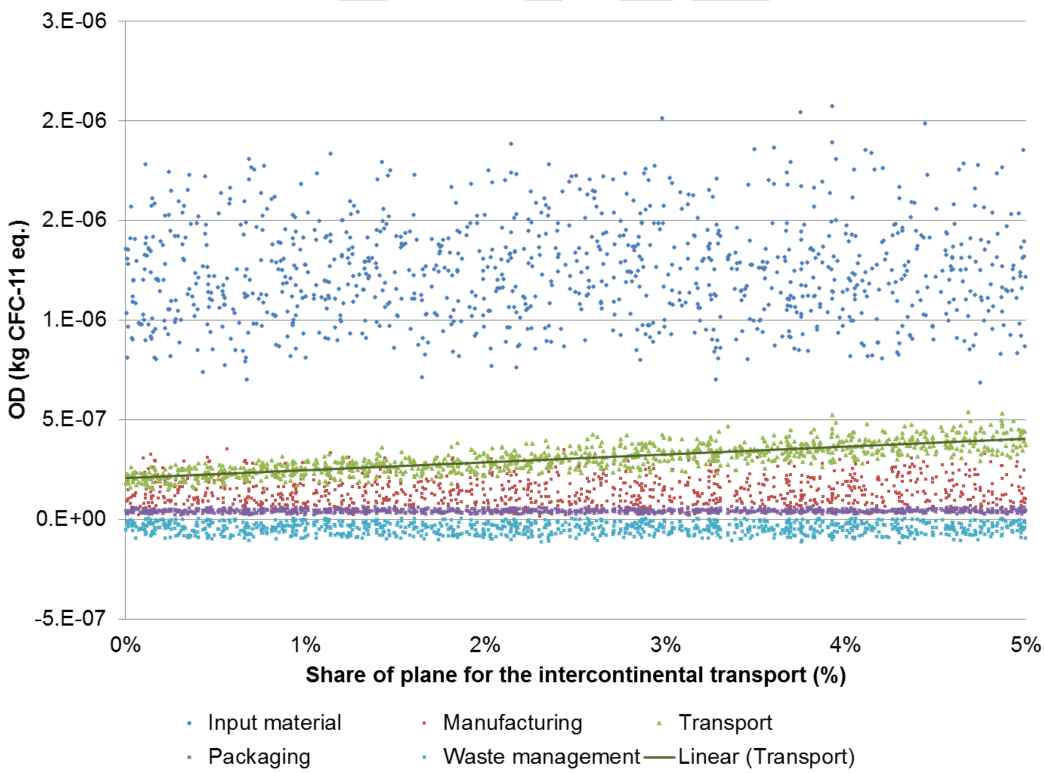


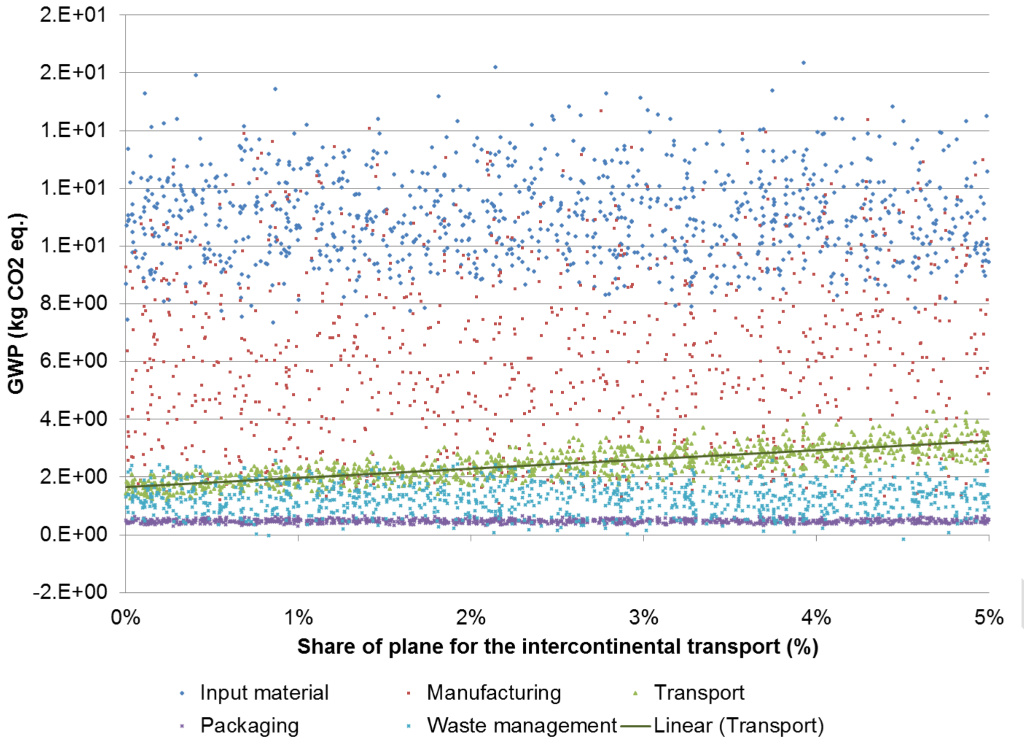
WC (m³)
2.E+00
2.E+00
1.E+00
1.E+00
1.E+00
8.E-01
6.E-01
4.E-01
2.E-01
0.E+00
-2.E-01
-4.E-01
0%
1%
2%
3%
4%
5%
Share of plane for the intercontinental transport (%)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Transport)

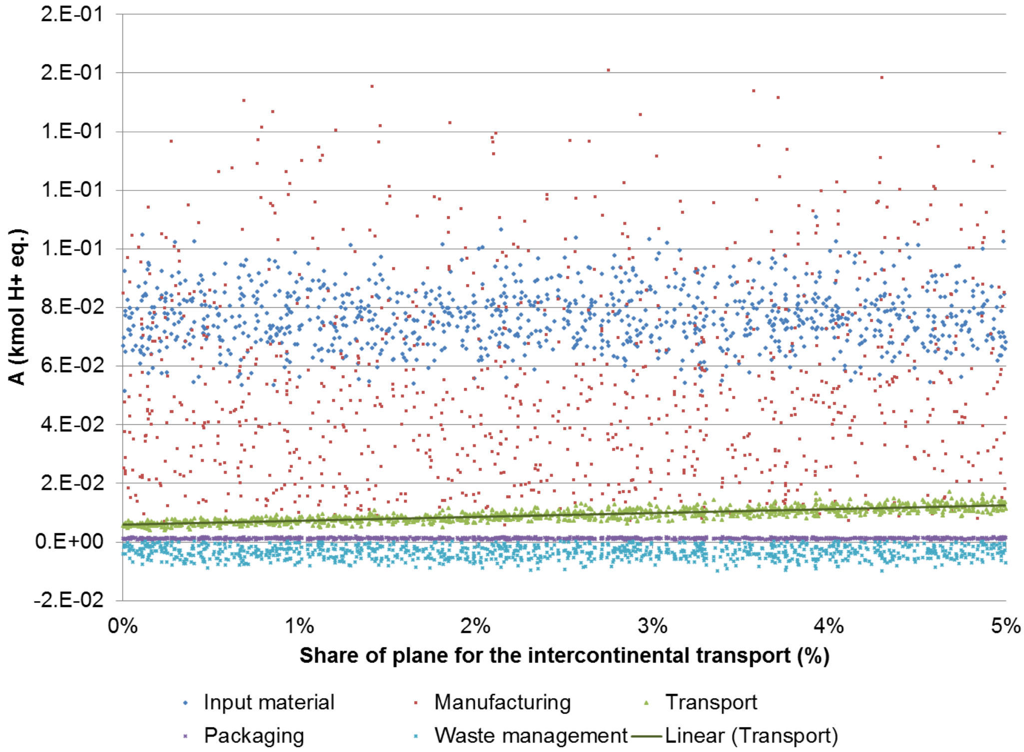


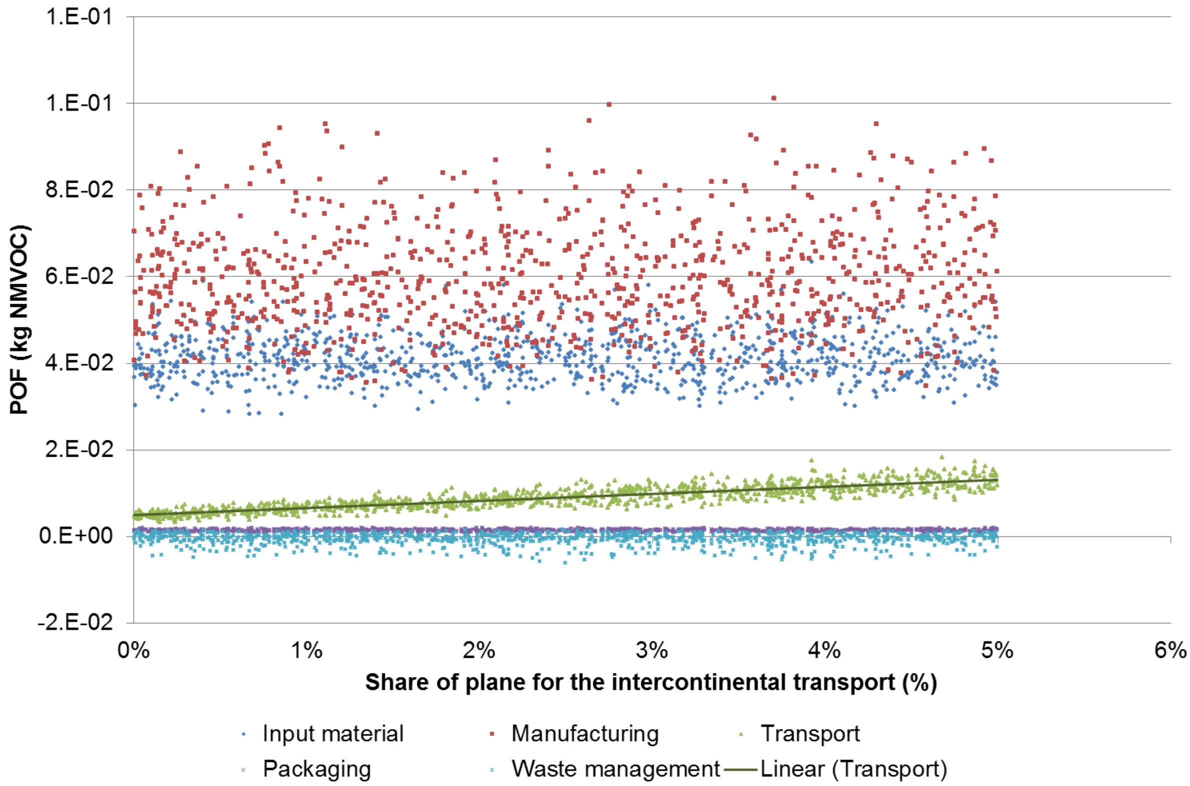
ME (kg N eq.)
3.E-02
3.E-02
2.E-02
2.E-02
1.E-02
5.E-03
0.E+00
-5.E-03
0%
1%
2%
3%
4%
5%
Share of plane for the intercontinental transport (%)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Transport)


2.E-03
2.E-03
1.E-03
5.E-04
0.E+00
-5.E-04
FE (kg P eq.)
0%
1%
2%
3%
4%
5%
Share of plane for the intercontinental transport (%)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Transport)

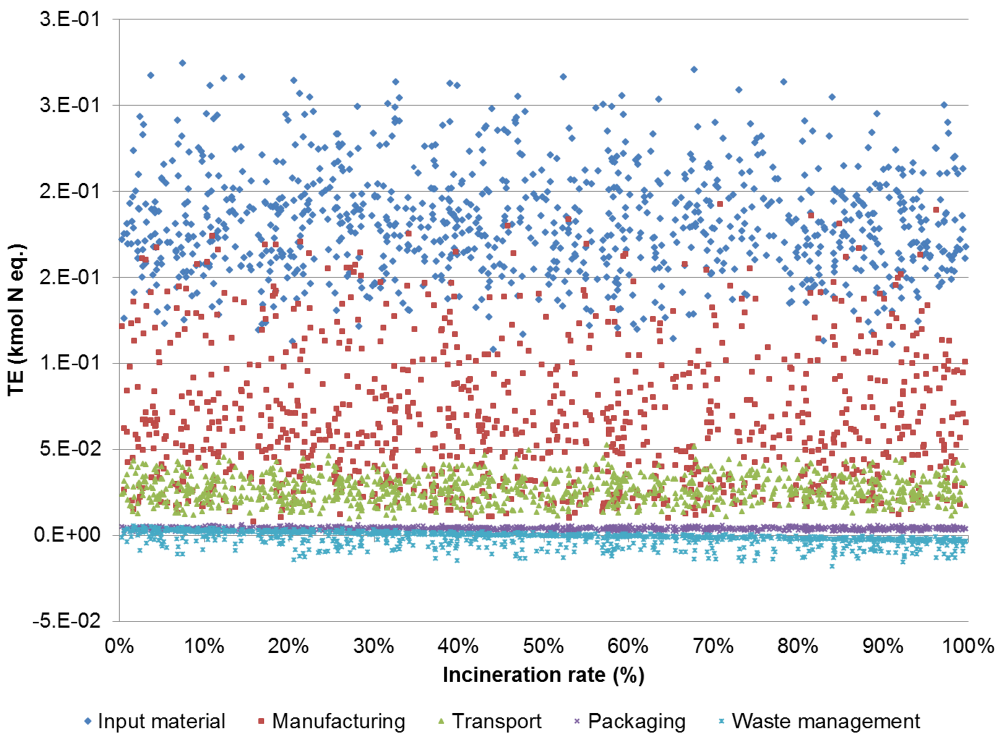

3.E-06
2.E-06
2.E-06
1.E-06
5.E-07
0.E+00
-5.E-07
OD (kg CFC-11 eq.)
0%
1%
2%
3%
4%
5%
Share of plane for the intercontinental transport (%)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Transport)

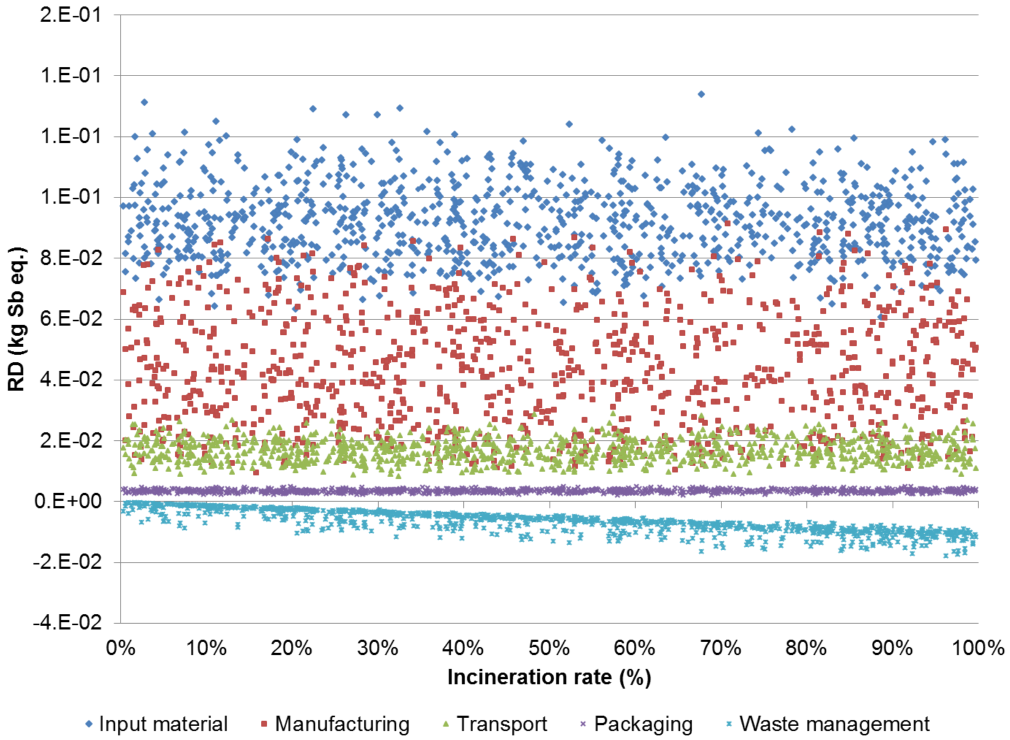

2.E+01
2.E+01
1.E+01
1.E+01
1.E+01
8.E+00
6.E+00
4.E+00
2.E+00
0.E+00
-2.E+00
GWP (kg CO2 eq.)
0%
1%
2%
3%
4%
5%
Share of plane for the intercontinental transport (%)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Transport)

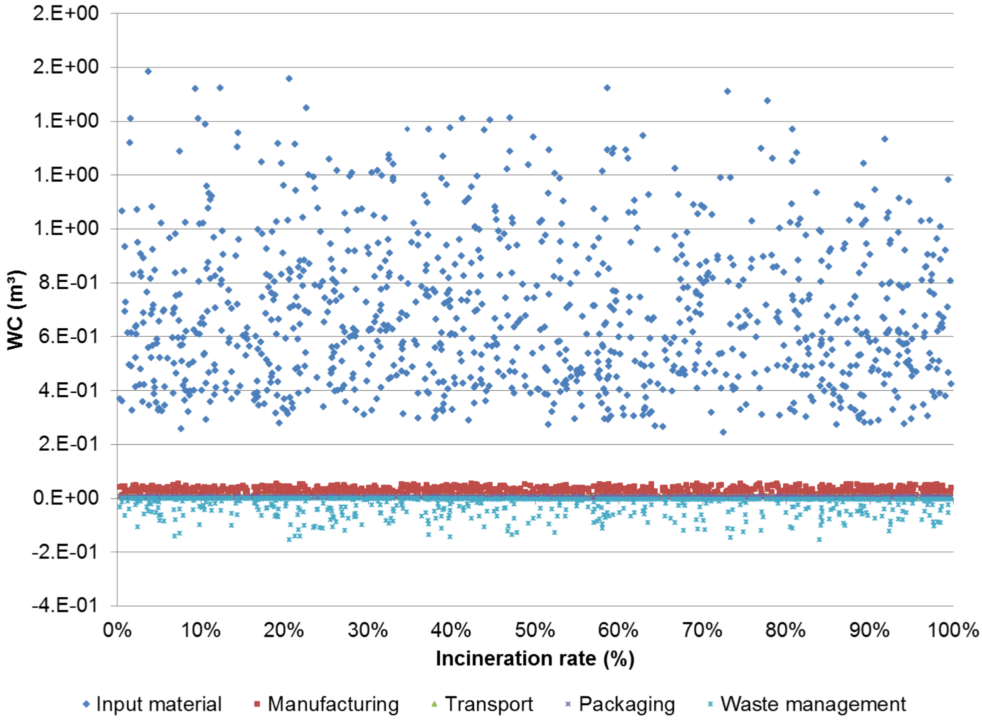

2.E-01
2.E-01
1.E-01
1.E-01
1.E-01
8.E-02
6.E-02
4.E-02
2.E-02
0.E+00
-2.E-02
A (kmol H+ eq.)
0%
1%
2%
3%
4%
5%
Share of plane for the intercontinental transport (%)
Input material
Manufacturing
Transport
Packaging
Waste management
Linear (Transport)

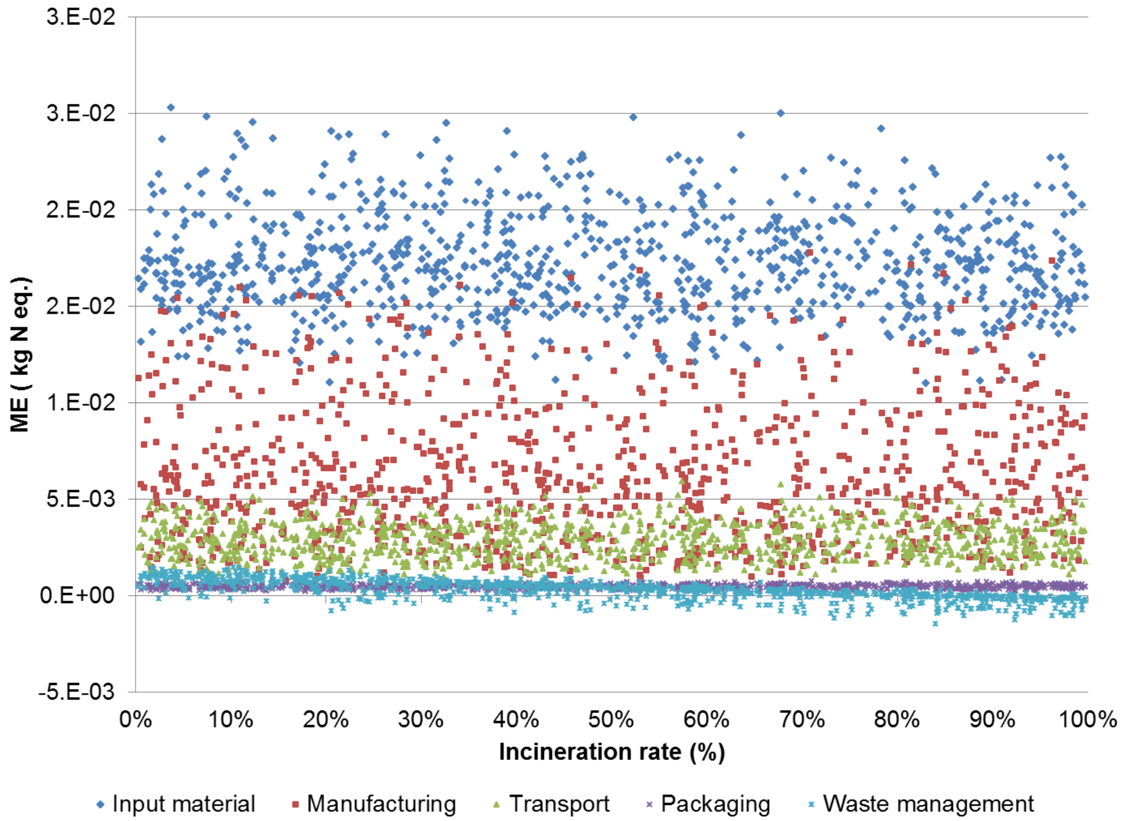


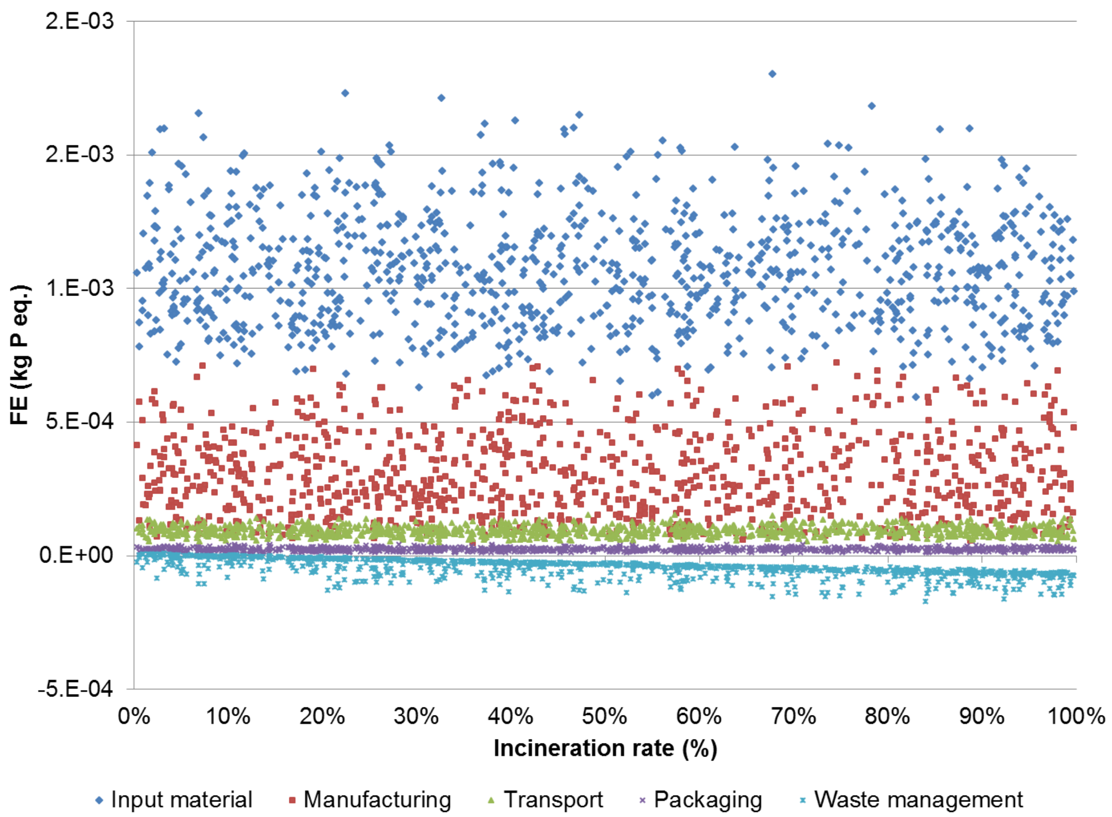
Sensitivity analysis – Incineration rate

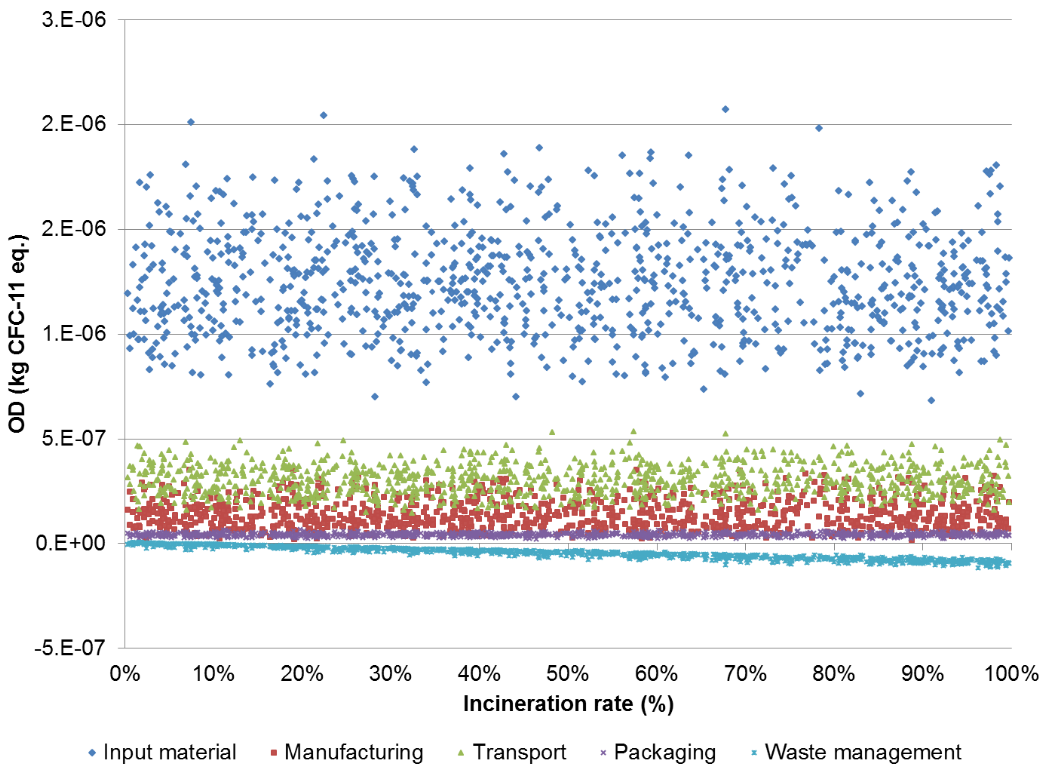



2.E-01
1.E-01
1.E-01
1.E-01
8.E-02
6.E-02
4.E-02
2.E-02
0.E+00
-2.E-02
-4.E-02
RD (kg Sb eq.)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Incineration rate (%)
Input material
Manufacturing
Transport
Packaging
Waste management

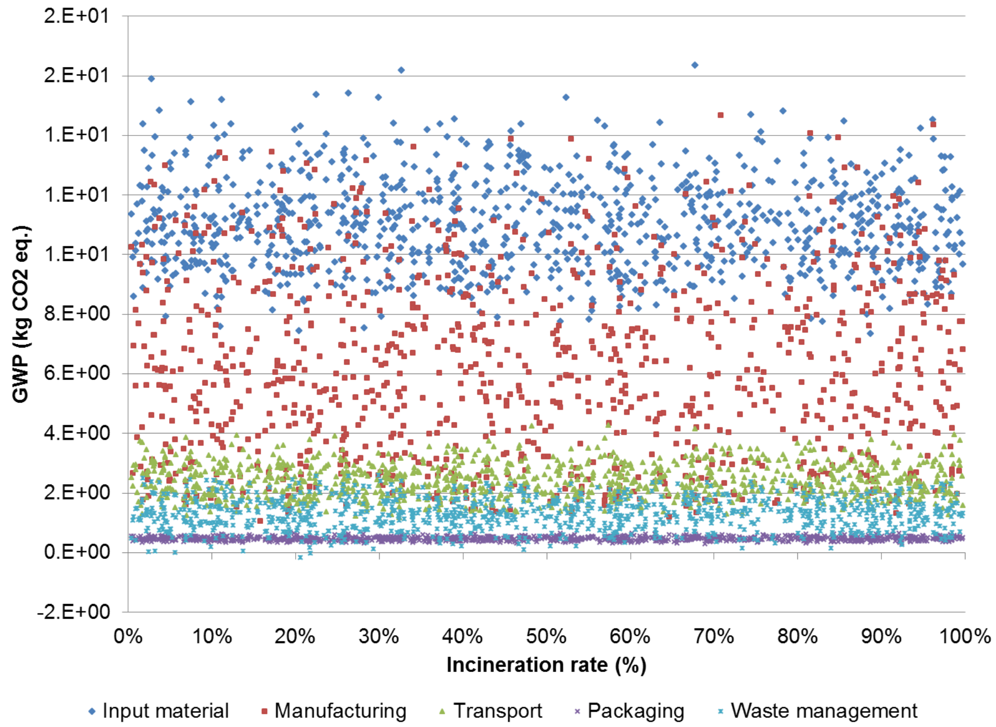

2.E+00
2.E+00
1.E+00
1.E+00
1.E+00
8.E-01
6.E-01
4.E-01
2.E-01
0.E+00
-2.E-01
-4.E-01
WC (m³)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Incineration rate (%)
Input material
Manufacturing
Transport
Packaging
Waste management


3.E-02
3.E-02
2.E-02
2.E-02
1.E-02
5.E-03
0.E+00
-5.E-03
ME (kg N eq.)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Incineration rate (%)
Input material
Manufacturing
Transport
Packaging
Waste management

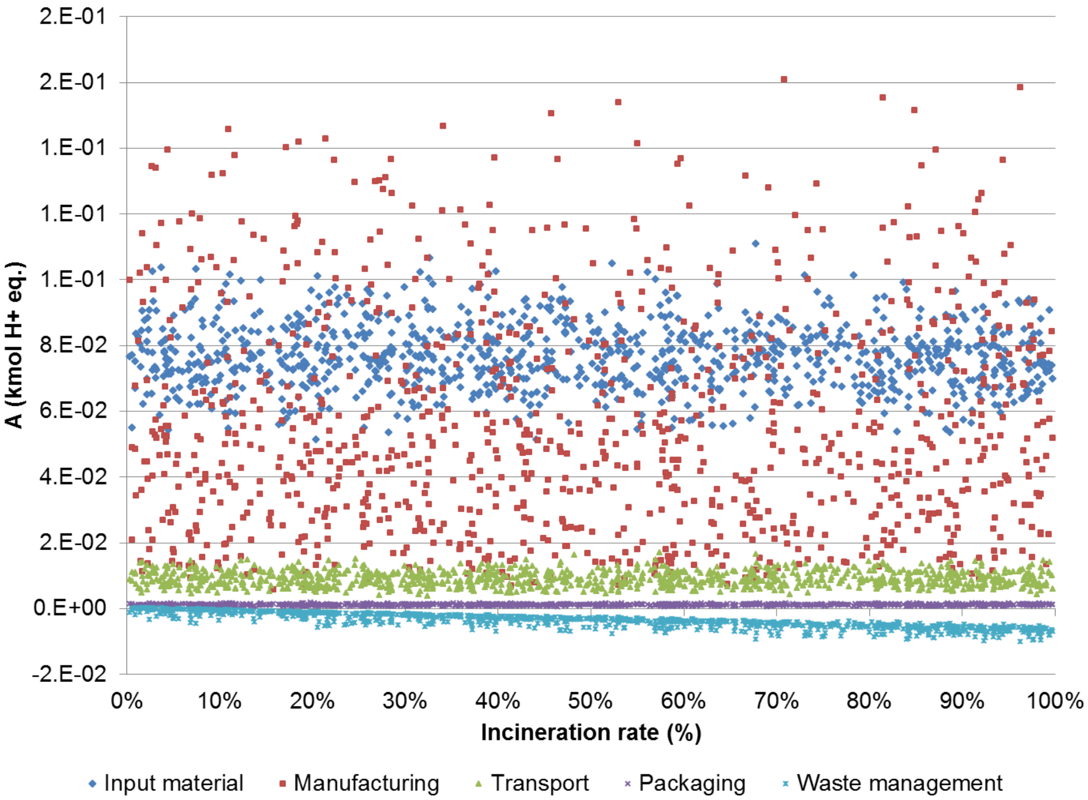

2.E-03
2.E-03
1.E-03
5.E-04
0.E+00
-5.E-04
FE (kg P eq.)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Incineration rate (%)
Input material
Manufacturing
Transport
Packaging
Waste management

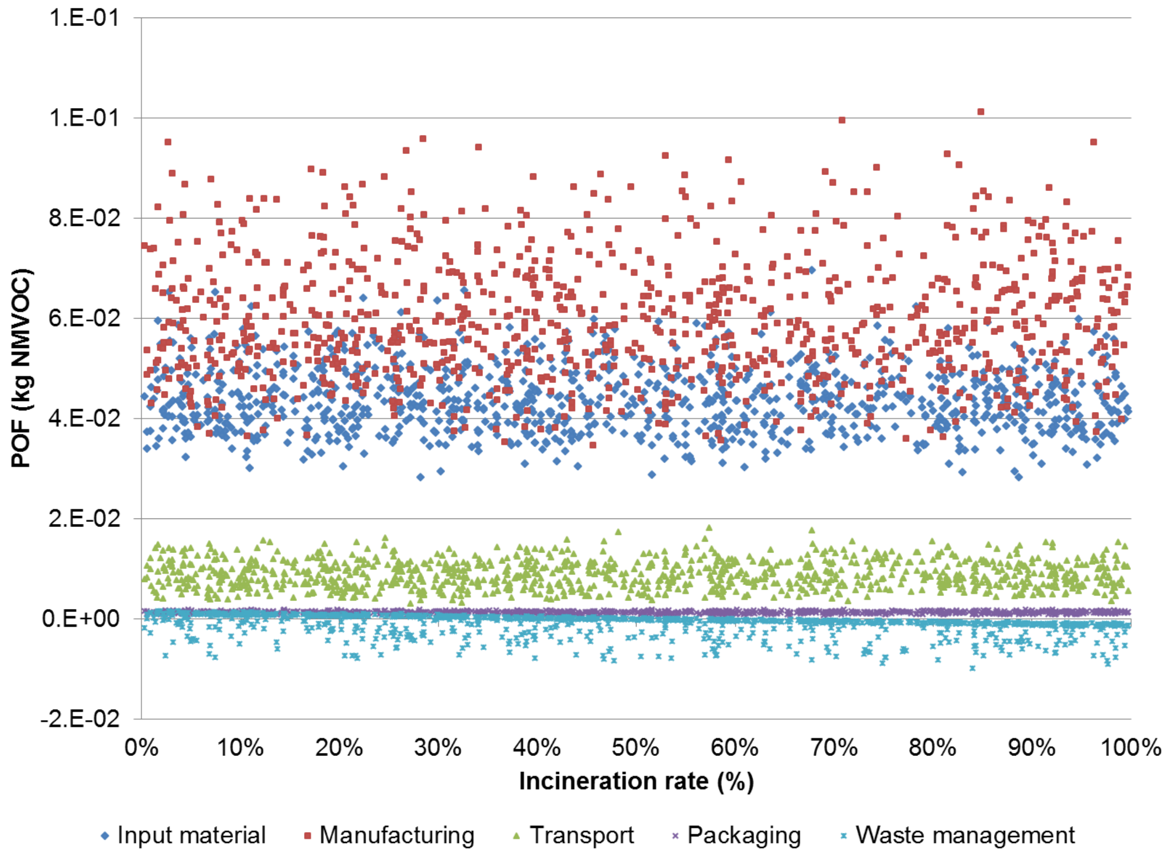


3.E-06
2.E-06
2.E-06
2.E-06
1.E-06
5.E-07
0.E+00
-5.E-07
OD (kg CFC-11 eq.)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Incineration rate (%)
Input material
Manufacturing
Transport
Packaging
Waste management

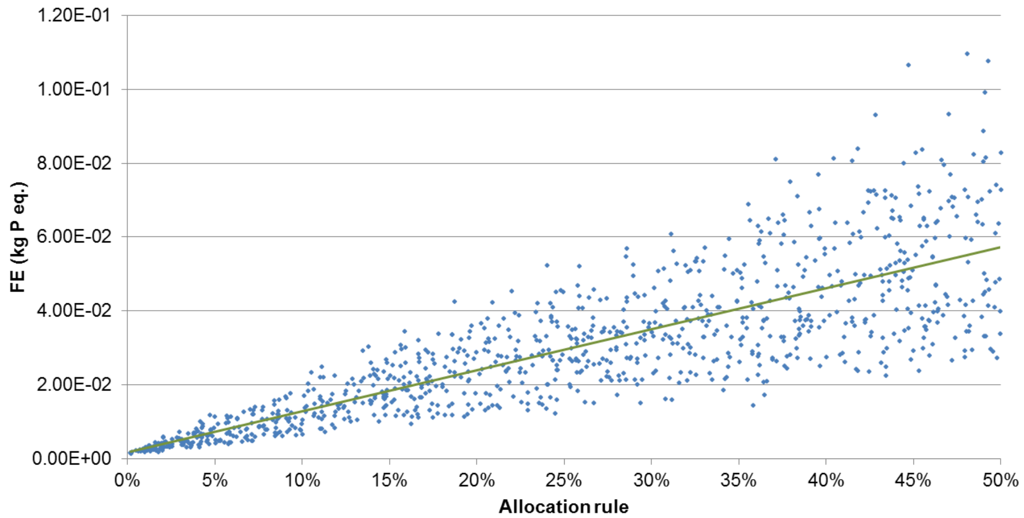


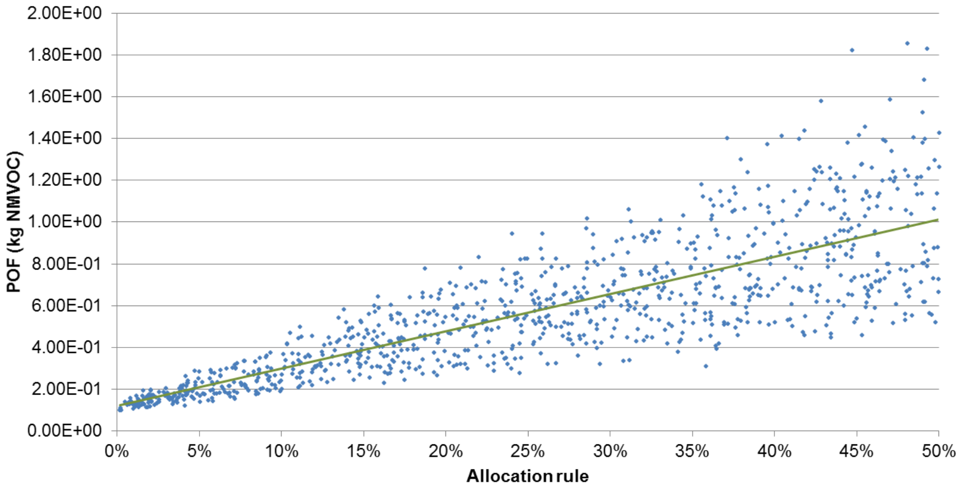
2.E+01
2.E+01
1.E+01
1.E+01
1.E+01
8.E+00
6.E+00
4.E+00
2.E+00
0.E+00
-2.E+00
GWP (kg CO2 eq.)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Incineration rate (%)
Input material
Manufacturing
Transport
Packaging
Waste management

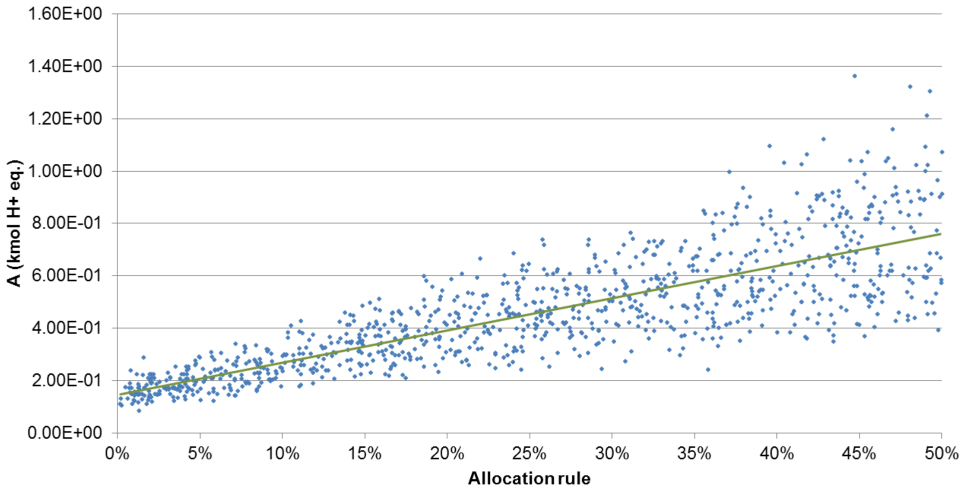

2.E-01
2.E-01
1.E-01
1.E-01
1.E-01
8.E-02
6.E-02
4.E-02
2.E-02
0.E+00
-2.E-02
A (kmol H+ eq.)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Incineration rate (%)
Input material
Manufacturing
Transport
Packaging
Waste management



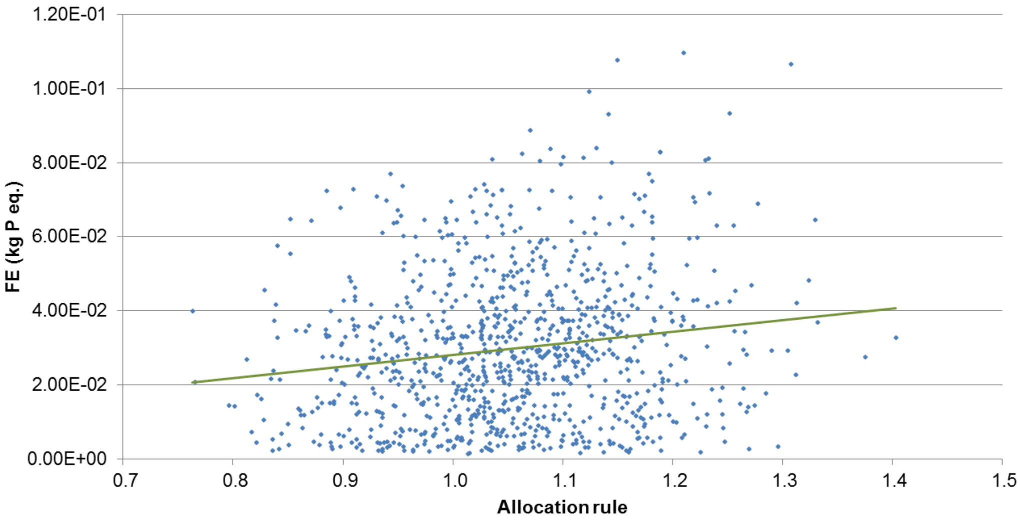
Sensitivity analysis – Allocation of agriculture, breeding and slaughtering

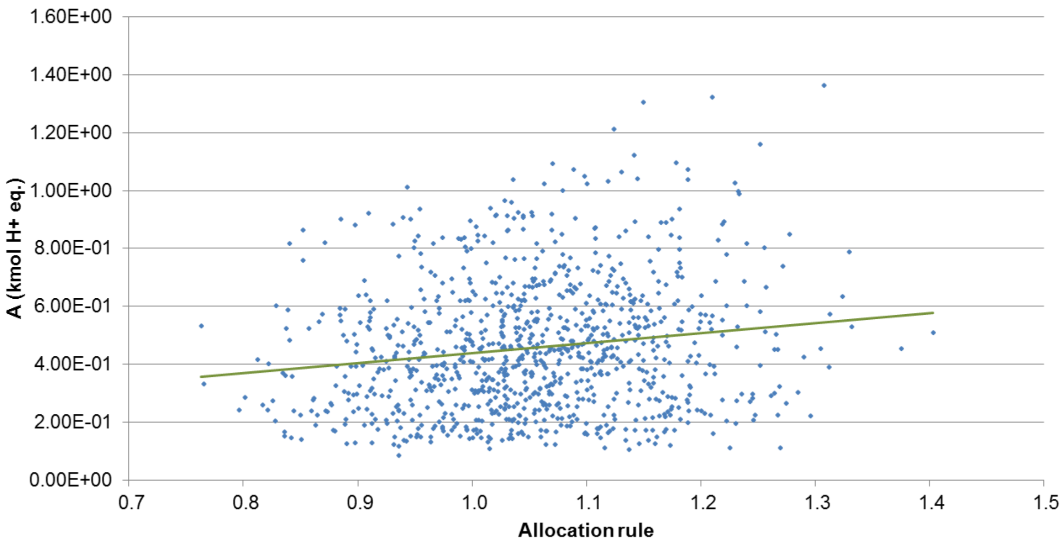


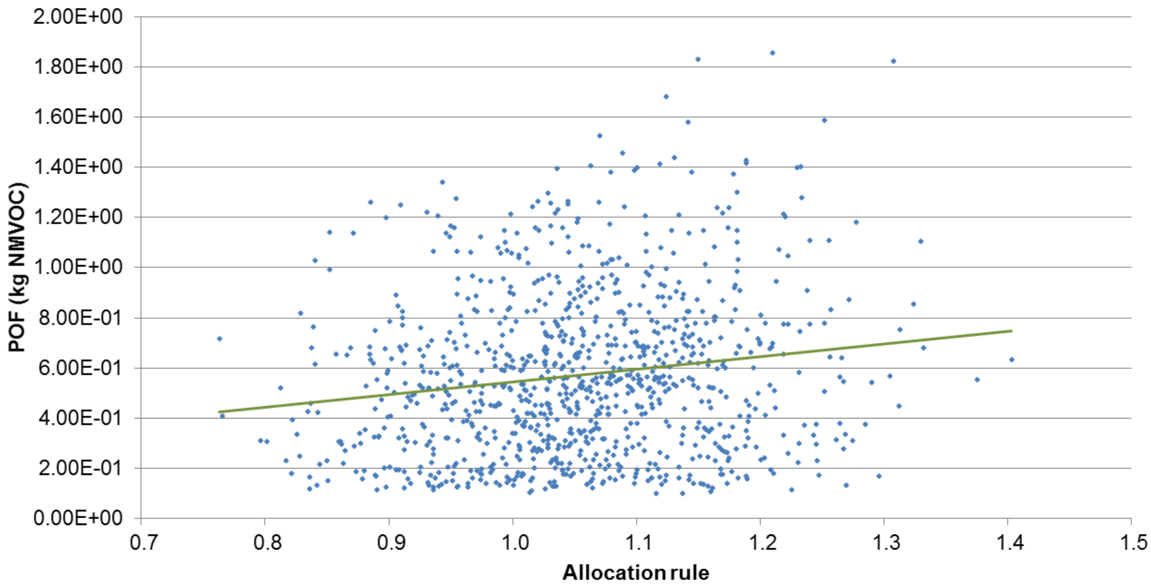




Sensitivity analysis – Variability of results of Milà et al


1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
FE (kg P eq.)
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
Allocation rule


1.60E+00
1.40E+00
1.20E+00
1.00E+00
8.00E-01
6.00E-01
4.00E-01
2.00E-01
0.00E+00
A (kmol H+ eq.)
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
Allocation rule


POF (kg NMVOC)
2.00E+00
1.80E+00
1.60E+00
1.40E+00
1.20E+00
1.00E+00
8.00E-01
6.00E-01
4.00E-01
2.00E-01
0.00E+00
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
Allocation rule

Annex IX Calculation of the reference flow – PCR from ADEME-AFNOR

This annex presents the way that the reference flow is calculated following the PCR of ADEME-AFNOR.

By default, it is considered that 2 pairs are required to have shoes in good condition for one year. A professional may prove his shoe lasts longer with the performance tests described in the harmonized standards that cover:

- strength of the upper-sole assembly,
- sole abrasion,
- sole flexion resistance,
- upper tearing,
- shoe lining and exterior abrasion resistance.

For each of these tests, the shoe is rated: 0; 2.5; 5 or 10. The tests do not all have the same degree of importance and are therefore weighted with a coefficient. The table below shows an example of the ratings received for the various tests for three distinct shoe models:

- an entry-level price model,
- a shoe model with an eco-label,
- an high-end model.

Test	Coef	Shoe model		
		Entry-level price	Eco-label	High-end
Upper/sole assembly	25/46	0	5	10
Sole abrasion	10/46	0	5	5
Sole flexion resistance	5/46	10	5	10
Upper tearing	5/46	5	10	10
Lining and exterior abrasion resistance	1/46	0	5	10
Overall rating		**16**	**55**	**89**

The overall rating makes it possible to determine the number of pairs of shoes required to satisfy the functional unit (reference flow) requirements. This rating on a scale of 0 to 10 is converted to a percentage (%).

For a given product, the range of the overall rating simply corresponds to the product reference flow:

Overall rating	Reference flow
[0 ; 40[	2
[40 ; 60[	1
[60 ; 80[	0.5
[80 ; 100[	0.25

In the table below, the overall performance test results are shown for the three shoe models.

Shoe model	Overall rating	Reference flow	Lifespan
Entry-level price	16%	2	6 months
Eco-label	55%	1	1 year
High-end	89%	0.25	> 2 years

The entry-level model receives an overall rating of 16%, which means that 2 pairs of shoes are required to "have shoes in good condition for one year" (functional unit). In other words, the mean lifespan of the entry-levels shoes is approximately 6 months.

For the high-end model, the overall rating is 89%. This should mean that this pair of shoes can be worn for 4 years before it reaches the end of its lifespan and is thrown out or replaced.

However, the lifespan is simply considered to be above 2 years.

Annex X Hazardous substances potentially present in footwear

Based on the review of documents mentioned above and the first stakeholders feedback (including testing experts[488]), hazardous substances of concern with possible application in the footwear industry are presented in Table 100 below and discussed further in the following sub-chapters.

It is important to note that this analysis remains quite general, therefore, the list of substances is not exhaustive and requires further consultation with stakeholders.

[488] Interview with Intertek members and reading of SGS documents available on line

Table 100 : List of relevant hazardous substances potentially present in footwear and link with related document mentioning their hazardous properties

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
Chemical intermediate for dyes, pigments, and finishing	Amine	Biphenyl-4-ylamine	92-67-1	Chemical intermediate for dyes				x	
Chemical intermediate for dyes, pigments, and finishing	Aryl amine	4,4'-Methylenedi-*o*-toluidine	838-88-0	Chemical intermediate for dyes				x	
Chemical intermediate for dyes, pigments, and finishing	Aryl amine	6-Methoxy-*m*-toluidine	120-71-8	Chemical intermediate for dyes				x	
Chemical intermediate for dyes, pigments, and finishing	Aryl amine	*o*-Toluidine	95-53-4	Use in the manufacture of dyes Use as an intermediate for synthetic rubber				x	
Chemical intermediate for dyes, pigments, and finishing	Amine	*o*-Aminoazotoluene C.I. Solvent Yellow 3 ;	97-56-3	Use in the manufacture of dyes	x			x	
Chemical intermediate for dyes, pigments, and finishing	Ethyl sulphate	Diethyl sulphate	64-67-5	Use in dye manufacture and pigment production Use as a finishing agent in textile manufacture				x	

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
Chemical intermediate for dyes, pigments, and finishing	Ethyl sulphate	Dimethyl sulphate	77-78-1	Use in polyurethane-based adhesives, fabric softeners and dyes				x	
Chemical intermediate for dyes, pigments, and finishing	Other substances	N,N,N',N'-tetramethyl-4,4'-methylenedianiline (Michler's base)	101-61-1	Intermediate in the manufacture of dyes and other substances.			x		
Chemical intermediate for dyes, pigments, and finishing	Other substances	4,4'-bis(dimethylamino)benzophenone (Michler's ketone)	90-94-8	Intermediate in the manufacture of triphenylmethane dyes and other substances			x		
Chemical intermediate for dyes, pigments, and finishing	Other substances	[4-[[4-anilino-1-naphthyl][4-(dimethylamino)phenyl]methylene]cyclohexa-2,5-dien-1-ylidene] dimethylammonium chloride (C.I. Basic Blue 26)	2580-56-5	Used in the production of inks, cleaners, and coatings, as well as for dyeing of paper, packaging, textiles, plastic products, and other types of articles.			x		
Chemical intermediate for dyes, pigments, and finishing	Substances containing halogen	Tris (2,3 dibromopropyl) phosphate	126-72-7		x				
Chemical intermediate for dyes, pigments, and finishing	Substances containing halogen	1-Bromopropane	106-94-5	Use in textile, ink, adhesive and coatings				x	

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
Chemical intermediate for dyes, pigments, and finishing	Other substances	Dimethylfumarate		Use as preservative					
Chemical intermediate for dyes, pigments, and finishing	Other substances	3-Ethyl-2-methyl-2-(3-methylbutyl)-1,3-oxazolidine	143860-04-2	Use in paint for polyurethane, polyuretahane finishing and sealants				x	
Surfactant	Alkyl phenols and their ethoxylates	4-(1,1,3,3-tetramethylbutyl)phenol, (4-tert-Octylphenol)	140-66-9	Used as surfactant in leather and textile industry. Only low level residue will be expected (less than 0,1 %)		x			
Detergent	Alkyl phenols and their ethoxylates	4-Nonylphenol, branched and linear	25154-52-3	Use as detergent and textile auxiliairies Use in paints and lacquers, varnishes, coloring agents, printing inks, adhesives and sealants Use in leather and footwear processing	x			x	x

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
Flame retardant	Chlorinated aliphates	Alkanes, C10-13,chloro [Short Chain Chlorinated paraffins] (SCCP)	85535-84-8	Possible (flame retardant for textile or fat liquor for leather)	x	x			
Flame retardant	Other substances	Tris(aziridinyl)phosphinoxide	545-55-1		x				
Flame retardant	Poly halogen phenyl	Bis(pentabromophenyl) ether (DecaBDE)	1163-19-5	Use as a flame retardant in plastics, textiles and adhesive				x	
Flame retardant	Substances containing boron	Disodium tetraborate anhydrous	1303-96-4, 1330-43-4, 12179-04-3	Possible contaminant (leather: possible traces, use for the preservation of raw hides. Flame retardant for plastics)		x			
Flame retardant	Substances containing boron	Boric acid	10043-35-3, 11113-50-1	Possible contaminant (leather: possible traces, use for the preservation of raw hides. Flame retardant for plastics)		x			
Flame retardant	Substances containing boron	Tetraboron disodium heptaoxide hydrate	12267-73-1	Possible contaminant (leather: possible traces, use for the preservation of raw		x			

Function in footwear processing	**Group**	**Substance name**	**CAS number**	**Occurrence in footwear**	**Annex XVII - REACH**	**SVHC based on CEN/TR16417**	**SVHC - 18/06/2012**	**SVHC - 19/12/2012**	**SVHC - 20/06/2013**
				hides. Flame retardant for plastics)					
Flame retardant	Substances containing halogen	Tris(2-chloroethyl)phosphate (TCEP)	115-96-8	Possible contaminant (flame retardant for furniture, plasticiser for PU-PVC)		x			
Formaldehyde	Other substances	Formaldehyde	50-00-0						
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing lead	Lead dinitrate	10099-74-8	Use as mordant in dyeing and printing on textiles				x	
Heavy metal (dyes / plasticizers / tanning agent)	Heavy metal	Mercury compounds							
Heavy metal (dyes / plasticizers / tanning agent)	Heavy metal	Cadmium	7440-43-9	Use in pigments. Use in stabilizers for plastics and polymer.	x				x
Heavy metal (dyes / plasticizers / tanning agent)	Heavy metal	Arsenic	440-38-2		x				
Heavy metal (dyes / plasticizers / tanning agent)	Heavy metal	Nickel	7440-02-0	Accessories	x				

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
Heavy metal (dyes / plasticizers / tanning agent)	Heavy metal - Substances containing chromium	Chromium VI compounds			x	x			
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing chromate	Sodium dichromate	7789-12-0 and 10588-01-9	Possible contaminant (Cr VI possible in leather at low concentration)		x			
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing chromate	Sodium chromate	03/11/7775	Possible contaminant (Cr VI possible in leather at low concentration)		x			
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing chromate	Ammonium dichromate	05/09/7789	Possible contaminant (Cr VI possible in leather at low concentration)		x			
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing chromate	Potassium dichromate	7778-50-9	Possible contaminant (Cr VI possible in leather at low concentration)		x			
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing chromate	Potassium chromate	7789-00-6	Possible contaminant (Cr VI possible in leather at low concentration)		x			

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing chromate	Strontium chromate	02/06/7789	Possible contaminant (Cr VI possible in leather at low concentration)		x			
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing chromate	Potassium hydroxyoctaoxodizincatedichromate	11103-86-9	Possible contaminant (Cr VI possible in leather at low concentration)		x			
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing chromium	Chromic acid, Dichromic acid, Oligomers of chromic acid and dichromic acid	7738-94-5, 13530-68-2, not yet assigned	Possible contaminant (Cr VI possible in leather at low concentration)		x			
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing chromium	Chromium trioxide	1333-82-0	Possible contaminant (Cr VI possible in leather at low concentration)		x			
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing chromium	Dichromium tris(chromate)	24613-89-6	Possible contaminant (Cr VI possible in leather at low concentration)		x			
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing chromium	Pentazinc chromate octahydroxide	49663-84-5	Possible contaminant (Cr VI possible in leather at low		x			

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
				concentration)					
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing lead	Lead sulfochromate yellow (C.I. Pigment Yellow 34)	1344-37-2	Possible pigment in certain surface coating		x			
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing lead	Lead chromate molybdate sulfate red (C.I. Pigment Red 104)	12656-85-8	Possible pigment in certain surface coating		x			
Heavy metal (dyes / plasticizers / tanning agent)	Substances containing lead	Lead chromate	7758-97-6	Possible pigment in certain surface coating		x			
PAHs (Polycyclic aromatic hydrocarbon)	PAHs	Anthracene	120-12-7	PAH compound. Possible contaminant (recycled materials or leather fat liquor)		x			
PAHs (Polycyclic aromatic hydrocarbon)	PAHs	Benzo[e]pyrene (BeP)	192-97-2	PAH compound. Possible contaminant (recycled materials or leather fat liquor)	x				
PAHs (Polycyclic aromatic hydrocarbon)	PAHs	Benzo[a]anthracene (BaA)	56-55-3	PAH compound. Possible contaminant (recycled materials or leather fat liquor)	x				

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
PAHs (Polycyclic aromatic hydrocarbon)	PAHs	Chrysene (CHR)	218-01-9	PAH compound. Possible contaminant (recycled materials or leather fat liquor)	x				
PAHs (Polycyclic aromatic hydrocarbon)	PAHs	Benzo[b]fluoranthene (BbFA)	205-99-2	PAH compound. Possible contaminant (recycled materials or leather fat liquor)	x				
PAHs (Polycyclic aromatic hydrocarbon)	PAHs	Benzo[j]fluoranthene (BjFA)	205-82-3	PAH compound. Possible contaminant (recycled materials or leather fat liquor)	x				
PAHs (Polycyclic aromatic hydrocarbon)	PAHs	Benzo[k]fluoranthene (BkFA)	207-08-9	PAH compound. Possible contaminant (recycled materials or leather fat liquor)	x				
PAHs (Polycyclic aromatic hydrocarbon)	PAHs	Dibenzo[a,h]anthracene (DBAhA)	53-70-3	PAH compound. Possible contaminant (recycled materials or leather fat liquor)	x				
Impregnation agent	Perfluorochemicals (PFCs)	Pentadecafluorooctanoic acid (PFOA)	335-67-1	Use in the production of fluoropolymers and fluoroelastomers					x

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
Impregnation agent	Perfluorochemicals (PFCs)	Henicosafluoroundecanoic acid (PFUnDA)	2058-94-8	Use in the production of fluoropolymers and fluoroelastomers				x	
Impregnation agent	Perfluorochemicals (PFCs)	Heptacosafluorotetradecanoic acid (PFTeDA)	376-06-7	Use in the production of fluoropolymers and fluoroelastomers				x	
Impregnation agent	Perfluorochemicals (PFCs)	Pentacosafluorotridecanoic acid (PFCA)	72629-94-8	Use in the production of fluoropolymers and fluoroelastomers				x	
Impregnation agent	Perfluorochemicals (PFCs)	Triccosafluorododecanoic acid	307-55-1	Use in the production of fluoropolymers and fluoroelastomers				x	
Phenols	Other substances	Pentachlorophenol;	87-85-5	Pesticides	x				
Phenols	Phenol	Dinoseb	88-85-7	Use as process regulators for polymerization processes in production of resins, rubbers, polymers				x	
Plasticizer	Amide	Acrylamide	79-06-1	Possible contaminant		x			
Plasticizer	Amide	C,C'-azodi(formamide)	123-77-3	Use as blowing agent for rubber and plastics				x	

Function in footwear processing	**Group**	**Substance name**	**CAS number**	**Occurrence in footwear**	**Annex XVII - REACH**	**SVHC based on CEN/TR16417**	**SVHC - 18/06/2012**	**SVHC - 19/12/2012**	**SVHC - 20/06/2013**
Plasticizer	Amine	2,2'-dichloro-4,4'-methylenedianiline (MOCA)	101-14-4	Used as a curing agent in PU industry, Possible in certain technical PU. Only low level residue will be expected (less than 0,1 %)		x			
Plasticizer	Furans	Hexahydro-2-benzofuran-1,3-dione, cis-cyclohexane-1,2-dicarboxylic anhydride, trans-cyclohexane-1,2-dicarboxylic anhydride (HHPA)	85-42-7;13149-00-3; 14166-21-3	Use in the manufacture of polyester and alkyd resins				x	
Plasticizer	Furans	Hexahydromethylphthalic anhydride, Hexahydro-4-methylphathalic anhydride, Hexahydro-1-methylphathalic anhydride, Hexahydro -3-methylphathalic anhydride	25550-51-0, 19438-60-9, 48122-14-1, 57110-29-9	Use in the manufacture of polyester and alkyd resins and plasticizers for thermoplastic polymers Use as harderners for epoxy resins and chain cross-linkers for thermoplastics polymers				x	
Plasticizer	Isocyanates	Methylenediphenyl diisocyanate (MDI)	26447-40-5	Use in polyurethane processing	x		x		
Plasticizer	Organostannic compounds	Dibutyltin compounds (DBT) (e.g. dibutyltin dichloride and dibutyltin hydrogen borate)	638-18-1; 75113-37-0	Use as additive in rubber, stabilizer in PVC	x			x	

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
				plastics					
Plasticizer	Organostannic compounds	Dioctyltin (DOT) compounds		Use as additive in rubber, stabilizer in PVC plastics	x				
Plasticizer	Organostannic compounds	Tri-substituted organotin compounds e.g. tributyltin (TBT) and triphenyltin (TPT) compounds		Use as additive in rubber, stabilizer in PVC plastics	x				
Plasticizer	Other substances	1,3,5-tris[(2S and 2R)-2,3-epoxypropyl]-1,3,5-triazine-2,4,6-(1H,3H,5H)-trione (β-TGIC)	59653-74-6	Use as a hardener in resins and coatings			x		
Plasticizer	Phthalates	1,2-Benzenedicarboxylic acid, di-C6-8-branched alkyl esters, C7-rich (DIHP)	71888-89-6	Possible contaminant		x			
Plasticizer	Phthalates	1,2-Benzenedicarboxylic acid, di-C7-11-branched and linear alkyl esters	68515-42-4	Possible contaminant		x			
Plasticizer	Phthalates	Bis(2-methoxyethyl) phthalate	117-82-8	Possible contaminant		x			
Plasticizer	Phthalates	Diisobutyl phthalate	84-69-5	Possible contaminant		x			
Plasticizer	Phthalates	bis (2-ethylhexyl) phthalate (DEHP)	117-81-7	Possible contaminant	x				
Plasticizer	Phthalates	dibutyl phthalate (DBP)	84-74-2	Possible contaminant	x				
Plasticizer	Phthalates	benzyl butyl phthalate (BBP)	85-68-7	Possible contaminant	x				
Plasticizer	Phthalates	di-"isononyl" phthalate (DINP)	28553-12-0	Possible contaminant	x				
Plasticizer	Phthalates	di-"isodecyl" phthalate (DIDP)	26761-40-0	Possible contaminant	x				
Plasticizer	Phthalates	di-n-octyl phthalate (DNOP)	117-84-0	Possible contaminant	x				
Plasticizer	Phthalates	Dipentyl phthalate (DPP)	131-18-0	Use as plasticizer in	x				

Function in footwear processing	**Group**	**Substance name**	**CAS number**	**Occurrence in footwear**	**Annex XVII - REACH**	**SVHC based on CEN/TR16417**	**SVHC - 18/06/2012**	**SVHC - 19/12/2012**	**SVHC - 20/06/2013**
				PVC					
Plasticizer	Phthalates	[Phthalato(2-)]dioxotrilead	69011-06-9	Use in PVC processing				x	
Plasticizer	Phthalates	1,2 -Benzenedicarboxylic acid, dipentylester, branched and linear	84777-06-0						
Plasticizer	Phthalates	Diisopentylphthalate (DIPP)	605-50-5	Use as plasticizer for PVC products and other polymers				x	
Plasticizer	Phthalates	N-pentyl-isopentylphthalate	776297-69-9	Use as plastizicer in plastic material				x	
Plasticizer	Poly halogen phenyl	Polybromobiphenyls; Polybrominatedbiphenyls (PBB)	59536-65-1		x				
Plasticizer	Poly halogen phenyl	Polychlorinated terphenyls (PCTs);			x				
Plasticizer	Substances containing lead	Dioxobis(stearato)trilead	12578-12-0	Use in PVC processing				x	
Plasticizer	Substances containing lead	Fatty acids, C16-C18, lead salts	91031-62-8	Use in PVC processing				x	
Plasticizer	Substances containing lead	Lead monoxide	1317-36-8	Use as a vulcanizing agent in rubber and plastic Use in the manufacture of pigments for rubber, porcelain and glass				x	

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
Plasticizer	Substances containing lead	Lead oxide sulphate	12036-76-9	Use in PVC processing				x	
Plasticizer	Substances containing lead	Lead tetroxide	1314-41-6	Use in vulcanization of rubber				x	
Plasticizer	Substances containing lead	Pentalead tetraoxide sulphate	12065-90-6	Use in PVC processing				x	
Plasticizer	Substances containing lead	Sulfurous acid, lead salt, dibasic	62229-08-7	Use in PVC processing				x	
Plasticizer	Substances containing lead	Tetralead trioxide sulphate	12202-17-4	Use in PVC processing				x	
Plasticizer	Substances containing lead	Trilead bis(carbonate)dihydroxide	1319-46-6	Use as heat stabilizer for PVC				x	
Plasticizer	Substances containing lead	Trilead dioxide phosphonate	12141-20-7	Use in PVC processing				x	
Residue	Amine	2-Methoxyaniline; o-Anisidine	90-04-0	Not used as a free compound. This substance can be detected after the degradation of azo colorant, (see Annex XVII of Reach). Only low level residue will be expected (less than		x			

Function in footwear processing	**Group**	**Substance name**	**CAS number**	**Occurrence in footwear**	**Annex XVII - REACH**	**SVHC based on CEN/TR16417**	**SVHC - 18/06/2012**	**SVHC - 19/12/2012**	**SVHC - 20/06/2013**
				0.1%).					
Solvent	Amide	N,N-dimethylacetamide (DMAC)	127-19-5	Solvent used in synthetic textile industry and in leather finishing. Only low level residue will be expected (less than 0,1 %.)		x			
Solvent	Amide	N,N-dimethylformamide (DMF)	68-12-2	Use in acrylic fiber production. Solvent for depositing polyurethane coatings on leather.				x	
Solvent	Chlorinated aliphates	1,2-Dichloroethane; ethylene dichloride	107-06-2	Solvent used in non-flammable adhesive; volatile product can be present only as a residue. Greater possibility to detect in the packaging of		x			

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
				footwear than in the footwear itself.					
Solvent	Chlorinated aliphates	1,2,3-trichloropropane	96-18-4	Solvent in rubber industry. Volatile product, traces can be present only as a residue.		x			
Solvent	Chlorinated aliphates	Trichloroethylene	79-01-6			x			
Solvent	Dihydroxy ethers	Bis(2-methoxyethyl) ether	111-96-6	Contaminant		x			
Solvent	Dihydroxy ethers	2-Methoxyethanol; Ethylene glycol monomethyl ether (EGME)	109-86-4	Contaminant (possible in certain leather finishing at low levels)		x			
Solvent	Dihydroxy ethers	2-Ethoxyethanol; Ethylene glycol monoethyl ether (EGEE)	110-80-5	Contaminant (possible in certain leather finishing at low levels)		x			
Solvent	Dihydroxy ethers	2-Ethoxyethyl acetate	111-15-9	Solvent volatile product; traces can be present only as a residue.		x			
Solvent	Furans	Furan	110-00-9	Use in adhesive				x	

Function in footwear processing	Group	Substance name	CAS number	Occurrence in footwear	Annex XVII - REACH	SVHC based on CEN/TR16417	SVHC - 18/06/2012	SVHC - 19/12/2012	SVHC - 20/06/2013
Solvent	Nitrogen containing heterocycles	N-methyl-2-pyrrolidone; 1-methyl-2-pyrrolidone	872-50-4	Solvent used in leather industry (concentration higher than 0.1 % possible)		x			

Annex XI List of restricted dyes

(a) Aromatic amines that are restricted by REACH Annex XVII		
Aryl amine	CAS Number	
4-aminodiphenyl	92-67-1	
Benzidine	92-87-5	
4-chloro-o-toluidine	95-69-2	
2-naphtylamine	91-59-8	
o-amino-azotoluene	97-56-3	
2-amino-4-nitrotoluene	99-55-8	
4-chloroaniline	106-47-8	
2,4-diaminoanisol	615-05-4	
4,4'-diaminodiphenylmethane	101-77-9	
3,3'-dichlorobenzidine	91-94-1	
3,3'-dimethoxybenzidine	119-90-4	
3,3'-dimethylbenzidine	119-93-7	
3,3'-dimethyl-4,4'-diaminodiphenylmethane	838-88-0	
p-cresidine	120-71-8	
4,4'-methylene-bis-(2-chloro-aniline)	101-14-4	
4,4'-oxydianiline	101-80-4	
4,4'-thiodianiline	139-65-1	
o-toluidine	95-53-4	
2,4-diaminotoluene	95-80-7	
2,4,5-trimethylaniline	137-17-7	
4-aminoazobenzene	60-09-3	
o-anisidine	90-04-0	
(b) Aromatic amines that are restricted in some EU Member States		
2,4-Xylidine	95-68-1	
2,6-Xylidine	87-62-7	
(c) Dyes that may cleave to aromatic amines		
Disperse dyes that may cleave to aromatic amines		
Disperse Orange 60		
Disperse Orange 149		
Disperse Red 151		
Disperse Red 221		
Disperse Yellow 7		
Disperse Yellow 23		
Disperse Yellow 56		

Disperse Yellow 218		
Basic dyes that may cleave to aromatic amines		
Basic Brown 4		
Basic Red 42		
Basic Red 76		
Basic Red 111		
Basic Red 114		
Basic Yellow 82		
Basic Yellow 103		
Acid dyes that may cleave to aromatic amines		
CI Acid Black 29	CI Acid Red 24	CI Acid Red 128
CI Acid Black 94	CI Acid Red 26	CI Acid Red 115
CI Acid Black 131	CI Acid Red 26:1	CI Acid Red 128
CI Acid Black 132	CI Acid Red 26:2	CI Acid Red 135
CI Acid Black 209	CI Acid Red 35	CI Acid Red 148
CI Acid Black 232	CI Acid Red 48	CI Acid Red 150
CI Acid Brown 415	CI Acid Red 73	CI Acid Red 158
CI Acid Orange 17	CI Acid Red 85	CI Acid Red 167
CI Acid Orange 24	CI Acid Red 104	CI Acid Red 170
CI Acid Orange 45	CI Acid Red 114	CI Acid Red 264
CI Acid Red 4	CI Acid Red 115	CI Acid Red 265
CI Acid Red 5	CI Acid Red 116	CI Acid Red 420
CI Acid Red 8	CI Acid Red 119:1	CI Acid Violet 12
Direct dyes that may cleave to aromatic amines		
Direct Black 4	Basic Brown 4	Direct Red 13
Direct Black 29	Direct Brown 6	Direct Red 17
Direct Black 38	Direct Brown 25	Direct Red 21
Direct Black 154	Direct Brown 27	Direct Red 24
Direct Blue 1	Direct Brown 31	Direct Red 26
Direct Blue 2	Direct Brown 33	Direct Red 22
Direct Blue 3	Direct Brown 51	Direct Red 28
Direct Blue 6	Direct Brown 59	Direct Red 37
Direct Blue 8	Direct Brown 74	Direct Red 39
Direct Blue 9	Direct Brown 79	Direct Red 44
Direct Blue 10	Direct Brown 95	Direct Red 46
Direct Blue 14	Direct Brown 101	Direct Red 62
Direct Blue 15	Direct Brown 154	Direct Red 67

Direct Blue 21	Direct Brown 222	Direct Red 72
Direct Blue 22	Direct Brown 223	Direct Red 126
Direct Blue 25	Direct Green 1	Direct Red 168
Direct Blue 35	Direct Green 6	Direct Red 216
Direct Blue 76	Direct Green 8	Direct Red 264
Direct Blue 116	Direct Green 8.1	Direct Violet 1
Direct Blue 151	Direct Green 85	Direct Violet 4
Direct Blue 160	Direct Orange 1	Direct Violet 12
Direct Blue 173	Direct Orange 6	Direct Violet 13
Direct Blue 192	Direct Orange 7	Direct Violet 14
Direct Blue 201	Direct Orange 8	Direct Violet 21
Direct Blue 215	Direct Orange 10	Direct Violet 22
Direct Blue 295	Direct Orange 108	Direct Yellow 1
Direct Blue 306	Direct Red 1	Direct Yellow 24
Direct Brown 1	Direct Red 2	Direct Yellow 48
Direct Brown 1:2	Direct Red 7	
Direct Brown 2	Direct Red 10	
(d) Dyes that are CMR or which potentially be sensitising		
Dyes that are carcinogenic, mutagenic or toxic to reproduction		
C.I. Acid Red 26	C. I. Direct Black 38	C.I. Disperse Blue 1
C.I. Basic Red 9	C. I. Direct Blue 6	C.I. Disperse Orange 11
C.I. Basic Violet 14	C. I. Direct Red 28	C. I. Disperse Yellow 3
Disperse dyes that are potentially sensitising		
C.I. Disperse Blue 1	C.I. Disperse Blue 124	C.I. Disperse Red 11
C.I. Disperse Blue 3	C.I. Disperse Brown 1	C.I. Disperse Red 17
C.I. Disperse Blue 7	C.I. Disperse Orange 1	C.I. Disperse Yellow 1
C.I. Disperse Blue 26	C.I. Disperse Orange 3	C.I. Disperse Yellow 3
C.I. Disperse Blue 35	C.I. Disperse Orange 37	C.I. Disperse Yellow 9
C.I. Disperse Blue 102	C.I. Disperse Orange 76	C.I. Disperse Yellow 39
C.I. Disperse Blue 106	C.I. Disperse Red 1	C.I. Disperse Yellow 49

Annex XII Candidate list of substances of very high concern

List of 144 substances on the Candidate list of substances of very high concern, according to the last update (20th June 2013)

Table 101 : Candidate list Substances of Very High Concern

Substance Name	EC Number	CAS Number	Date of inclusion	Reason for inclusion
Cadmium	231-152-8	7440-43-9	20/06/2013	Carcinogenic (Article 57a); Equivalent level of concern having probable serious effects to human health (Article 57 f)
Ammonium pentadecafluorooctanoate (APFO)	223-320-4	3825-26-1	20/06/2013	Toxic for reproduction (Article 57 c); PBT (Article 57 d)
Pentadecafluorooctanoic acid (PFOA)	206-397-9	335-67-1	20/06/2013	Toxic for reproduction (Article 57 c); PBT (Article 57 d)
Dipentyl phthalate (DPP)	205-017-9	131-18-0	20/06/2013	Toxic for reproduction (Article 57 c);
4-Nonylphenol, branched and linear, ethoxylated			20/06/2013	Equivalent level of concern having probable serious effects to the environment (Article 57 f)
Cadmium oxide	215-146-2	1306-19-0	20/06/2013	Carcinogenic (Article 57a); Equivalent level of concern having probable serious effects to human health (Article 57 f)
Hexahydromethylphthalic anhydride [1], Hexahydro-4-methylphthalic anhydride [2], Hexahydro-1-methylphthalic anhydride [3], Hexahydro-3-methylphthalic anhydride [4]	247-094-1, 243-072-0, 256-356-4, 260-566-1	25550-51-0, 19438-60-9, 48122-14-1, 57110-29-9	19/12/2012	Equivalent level of concern having probable serious effects to human health (Article 57 f)
6-methoxy-m-toluidine (p-cresidine)	204-419-1	120-71-8	19/12/2012	Carcinogenic (Article 57a)
Cyclohexane-1,2-dicarboxylic anhydride [1], cis-cyclohexane-1,2-dicarboxylic anhydride [2], trans-cyclohexane-1,2-dicarboxylic anhydride [3] covered by this entry]	201-604-9, 236-086-3, 238-009-9	85-42-7, 13149-00-3, 14166-21-3	19/12/2012	Equivalent level of concern having probable serious effects to human health (Article 57 f)
Pyrochlore, antimony lead yellow	232-382-1	8012-00-8	19/12/2012	Toxic for reproduction (Article 57 c)
Henicosafluoroundecanoic	218-165-4	2058-94-8	19/12/2012	vPvB (Article 57 e)

acid				
4-Aminoazobenzene	200-453-6	60-09-3	19/12/2012	Carcinogenic (Article 57a)
Silicic acid, lead salt	234-363-3	11120-22-2	19/12/2012	Toxic for reproduction (Article 57 c)
Lead titanium zirconium oxide	235-727-4	12626-81-2	19/12/2012	Toxic for reproduction (Article 57 c)
Lead monoxide (lead oxide)	215-267-0	1317-36-8	19/12/2012	Toxic for reproduction (Article 57 c)
o-Toluidine	202-429-0	95-53-4	19/12/2012	Carcinogenic (Article 57a)
3-ethyl-2-methyl-2-(3-methylbutyl)-1,3-oxazolidine	421-150-7	143860-04-2	19/12/2012	Toxic for reproduction (Article 57 c)
Dibutyltin dichloride (DBTC)	211-670-0	683-18-1	19/12/2012	Toxic for reproduction (Article 57 c)
Lead bis(tetrafluoroborate)	237-486-0	13814-96-5	19/12/2012	Toxic for reproduction (Article 57 c)
Lead dinitrate	233-245-9	10099-74-8	19/12/2012	Toxic for reproduction (Article 57 c)
Silicic acid	272-271-5	68784-75-8	19/12/2012	Toxic for reproduction (Article 57 c)
Trilead bis(carbonate)dihydroxide	215-290-6	1319-46-6	19/12/2012	Toxic for reproduction (Article 57 c)
4,4'-methylenedi-o-toluidine	212-658-8	838-88-0	19/12/2012	Carcinogenic (Article 57a)
Diethyl sulphate	200-589-6	64-67-5	19/12/2012	Carcinogenic (Article 57a); Mutagenic (Article 57b)
Dimethyl sulphate	201-058-1	77-78-1	19/12/2012	Carcinogenic (Article 57a)
N,N-dimethylformamide	200-679-5	68-12-2	19/12/2012	Toxic for reproduction (Article 57 c)
4-(1,1,3,3-tetramethylbutyl)phenol, ethoxylated	-	-	19/12/2012	Equivalent level of concern having probable serious effects to the environment (Article 57 f)
4-Nonylphenol, branched and linear	-	-	19/12/2012	Equivalent level of concern having probable serious effects to the environment (Article 57 f)
Furan	203-727-3	110-00-9	19/12/2012	Carcinogenic (Article 57a)
Lead oxide sulfate	234-853-7	12036-76-9	19/12/2012	Toxic for reproduction (Article 57 c)
Lead titanium trioxide	235-038-9	12060-00-3	19/12/2012	Toxic for reproduction (Article 57 c)
Bis(pentabromophenyl) ether (decabromodiphenyl ether; DecaBDE)	214-604-9	1163-19-5	19/12/2012	PBT (Article 57 d); vPvB (Article 57 e)
Dinoseb (6-sec-butyl-2,4-dinitrophenol)	201-861-7	88-85-7	19/12/2012	Toxic for reproduction (Article 57 c)
1,2-Diethoxyethane	211-076-1	629-14-1	19/12/2012	Toxic for reproduction (Article 57 c)
N-methylacetamide	201-182-6	79-16-3	19/12/2012	Toxic for reproduction (Article 57 c)

Tetralead trioxide sulphate	235-380-9	12202-17-4	19/12/2012	Toxic for reproduction (Article 57 c)
Acetic acid, lead salt, basic	257-175-3	51404-69-4	19/12/2012	Toxic for reproduction (Article 57 c)
[Phthalato(2-)]dioxotrilead	273-688-5	69011-06-9	19/12/2012	Toxic for reproduction (Article 57 c)
Tetraethyllead	201-075-4	78-00-2	19/12/2012	Toxic for reproduction (Article 57 c)
N-pentyl-isopentylphthalate	-	776297-69-9	19/12/2012	Toxic for reproduction (Article 57 c)
Pentalead tetraoxide sulphate	235-067-7	12065-90-6	19/12/2012	Toxic for reproduction (Article 57 c)
Heptacosafluorotetradecanoic acid	206-803-4	376-06-7	19/12/2012	vPvB (Article 57 e)
Tricosafluorododecanoic acid	206-203-2	307-55-1	19/12/2012	vPvB (Article 57 e)
1-bromopropane (n-propyl bromide)	203-445-0	106-94-5	19/12/2012	Toxic for reproduction (Article 57 c)
Dioxobis(stearato)trilead	235-702-8	12578-12-0	19/12/2012	Toxic for reproduction (Article 57 c)
Pentacosafluorotridecanoic acid	276-745-2	72629-94-8	19/12/2012	vPvB (Article 57 e)
Methoxyacetic acid	210-894-6	625-45-6	19/12/2012	Toxic for reproduction (Article 57 c)
Methyloxirane (Propylene oxide)	200-879-2	75-56-9	19/12/2012	Carcinogenic (Article 57a); Mutagenic (Article 57b)
Trilead dioxide phosphonate	235-252-2	12141-20-7	19/12/2012	Toxic for reproduction (Article 57 c)
o-aminoazotoluene	202-591-2	97-56-3	19/12/2012	Carcinogenic (Article 57a)
4-methyl-m-phenylenediamine (toluene-2,4-diamine)	202-453-1	95-80-7	19/12/2012	Carcinogenic (Article 57a)
Diisopentylphthalate	210-088-4	605-50-5	19/12/2012	Toxic for reproduction (Article 57 c)
1,2-Benzenedicarboxylic acid, dipentylester, branched and linear	284-032-2	84777-06-0	19/12/2012	Toxic for reproduction (Article 57 c)
Biphenyl-4-ylamine	202-177-1	92-67-1	19/12/2012	Carcinogenic (Article 57a)
Fatty acids, C16-18, lead salts	292-966-7	91031-62-8	19/12/2012	Toxic for reproduction (Article 57 c)
Orange lead (lead tetroxide)	215-235-6	1314-41-6	19/12/2012	Toxic for reproduction (Article 57 c)
4,4'-oxydianiline and its salts	202-977-0	101-80-4	19/12/2012	Carcinogenic (Article 57a); Mutagenic (Article 57b)
Diazene-1,2-dicarboxamide (C,C'-azodi(formamide))	204-650-8	123-77-3	19/12/2012	Equivalent level of concern having probable serious effects to human health (Article 57 f)

Sulfurous acid, lead salt, dibasic	263-467-1	62229-08-7	19/12/2012	Toxic for reproduction (Article 57 c)
Lead cyanamidate	244-073-9	20837-86-9	19/12/2012	Toxic for reproduction (Article 57 c)
Î±,Î±-Bis[4-(dimethylamino)phenyl]-4 (phenylamino)naphthalene-1-methanol (C.I. Solvent Blue 4)	229-851-8	6786-83-0	18/06/2012	Carcinogenic (Article 57a)
1,3,5-tris[(2S and 2R)-2,3-epoxypropyl]-1,3,5-triazine-2,4,6-(1H,3H,5H)-trione (Î²-TGIC)	423-400-0	59653-74-6	18/06/2012	Mutagenic (Article 57b)
N,N,N',N'-tetramethyl-4,4'-methylenedianiline	202-959-2	101-61-1	18/06/2012	Carcinogenic (Article 57a)
Diboron trioxide	215-125-8	1303-86-2	18/06/2012	Toxic for reproduction (Article 57 c)
1,2-bis(2-methoxyethoxy)ethane (TEGDME; triglyme)	203-977-3	112-49-2	18/06/2012	Toxic for reproduction (Article 57 c)
Formamide	200-842-0	75-12-7	18/06/2012	Toxic for reproduction (Article 57 c)
4,4'-bis(dimethylamino)-4''-(methylamino)trityl alcohol <em>	209-218-2	561-41-1	18/06/2012	Carcinogenic (Article 57a)
Lead(II) bis(methanesulfonate)	401-750-5	17570-76-2	18/06/2012	Toxic for reproduction (Article 57 c)
[4-[4,4'-bis(dimethylamino) benzhydrylidene]cyclohexa-2,5-dien-1-ylidene]dimethylammonium chloride (C.I. Basic Violet 3)	208-953-6	548-62-9	18/06/2012	Carcinogenic (Article 57a)
1,2-dimethoxyethane; ethylene glycol dimethyl ether (EGDME)	203-794-9	110-71-4	18/06/2012	Toxic for reproduction (Article 57 c)
[4-[[4-anilino-1-naphthyl][4-(dimethylamino)phenyl]methylene]cyclohexa-2,5-dien-1-ylidene] dimethylammonium chloride (C.I. Basic Blue 26)	219-943-6	2580-56-5	18/06/2012	Carcinogenic (Article 57a)
1,3,5-Tris(oxiran-2-ylmethyl)-1,3,5-triazinane-2,4,6-trione (TGIC)	219-514-3	2451-62-9	18/06/2012	Mutagenic (Article 57b)
4,4'-bis(dimethylamino)benzop	202-027-5	90-94-8	18/06/2012	Carcinogenic (Article 57a)

henone				
Phenolphthalein	201-004-7	77-09-8	19/12/2011	Carcinogenic (article 57 a)
N,N-dimethylacetamide	204-826-4	127-19-5	19/12/2011	Toxic for reproduction (article 57 c)
4-(1,1,3,3-tetramethylbutyl)phenol	205-426-2	140-66-9	19/12/2011	Equivalent level of concern having probable serious effects to the environment (article 57 f)
Lead diazide, Lead azide	236-542-1	13424-46-9	19/12/2011	Toxic for reproduction (article 57 c),
Lead dipicrate	229-335-2	6477-64-1	19/12/2011	Toxic for reproduction (article 57 c)
1,2-dichloroethane	203-458-1	107-06-2	19/12/2011	Carcinogenic (article 57 a)
Calcium arsenate	231-904-5	7778-44-1	19/12/2011	Carcinogenic (article 57 a)
Dichromium tris(chromate)	246-356-2	24613-89-6	19/12/2011	Carcinogenic (article 57 a)
2-Methoxyaniline; o-Anisidine	201-963-1	90-04-0	19/12/2011	Carcinogenic (article 57 a)
Pentazinc chromate octahydroxide	256-418-0	49663-84-5	19/12/2011	Carcinogenic (article 57 a)
Zirconia Aluminosilicate Refractory Ceramic Fibres	-	-	19/12/2011	Carcinogenic (article 57 a)
Arsenic acid	231-901-9	7778-39-4	19/12/2011	Carcinogenic (article 57 a)
Potassium hydroxyoctaoxodizincatedi chromate	234-329-8	11103-86-9	19/12/2011	Carcinogenic (article 57 a)
Formaldehyde, oligomeric reaction products with aniline	500-036-1	25214-70-4	19/12/2011	Carcinogenic (article 57 a)
Lead styphnate	239-290-0	15245-44-0	19/12/2011	Toxic for reproduction (article 57 c)
Bis(2-methoxyethyl) phthalate	204-212-6	117-82-8	19/12/2011	Toxic for reproduction (article 57 c)
Trilead diarsenate	222-979-5	3687-31-8	19/12/2011	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Aluminosilicate Refractory Ceramic Fibres	-	-	19/12/2011	Carcinogenic (article 57 a)
Bis(2-methoxyethyl) ether	203-924-4	111-96-6	19/12/2011	Toxic for reproduction (article 57 c)
2,2'-dichloro-4,4'-methylenedianiline	202-918-9	101-14-4	19/12/2011	Carcinogenic (article 57 a)
Cobalt dichloride	231-589-4	7646-79-9	2011/06/20 - 2008/10/28	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
1,2-Benzenedicarboxylic acid, di-C6-8-branched alkyl esters, C7-rich	276-158-1	71888-89-6	20/06/2011	Toxic for reproduction (article 57c)
Strontium chromate	232-142-6	02/06/7789	20/06/2011	Carcinogenic (article 57a)

1,2-Benzenedicarboxylic acid, di-C7-11-branched and linear alkyl esters	271-084-6	68515-42-4	20/06/2011	Toxic for reproduction (article 57c)
1-Methyl-2-pyrrolidone	212-828-1	872-50-4	20/06/2011	Toxic for reproduction (article 57c)
1,2,3-Trichloropropane	202-486-1	96-18-4	20/06/2011	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
2-Ethoxyethyl acetate	203-839-2	111-15-9	20/06/2011	Toxic for reproduction (article 57c)
Hydrazine	206-114-9	302-01-2, 7803-57-8	20/06/2011	Carcinogenic (article 57a)
Cobalt(II) diacetate	200-755-8	71-48-7	15/12/2010	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
2-Ethoxyethanol	203-804-1	110-80-5	15/12/2010	Toxic for reproduction (article 57c)
Cobalt(II) sulphate	233-334-2	10124-43-3	15/12/2010	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Acids generated from chromium trioxide and their oligomers.	231-801-5, 236-881-5	7738-94-5, 13530-68-2	15/12/2010	Carcinogenic (article 57a)
2-Methoxyethanol	203-713-7	109-86-4	15/12/2010	Toxic for reproduction (article 57c)
Chromium trioxide	215-607-8	1333-82-0	15/12/2010	Carcinogenic and mutagenic (articles 57 a and 57 b)
Cobalt(II) carbonate	208-169-4	513-79-1	15/12/2010	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Cobalt(II) dinitrate	233-402-1	10141-05-6	15/12/2010	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Trichloroethylene	201-167-4	79-01-6	18/06/2010	Carcinogenic (article 57 a)
Potassium dichromate	231-906-6	7778-50-9	18/06/2010	Carcinogenic, mutagenic and toxic for reproduction (articles 57 a, 57 b and 57 c)
Tetraboron disodium heptaoxide, hydrate	235-541-3	12267-73-1	18/06/2010	Toxic for reproduction (article 57 c)
Boric acid	233-139-2, 234-343-4	10043-35-3, 11113-50-1	18/06/2010	Toxic for reproduction (article 57 c)
Ammonium dichromate	232-143-1	05/09/7789	18/06/2010	Carcinogenic, mutagenic and toxic for reproduction (articles 57 a, 57 b and 57 c)
Sodium chromate	231-889-5	03/11/7775	18/06/2010	Carcinogenic, mutagenic and toxic for reproduction (articles 57 a, 57 b and 57 c)
Disodium tetraborate, anhydrous	215-540-4	1303-96-4, 1330-43-4, 12179-04-3	18/06/2010	Toxic for reproduction (article 57 c)
Potassium chromate	232-140-5	7789-00-6	18/06/2010	Carcinogenic and mutagenic (articles 57 a and 57 b).
Acrylamide	201-173-7	79-06-1	30/03/2010	Carcinogenic and mutagenic (articles 57 a

				and 57 b)
Lead sulfochromate yellow (C.I. Pigment Yellow 34)	215-693-7	1344-37-2	13/01/2010	Carcinogenic and toxic for reproduction (articles 57 a and 57 c))
Lead chromate molybdate sulphate red (C.I. Pigment Red 104)	235-759-9	12656-85-8	13/01/2010	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
2,4-Dinitrotoluene	204-450-0	121-14-2	13/01/2010	Carcinogenic (article 57a)
Anthracene oil	292-602-7	90640-80-5	13/01/2010	Carcinogenic¹, PBT and vPvB (articles 57a, 57d and 57e)
Anthracene oil, anthracene paste, anthracene fraction	295-275-9	91995-15-2	13/01/2010	Carcinogenic², mutagenic³, PBT and vPvB (articles 57a, 57b, 57d and 57e)
Anthracene oil, anthracene-low	292-604-8	90640-82-7	13/01/2010	Carcinogenic², mutagenic³, PBT and vPvB (articles 57a, 57b, 57d and 57e)
Diisobutyl phthalate	201-553-2	84-69-5	13/01/2010	Toxic for reproduction (article 57c)
Tris(2-chloroethyl)phosphate	204-118-5	115-96-8	13/01/2010	Toxic for reproduction (article 57c)
Lead chromate	231-846-0	7758-97-6	13/01/2010	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Anthracene oil, anthracene paste	292-603-2	90640-81-6	13/01/2010	Carcinogenic², mutagenic³, PBT and vPvB (articles 57a, 57b, 57d and 57e)
Pitch, coal tar, high temp.	266-028-2	65996-93-2	13/01/2010	Carcinogenic, PBT and vPvB (articles 57a, 57d and 57e)
Anthracene oil, anthracene paste,distn. lights	295-278-5	91995-17-4	13/01/2010	Carcinogenic², mutagenic³, PBT and vPvB (articles 57a, 57b, 57d and 57e)
Lead hydrogen arsenate	232-064-2	7784-40-9	28/10/2008	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Benzyl butyl phthalate (BBP)	201-622-7	85-68-7	28/10/2008	Toxic for reproduction (article 57c)
Bis (2-ethylhexyl)phthalate (DEHP)	204-211-0	117-81-7	28/10/2008	Toxic for reproduction (article 57c)
Bis(tributyltin)oxide (TBTO)	200-268-0	56-35-9	28/10/2008	PBT (article 57d)
5-tert-butyl-2,4,6-trinitro-m-xylene (musk xylene)	201-329-4	81-15-2	28/10/2008	vPvB (article 57e)
Diarsenic trioxide	215-481-4	1327-53-3	28/10/2008	Carcinogenic (article 57a)
Triethyl arsenate	427-700-2	15606-95-8	28/10/2008	Carcinogenic (article 57a)
Diarsenic pentaoxide	215-116-9	1303-28-2	28/10/2008	Carcinogenic (article 57a)

Sodium dichromate	234-190-3	7789-12-0, 10588-01-9	28/10/2008	Carcinogenic, mutagenic and toxic for reproduction (articles 57a, 57b and 57c)
Dibutyl phthalate (DBP)	201-557-4	84-74-2	28/10/2008	Toxic for reproduction (article 57c)
4,4'-Diaminodiphenylmethane (MDA)	202-974-4	101-77-9	28/10/2008	Carcinogenic (article 57a)
Alkanes, C10-13, chloro (Short Chain Chlorinated Paraffins)	287-476-5	85535-84-8	28/10/2008	PBT and vPvB (articles 57 d and 57 e)
Anthracene	204-371-1	120-12-7	28/10/2008	PBT (article 57d)
Hexabromocyclododecane (HBCDD) and all major diastereoisomers identified	247-148-4 and 221-695-9	25637-99-4, 3194-55-6 (134237-50-6) (134237-51-7) (134237-52-8)	28/10/2008	PBT (article 57d)

Source: European Chemicals Agency website

According to the Article 6(6) of EU Ecolabel legislation EC/66/2010[489], the product or any part of it thereof shall not contain substances or mixtures meeting the criteria for classification as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction (CMR), in accordance with CLP Regulation (EC) No 1272/2008, nor to goods containing substances referred to in Article 57 of REACH Regulation. The list of hazard statements according to CLP for hazardous substances which are excluded from the EU ecolabelled products is provided below:

[489] Regulation (EC) N $_0$ 66/2010 of the European Parliament and the council of 25 November 20009 on the EU Ecolabel. For more details see: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:027:0001:0019:EN:PDF

Table 102 List of hazard statements and risk phrases

Hazard statement according to CLP 1272/2008/EEC	Associated risk phrases according to Directive 67/548/EEC
H300 Fatal if swallowed	R28
H301 Toxic if swallowed	R25
H304 May be fatal if swallowed and enters airways	R65
H310 Fatal in contact with skin	R65
H311 Toxic in contact with skin	R65
H330 Fatal if inhaled	R23; R26
H331 Toxic if inhaled	R23
H340 May cause genetic defects	R23
H341 Suspected of causing genetic defects	R68
H350 May cause cancer	R45
H350i May cause cancer by inhalation	R49
H351 Suspected of causing cancer	R40
H360F May damage fertility	R60
H360D May damage the unborn child	R61
H360FD May damage fertility. May damage the unborn child	R60-61
H360Fd May damage fertility. Suspected of damaging the unborn child	R60-63
H360Df May damage the unborn child. Suspected of damaging fertility	R61-62
H361f Suspected of damaging fertility	R62
H361d Suspected of damaging the unborn child	R63
H361fd Suspected of damaging fertility. Suspected of damaging the unborn child	R62-63
H362 May cause harm to breast-fed children	R64
H370 Causes damage to organs	R39/23; R39/24; R39/25; R39/26; R39/27; R39/28
H371 May cause damage to organs	R68/20; R68/21; R68/22
H372 Causes damage to organs through prolonged or repeated exposure	R48/25; R48/24; R48/23
H373 May cause damage to organs through prolonged or repeated exposure	R48/20; R48/21; R48/22
H400 Very toxic to aquatic life	R50
H410 Very toxic to aquatic life with long-lasting effects	R50-53
H411 Toxic to aquatic life with long-lasting effects	R51-53
H412 Harmful to aquatic life with long-lasting effects	R52-53
H413 May cause long-lasting harmful effects to aquatic life	R53
EUH059 Hazardous to the ozone layer	R59
EUH029 Contact with water liberates toxic gas	R29
EUH031 Contact with acids liberates toxic gas	R31
EUH032 Contact with acids liberates very toxic gas	R32
EUH070 Toxic by eye contact	R39-41
H334 May cause allergy or asthma symptoms or breathing difficulties if inhaled	R42
H317 May cause allergic skin reaction	R43

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