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"WOODEN FLOOR COVERING"

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LIST OF ABBREVIATIONS AND ACRONYMS

AP	Acification Potential
APCOR	Portuguese Cork Association
BAT	Best Available Technologies
BNAT	Best Not Available Technologies
BREF	Best Available Techniques Reference Document
BPR	Biocidal Product Regulation
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLP	Classification, Labelling and Packaging
COD	Chemical Oxygen Demand
DPD	Dangerous Preparations Directive
DPLF	Direct Pressure Laminate Flooring
DSD	Dangerous Substance Directive
ECHA	European Chemicals Agency
EEA	European Economic Area
EP	Eutrophication Potential
EPD	Environmental Product Declaration
EPLF	European Producers of Laminate Flooring
EoL	End of Life
EXPVAL	Export value
FLEGT	Forest Law Enforcement, Governance and Trade
FSC	Forest Stewardship Council
GWP	Global Warming Potential
GDP	Gross domestic product
GHS	Globally Harmonized System of Classification and Labelling of Chemicals (United Nations)
GPP	Green Public Procurement
HPLF	High Pressure Laminate Flooring
HS	Codes Harmonized System Codes
HTP	Human Toxicity Potential
IBU	Institut Bauen und Umwelt e.V.
IMPVAL	Import value
IPCC	Intergovernmental Panel on Climate Change
LCA	Life Cycle Assessment
MDA	4,4-Diaminodiphenylmethane
MDF	Medium Density Fibreboard
MSs	Member States
ODP	Ozone Depletion Potential
OSB	Oriented Strand Board
PCR	Product Category Rules
PE	Polyethylene
PEF	Product Environmental Footprint
PEFC	Programme for the Endorsement of Forest Certification

PET	Polyethylene terephthalate
POCP	Photochemical Ozone Creation Potential
PP	Polypropylene
PRC	EUROCONTROL Performance Review Commission
PRODCOM	PRODuction COMmunautaire (Community Production)
PRODVAL	Production value
PS	Polystyrene
PVC	Polyvinyl chloride
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SFM	Sustainable Forest Management
SME	Small and Medium Enterprise
SVHC	Substance of Very High Concern
TOC	Total Organic Carbon
TSS	Total Suspended Solid
VOC	Volatile Organic Compound
VPAs	Voluntary Partnership Agreements
WFC	Wooden Floor Covering
WIP	Waste Incineration Plant
WPB	Weather and Boil Proof

Units: Conventional SI units and prefixes used throughout: {kg, kilogramme, unit mass}; {t, metric tonne, 10^3 kg};{k, kilo, 10^3}; {M, mega, 10^6}; {G, giga, 10^9}

INTRODUCTION

1.1 Background

The EU Ecolabel initiative is a policy instrument designed to encourage the production and use of more environmentally friendly products and services through the certification and specification of products or services which have a reduced environmental footprint. It forms part of the European Commission's Action Plan on Sustainable Consumption and Production[1] and Sustainable Industrial Policy adopted on 16 July 2008.

The EU Ecolabel, as a voluntary scheme at EU level is used to distinguish environmentally beneficial products and services, is awarded through a process in which an applicant has to demonstrate that the specified Ecolabel criteria for a particular product group are met. Successful applicants are then allowed to use the EU Ecolabel logo and to advertise their products as having been awarded the EU Ecolabel.

1.2 Purpose of the document

This document forms part of the process of revision existing EU Ecolabel criteria for **Wooden Floor Covering (WFC)** and encapsulates the activities and outputs related to the revision of the legislation and voluntary schemes, economic and market analysis, technical analysis and improvement potentials. This report represents a first evaluation of likely areas for investigation as a result of stakeholder surveys, research on market aspects and known concerns with existing criteria including, for example, changes in hazardous substances

The information contained in this document provides an overview of changes to the wooden floor covering market since the last revision of the criteria in 2007/2009 and a technical analysis to understand where the greatest environmental impacts arise in the life cycle of wooden flooring. This report is also supporting the documents sent to gain feedback, evidence and opinion form stakeholders and experts on the proposed changes and significant environmental issues.

[1] Communication COM/2008/0397 from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan {SEC(2008) 2110} {SEC(2008) 2111} final available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52008DC0397&from=EN

This document covers the revision of the current EU Ecolabel criteria for Wooden Floor Coverings that came into force by the Commission Decision of 26 November 2009[2] and are due to expire in 2015. The aim of this revision is to adapt the criteria to benchmark the best 10-20% of the products available on the European market in terms of environmental performance considering the whole life-cycle perspective. The benchmarking should be in accordance with the last market and technological changes occurred in the sector.

1.3 Investigation overview

The revision process takes the existing criteria document as the starting point and seeks to update these, taking into account technological and economic changes in the European market, relevant legislative changes and improved scientific knowledge.

To review the existing EU Ecolabel, the following aspects have been investigated:

a) product definition and categorization of wooden floor covering: this includes a review of the legislation, European standards, other voluntary schemes, etc.

b) an economic and market analysis

c) technical analysis including environmental performance investigation of the wooden floor covering product groups, feedback from stakeholders, assessment of hazardous substances and identification of the most relevant areas for setting criteria and evaluation and monitoring measures

d) Improvement potential of proposed measures and /or criteria.

Finally, inputs from the revision of EU Ecolabel criteria for other product groups that can be of interest to the revision of EU Ecolabel criteria for wooden floor coverings and that are currently on-going will be considered. Therefore, outputs and findings of these studies will be considered in this revision aiming at aligning all the related EU Ecolabel schemes.

[2] Commission Decision of 26 November 2009 on establishing the ecological criteria for the award of the Community Ecolabel for wooden floor coverings (2010/18/EC) available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:008:0032:0042:EN:PDF

2 DEFINITION AND CATEGORIZATION

2.1 Introduction

The aim of this revision is first to conduct a review of the practicality of the existing product group definition and scope. The areas where the existing criteria and scope are no longer in line with the current legislation or standards will be identified. This identification will be mainly done by considering a legislation and national labels review. This first chapter has been divided into the following sections:

a) an introduction to the existing product group and definition

b) a summary of the feedback received from the stakeholder questionnaire

c) a review of existing EU legislation that is likely to affect the criteria revision

d) a review of the alternative and national schemes for wooden floor covering

e) summary of the proposed changes and new proposal for the definition and scope.

2.2 Introduction to the existing product group and definition

Commission Decision 2010/18/EC defines wooden floor covering as the following:

> The product group '**wooden floor coverings'** shall comprise wood- and plant-based coverings, including wood and timber coverings, laminate floorings, cork coverings and bamboo floorings which are made, for more than 90 % in mass (in the final product), from wood, wood powder and/or wood/ plant-based material. It does not apply to wall coverings where properly indicated, or coverings for external use or for coverings with a structural function.
>
> This product group will not include any covering treated with biocidal products at any stage of the production process, except where those biocidal products are included in Annex IA to Directive 98/8/EC of the European Parliament and of the Council (2) and where the active substance is authorised for the use in question according to Annex V to Directive 98/8/EC.

Before discussing in detail the classification of wooden floor covering, it is important that certain key concepts of their composition are described. The wooden floor covering product group is currently divided into four main product groups, which are:

> **Wood and timber coverings** are 'wood floors or wall coverings made of one solid piece of wood that have tongue and groove sides or constructed from several wood plies that are glued together in a multilayer panel. A wood covering can be unfinished, and once installed sanded, then finished on site or pre-finished in a factory.'
>
> Wood and timber coverings criteria can be applicable both for wall and floor coverings, if the production processes remain the same, using the same materials and the same manufacturing methods. The criteria are set and valid for internal use only.

The industry producing wood floor coverings determines its technical position in the European Committee for Standardisation CEN/TC 112.

Laminate floorings are 'rigid floor covering with a surface layer consisting of one or more thin sheets of a fibrous material (usually paper), impregnated with aminoplastic thermosetting resins (usually melamine), pressed or bonded on a substrate, normally finished with a backer'.

Laminates coverings criteria can be applicable only for floor coverings and for indoor use.

The industry producing laminate floor coverings determines its technical position in the European Committee for Standardisation CEN/TC 134.

Cork coverings are floor or wall coverings the main component of which is cork. The granulated cork is mixed with a binder, and then cured or several layers of cork (agglomerated/veneer) can be pressed together with glue.

The cork coverings can be divided into natural cork tiles (the main component of which is agglomerated composition cork, intended to be used with a finish) and in engineered cork panels (consisting of several layers including a fibreboard the main component of which is agglomerated cork or has cork as technical solution, intended to be used with a finishing wear layer).

Cork coverings criteria can be applicable both for wall and floor coverings, if the production processes remain the same, using the same materials and the same manufacturing methods. The criteria are set for indoor use only.

The European 'cork' floor covering industry determines its technical position in the European Committee for Standardisation CEN/TC134.

Bamboo floor covering are made of bamboo in solid pieces or in agglomerates as a main component. Bamboo coverings criteria can be applicable only for floor coverings and for indoor use.

2.3 Feedback from stakeholder consultation on the product group definition

A customized questionnaire was prepared and sent to stakeholders to obtain feedback from stakeholder consultation. The addressed list includes European Ecolabel Boarding (EUEB) members, Competent Bodies of the Member States, manufacturers of wooden floor coverings, NGOs and consumer associations, technology institutes and trade associations. A blank copy of the questionnaire can be found in Annex I and stakeholder's feedback is summarized and analysed along the document.

Stakeholders were asked whether they agree or not with the existing definition of products in scope and whether any further wooden flooring should be included. Around 80% of the respondents agreed with the existing scope although they suggested that a drop of the wood and wood-based material content, currently restricted to 90% w/w, would be beneficial.

2.4 Review of relevant European llegislation and key changes since the last revision

There is no specific EU legislation for wooden floor covering. However, several tools and standards related to the environment, chemicals, health and safety directly affect this product group and have been identified in this report.

Wood and wood-based products are regulated by several directives and regulations that prevent from potential harmful impacts on human health and the environment. The main regulatory framework is briefly listed in this section:

a) Directives of the European Parliament and the European Council:

- **Directive 76/769/EEC**[3] **on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations**. This Directive compiles marketing and use restrictions for a wide variety of substances, preparations and products. No major changes have occurred.
- **Directive 79/117/EEC**[4] **prohibiting the placing on the market and use of plant protection products containing certain active substances.** No major changes have occurred.
- **Directive 93/68/EEC on CE marking**[5] should be applied by European floor covering producers to guarantee the safety of their products. The CE sign certifies that a product complies with EU safety, health and environmental protection regulations.
- **Directive 94/62/EC**[6] **on packaging and packaging waste**. This Directive aims to prevent or reduce the impact of packaging and packaging waste on the environment. It contains provisions on the prevention of packaging waste, on the re-use of packaging and on the recovery and recycling of packaging waste. No major changes have occurred.
- **Directive 1996/61/EC**[7] **concerning integrated pollution prevention and control**. No major changes have occurred.
- **Directive 1999/13/EC**[8] **on the limitation of emissions of volatile organic compounds (VOCs) due to the use of organic solvents in certain activities and installations**. No major changes have occurred.

[3] Directive 76/769/EEC of 27 July 1976 on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations, (OJ L 262, 27.9.1976, p. 201), available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31976L0769:EN:HTML

[4] Directive 79/117/EEC of 21 December 1978 prohibiting the placing on the market and use of plant protection products containing certain active substances, available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31979L0117:EN:HTML

[5] http://ec.europa.eu/enterprise/policies/single-market-goods/cemarking/index_en.htm

[6] Directive 94/62/EC of 20 December 1994on packaging and packaging waste. OJL 365, 31.12.1994, p. 10-23, available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31994L0062:EN:HTML

[7] Council Directive 96/61/EC of 24September 1996 concerning integrated pollution prevention and control: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31996L0061:EN:HTML

- **Directive 1999/44/EC[9] on certain aspects of the sale of consumer goods and associated guarantees**. No major changes have occurred.
- **Directive 2002/45/EC[10] amending for the twentieth time Directive 76/769/EEC relating to restrictions on the marketing and use of certain dangerous substances and preparations (short-chain chlorinated paraffin)**. No major changes have occurred.
- **Directive 2004/42/EC[11] on the limitation of emissions of volatile organic compounds (VOCs) due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC**. No major changes have occurred.
- **Directive 2008/98/EC[12] on waste**. Wooden floor covering production generates waste for example waste from wood processing and the production of slabs, wood preservation wastes and wastes from the use of coatings and varnishes. This Directive lays down measures to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use. No major changes have occurred. No major changes have occurred.

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[8] Directive 1999/13/EC of 11March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations, available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0013:EN:HTML

[9] Directive 1999/44/EC of 25 May 1999 on certain aspects of the sale of consumer goods and associated guarantees, available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0044:EN:HTML

[10] Directive 2002/45/EC of 25 June 2002amending for the twentieth time Council Directive 76/769/EEC relating to restrictions on the marketing and use of certain dangerous substances and preparations (short-chain chlorinated paraffins), available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:177:0021:01:EN:HTML

[11] Directive 2004/42/CE of the European Parliament and of the Council of 21April 2004on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC, available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:143:0087:0096:EN:PDF

[12] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0030:EN:PDF

b) Regulations of the European Parliament and the Council:

- **Regulation (EC) No 1907/2006**[13] **concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH),** establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EC) N° 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.

REACH does not allow marketing of a chemical substance if it does not have appropriate registration, which has to be carried out by every legal entity that manufacture or import from outside of the European Union substances on their own, in preparations or in articles in quantities of 1 tonne or above per year. REACH places responsibility on industry to manage the risks that chemicals may pose to human health and environment, as well as to provide safety information that would be passed down the supply chain. The companies that do not undertake this procedure, will not be able to produce, sell or use their products and would consequently be forced to stop their activity.

In addition to the registration, **REACH** regulates other procedures such as the management of the risk and hazardous properties of the substance, authorisation of substances of very high concern (**SVHC**) such as carcinogenic, mutagenic and/or toxic for reproduction, persistent, bio-accumulative and toxic or very persistent and very bio-accumulative and the restriction on the manufacturing, placing on the market and use of certain dangerous substances, preparations and articles when an unacceptable risk to human health or the environment exists.

Certain substances[14] that may cause serious and often irreversible effects on human health and the environment can be identified as SVHC. REACH aims at ensuring that the risks resulting from the use of SVHCs are controlled and that the substances are replaced where possible. A Member State, or ECHA[15] on request of the European Commission, can propose a substance to be identified as an SVHC. Placing on the market and use of SVHC included in the Authorisation List: Annex XIV of REACH regulation, requires authorisation. A manufacturer, importer or downstream user can apply for the authorisation. Applications for authorisation are submitted to ECHA. At the end of the authorisation process, which includes a public consultation and the development of opinions by ECHA´s Committees on Risk Assessment and Socio-economic Analysis, the European Commission decides on the granting or refusing of authorisations. SVHC listed in Annex XIV of REACH Regulation (Authorisation list) are given in the table below:

[13] 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, amending Directive 1999/45/EC and repealing 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; Official Journal of the European Union L 396 of 30 December 2006; available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:136:0003:0280:en:PDF.

[14] Substances of Very High Concern: http://echa.europa.eu/web/guest/addressing-chemicals-of-concern/authorisation.

[15] ECHA: European Chemicals Agency (http://echa.europa.eu/)

Table 1 - Substances of Very High Concern listed in Annex XIV (Authorisation List)[16]

SUBSTANCE NAME	EC NUMBER	CAS NUMBER	SUNSET DATE	Latest application date
Tris(2-chloroethyl)phosphate (TCEP)	204-118-5	115-96-8	21/08/2015	21/02/2014
Hexabromocyclododecane (HBCDD), alpha-hexabromocyclododecane, beta-hexabromocyclododecane, gamma-hexabromocyclododecane	221-695-9, 247-148-4	3194-55-6, 25637-99-4 , 134237-50- , 134237-51-7, 134237528	21/08/2015	21/02/2014
2,4 – Dinitrotoluene (2,4-DNT)	204-450-0	121-14-2	21/08/2015	21/02/2014
Diarsenic pentaoxide	215-116-9	1303-28-2	21/05/2015	21/11/2013
Lead chromate	231-846-0	7758-97-6	21/05/2015	21/11/2013
Lead sulfochromate yellow *(C.I. Pigment Yellow 34)*	215-693-7	1344-37-2	21/05/2015	21/11/2013
Lead chromate molybdate sulphate red *(C.I. Pigment Red 104)*	235-759-9	12656-858	21/05/2015	21/11/2013
Diarsenic trioxide	215-481-4	1327-53-3	21/05/2015	21/11/2013
Dibutyl phthalate (DBP)	201-557-4	84-74-2	21/02/2015	21/08/2013
Bis(2-ethylhexyl) phthalate (DEHP)	204-211-0	117-81-7	21/02/2015	21/08/2013
Benzyl butyl phthalate (BBP)	201-622-7	85-68-7	21/02/2015	21/08/2013
Diisobutyl phthalate (DIBP)	201-553-2	84-69-5	21/02/2015	21/08/2013
5-tert-butyl-2,4,6-trinitro-m-xylene *(Musk xylene)*	201-329-4	81-15-2	21/08/2014	21/02/2013
4,4'-Diaminodiphenylmethane (MDA)	202-974-4	101-77-9	21/08/2014	21/02/2013

The identification of a substance as SVHC and its inclusion in the Candidate List[17] is the first step of the authorisation procedure. Companies may have immediate legal obligations following such inclusion which are linked to the listed substances on its own, in preparations and articles. Chemicals that are restricted are referred to under Article 57 and listed in Annex XVII[18] of REACH, while Article 59 (1) sets out a procedure for the recommendation of chemicals considered posing risks to human health and/or the environment.

[16] European Chemicals Agency list (http://echa.europa.eu/web/guest/candidate-list-table)
[17] Substances on the Candidate List. More information available online at: http://echa.europa.eu/web/guest/candidate-list-table
[18] European Chemicals Agency website: http://echa.europa.eu/web/guest/addressing-chemicals-of-concern/restrictions/list-of-restrictions

- **Regulation (EC) 1272/2008**[19] **on classification, labelling and packaging of substances and mixtures.** On 20 January 2009 this regulation entered into force. It aligns existing EU legislation to the United Nations Globally Harmonised System (GHS)[20]. The date from which substance classification and labelling must be consistent with the new rules was December 2010 and for mixtures will be June 2015. Then the CLP Regulation will replace fully the: Dangerous Substance Directive (67/548/EC) and the Dangerous Preparations Directive (1999/45/EC).

- **Regulation (EC) 66/2010**[21] **on the EU Ecolabel**. The European Union Ecolabel is a voluntary environmental labelling system. It enables consumers to recognize high quality eco-friendly products. This Regulation aims to improve the rules on the award, use and operation of the label.

  A number of key changes, relevant to this product group, were incorporated:

  - criteria would be determined on a scientific basis

  - there would be a focus on the most significant environmental impacts over the product lifecycle

  - the substitution of hazardous substances with safer substances should be promoted

  - any substances classified according to CLP as hazardous to the environment, toxic, carcinogenic, mutagenic or toxic for reproduction (CMR) and referred to in article 57 of Regulation EC/1907/2006 (REACH regulation) would be restricted

  - derogations may be given in respect of the above, if substitution or use of alternative materials is not technically feasible. However no derogations are possible in respect of substances of very high concern (SVHC) identified in accordance with eh procedure set out in REACH article 59

  In developing practical means to implement the Regulation the EUEB has identified the hazard classifications for substances and preparations which would be restricted in all product criteria.

- **Regulation (EC) 995/2010**[22] **laying down the obligations of operators who place timber and timber products on the market**. The main obligations that this regulation sets are:

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[19] 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, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006, Official Journal of the European Union L353 of 31 December 2008, pp. 1–1355, available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:EN:PDF.

[20] United Nations Globally Harmonised System (GHS): http://ec.europa.eu/enterprise/sectors/chemicals/documents/classification/.

[21] Regulation 66/2010 of the European Parliament and of the Council on the EU Ecolabel, available online at: http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:027:0001:0019:EN:PDF

[22] Regulation (EU) 995/2010 of the European parliament and of the Council laying down the obligations of operators who place timber and timber products on the market, available online at: http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:295:0023:0034:EN:PDF

- It prohibits the placing on the EU market for the first time of illegally harvested timber and products derived from such timber;

- It requires EU traders who place timber products on the EU market for the first time to exercise 'due diligence'[23] and

- keep records of their suppliers and customers for at least 5 years. This information is only needed for the period up to the last point of sale between businesses. No information is needed on sales to end consumers

This Regulation covers a wide range of timber products listed in Table 2 that can be of interest in this EU Ecolabel criteria revision. Timber and timber products covered by valid FLEGT[24] or CITES[25] license are considered to comply with the requirements of this Regulation.

Table 2 - Product groups of interest covered by the EU Timber Regulation 995/2010

Code	Definition
4403	Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared
4407	Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm
4408	Sheets for veneering (including those obtained by slicing laminated wood), for plywood or for other similar laminated wood and other wood, sawn lengthwise, sliced or peeled, whether or not planed, sanded, spliced or end-jointed, of a thickness not exceeding 6 mm
4409	Wood (including strips and friezes for parquet flooring, not assembled) continuously shaped (tongued, grooved, rebated, chamfered, V-jointed, beaded, moulded, rounded or the like) along any of its edges, ends or faces, whether or not planed, sanded or end-jointed
4410	Particle board, oriented strand board (OSB) and similar board (for example, waferboard) of wood or other ligneous materials, whether or not agglomerated with resins or other organic binding substances
4411	Fibreboard of wood or other ligneous materials, whether or not bonded with resins or other organic substances

[23] Due diligence is that operators have to undertake a risk management exercise so as to minimise the risk of placing illegally harvested timber, or timber products containing illegally harvested timber, on the EU market. The three key elements of the "due diligence system" are:

a) Information: The operator must have access to information describing the timber and timber products, country of harvest, quantity, details of the supplier and information on compliance with national legislation.

b) Risk assessment: The operator should assess the risk of illegal timber in his supply chain, based on the information identified above and taking into account criteria set out in the regulation.

c) Risk mitigation: When the assessment shows that there is a risk of illegal timber in the supply chain that risk can be mitigated by requiring additional information and verification from his supplier

[24] FLEGT Council Regulation (EC) N° 2173/2005 of 20 December 2005 on the establishment of a FLEGT licensing scheme for imports of timber into the European Community, available online at:
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2005:347:0001:01:EN:HTML

[25] CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora Signed at Washington, D.C., on 3 March 1973 and amended at Bonn, on 22 June 1979, available online at:
http://www.cites.org/sites/default/files/eng/disc/E-Text.pdf

4412	Plywood, veneered panels and similar laminated wood
4413	Densified wood, in blocks, plates, strips or profile shapes

However, the EU Timber regulation does not include recycled products, some bamboo and rattan products and the timber that is being bought or sold by private individuals for their own personal use.

Regarding the effects that this Regulation on the EU Ecolabel criteria, it seems that it will force manufacturers and operators to show and their due of diligence on the traceability of the wood and wood-based material origin and, thus, the consumers (to which is not mandatory to show the information) will get a better understanding of where the timber is coming from.

- **Regulation (EC) No 305/2011[26] on construction products (CPR)** repeals the previous Construction Product Declaration directive. The CPR aims at removing possible obstacles to trade between Member States and ensuring the free movement of construction products. The CPR also ensured that construction products on the market meet the basic requirements concerning among other aspects mechanical resistance and stability.

- Regulation (EC) No 528/2013 concerning the making available on the market and use of biocidal Products Replaced (BPR) repeals and replaces the 1998 Biocides Directive (98/8/EC) concerning the placing of biocidal products on the market. That directive applied only to products containing active agents that imparted biocidal properties to the product into which they were incorporated. Under the 1998 Directive, active substances had to be assessed at the Community level. Once an active substance has been assessed, it could be included in Annex I. Each Member State was then required to authorise products containing the biocide before they could be placed in the market in that individual Member State. Once authorized by one EU Member State, the product could then be placed on the market in any other EU Member State.

Under the 2012 Biocides Regulation, EU Member states retain the obligation to authorize products containing biocides before they can be placed on the market in that individual Member State. In addition, the rules on the mutual recognition of existing authorization have been simplified, in order to speed up decision-making, facilitate market access to other Member States and avoid duplication. The mandate for the regulation of biocidal products has been transferred to the ECHA with the aim being further converge with the biocidal requirements of REACH. The 2012 regulation also establishes a Register for Biocidal Products, which allows the Member States, the commission and ECHA to make available to each other the particulars and scientific documentation submitted in connection with applications for authorization of biocidal products.

The key principle is that treated articles should not be placed on the EU market unless all active substances contained in the biocidal products with which they were treated or

[26] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:088:0005:0043:EN:PDF

which they incorporate are approved for use in the BPR. In addition to this, biocide[27] treated articles require additional labelling under BPR. This means that companies who are placing wooden floor covering on the EU market must receive information from their suppliers (even third countries suppliers) regarding whether these products have been treated by biocides. If yes, companies need to know which biocides have been used for treatment and then make a decision regarding whether to stop selling treated coverings or re-label them in accordance with BPR.

c) Commission communications:

- **Commission communication COM(2013)659 on "A new EU Forest strategy: for forests and forest-based sector"[28].** The 1998 EU Forest Strategy established a framework for forest-related actions that support sustainable forest management and are based on cooperative, beneficial links between EU and Member State policies and initiatives. The Forest Action Plan[29] 2007-2011 was an important instrument for implementing the strategy but ex-post evaluation of this plan underlined the need for a new forest strategy that develops and implements a common vision of multifunctional and sustainable forest management in Europe, defines action priorities and targets, links EU and Member State funding strategies and plans, strengths coherent cross-sectional activity planning, funding and implementation, establishes clear mechanisms for monitoring, evaluating and reporting and revises stakeholder involvement.

  The COM(2013)659 supports and identifies those principles needed to strengthen sustainable forest management and to improve competitiveness while ensuring forest protection and delivery of ecosystem services. These guiding principles are the FOREST EUROPE principles[30] applied by Member States' policies and supported by the EU. The six criteria are listed below and a brief explanation together with the indicators to be measured and monitored included in the Annex II.

  - Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles;

[27] Biocides are chemicals used to suppress organisms that are harmful to human or animal health, or that cause damage to natural or manufactured materials. These harmful organisms include pests and germs (i.e. moulds and bacteria). Examples of biocidal products are insect repellents, disinfectants and industrial chemicals like anti-fouling paints for ships and material preservatives. However, because of their intrinsic properties biocides can pose risks to humans, animals and the environment.

[28] Communication from the Commission to the Council and the European Parliament on a Forestry Strategy for the European Union, available online at: http://ec.europa.eu/agriculture/fore/publi/1998_649_en.pdf
Communication from the Commission to the Council and the European Parliament reporting on the implementation of the EU Forestry Strategy, available online at: http://ec.europa.eu/agriculture/fore/publi/1998_649_en.pdf
Commission Staff Working document, Annex to the: Communication on the implementation of the EU Forestry Strategy, available online at: http://ec.europa.eu/agriculture/publi/reports/forestry/workdoc_en.pdf

[29] Communication from the Commission to the Council and the European Parliament on na EU Forest Action Plan {SEC(2006) 748}

[30] http://www.foresteurope.org/sfm_criteria/criteria

- Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems;

- Maintenance of forest ecosystems' health and vitality;

- Maintenance and encouragement of productive functions of forests (wood and non-wood);

- Maintenance, conservation and appropriate enhancement of protective functions in forest management (notably soil and water);

- Maintenance of other socio-economic functions and conditions.

Forest management plans are an important tool for the implementation of the sustainable forest management at the operational level, and can be a proxy to sustainability; They provide information (in the form of text, maps, tables and graphs) collected during periodic forest inventories at operational forest unit level (stands, compartments) and operations planned for individual stands or compartments to reach the management goals.

2.5 Review of national and third country voluntary schemes

Similar to the EU Ecolabel that operates at European level, there are a variety of national labels in Europe and third countries that operate at national or regional level. The product scope and definitions for a range of national labels have been revised in this section. All labels are multi-attribute Type 1 labelling schemes whose product categories apply to wooden floor covering.

Table 3 - Summary of other labels applicable to wooden floor covering

ECOLABEL NAME	LOGO	REGION	PRODUCT CATEGORY	DATE OF ADOPTION
European Ecolabel[31]		EU-28	Wooden floor covering	From 2010 --> now (under revision)
Nordic Ecolabel or Swan[32]		Denmark, Finland, Iceland, Norway, Sweden	Floor covering	Created in 2002 and extended several times has a validity until October 2015. Revision on-going[33]
Environmentally Friendly Products[34]		Czech Republic	Wooden flooring	May 2010

[31] http://ec.europa.eu/environment/ecolabel/documents/User_manual_wooden_covering.pdf
[32] www.svanen.se/Templates/Criteria/CriteriaGetFile.aspx?fileID
[33] The actual scheme in place for wooden floor coverings, version 5.2, is currently under revision: next version, 6.0, is the set of criteria expected to come in the next months.
[34] http://www.ecolabelindex.com/ecolabel/environmentally-friendly-product-czech-republic

Blue Angel[35] RAL-UZ 38		Germany	Low-Emission Wood Products and Wood-Base Products	January 2013
NF Environnement[36]		France	Parquet	June 2012
ÖSTERREICHISCHES UMWELTZEICHEN[37]		Austria	Floor covering	January 2011 (Issue 1)
Environmental choice[38]		New Zealand	Floor covering	January 2012

A brief description of them is given below:

- **Nordic Ecolabel or Swan**: Is a voluntary ecolabelling scheme that evaluates a product´s impact on the environment throughout the whole life cycle. The label guarantees among other that climate requirements are taken into account and CO_2 emissions (and other harmful gasses) are limited – where it is most relevant. The Nordic Ecolabel is available for 65 product groups among them floor coverings, that has been updated several times and whose last revision is currently at the consultation stage. The label ensures that the products fulfil certain criteria using methods such as samples from independent laboratories, certificates and control visits.
- **NF-Environnement Mark**: A voluntary certification mark issued by AFNOR[39] Certification. To be issued the NF Environment mark the product must comply with ecological and fitness for purpose criteria. These criteria are the result of negotiations between representatives of manufacturers, consumer, environmental protection and distributor associations and public authorities.
- **Blue Angel:** Is the first and oldest environment-related label for products and services in the world. It was created in 1978 in Germany. It considers itself as a market-conform instrument of environmental policy designed to distinguish the positive environmental features of products and services on a voluntary basis.
- **Österreichisches Umweltzeichen**: The Austrian Ecolabel addresses itself primarily to consumers but also to manufacturers and public procurement. The label provides consumers with guidance in order to choose products or services with least hazardous

[35] http://www.blauer-engel.de/en/products_brands/search_products/produkttyp.php?id=316
[36] NF - Wood flooring: http://www.marque-nf.com/appli.asp?NumAppli=NF061&lang=English
[37] http://www.umweltzeichen.at/richtlinien/Uz63_R1.0a_Bodenpflegemittel_1.J%C3%A4nner%202014.pdf
[38] http://www.environmentalchoice.org.nz/, http://www.environmentalchoice.org.nz/docs/licensees/forbo/ec2808floorcoverings.pdf
[39] AFNOR is an international services delivery network that revolves around 4 core competency areas: standardization, certification, industry press, and training.

to the environment or health. The label draws the consumer's attention to aspects of environment, health and quality (fitness for use).

- **Environmental choice (New Zealand):** is an 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.
- **Environmentally Friendly Products**: is the official registered label of The Czech ecolabelling programme. It was launched in 1994 and extended in 2004 to certify services, beginning with tourist accommodation services. At present, the ecolabel can be acquired at 41 categories of products and two categories of services about 400 products and services bearing the label on the market from about 100 companies.

Other labels (Type III) within a broader scope would also cover this product group:

- **Environmental Product Declaration[40]:** The overall goal of the International Environmental Product Declaration (EPD) System is to communicate the environmental performance of their products (goods and services) in an understandable way.

A comparison of the scope and definitions included in each of the above summarized national labels is shown in Table 4.

[40] Environmental Product Declaration, available online at: http://www.environdec.com/

Table 4 - Comparison of the scope established for the most recognized European labels

Label Name	Scope/Definition	CONDITIONS TO BE FULFILLED
CURRENT EU ECOLABEL	Wooden floor coverings shall comprise wood- and plant-based coverings: including **wood and timber coverings, laminate floorings, cork coverings and bamboo floorings** which are made, **for more than 90 % in mass** (in the final product), from wood, wood powder and/or wood/plant-based material.	Excludes: - **wall coverings**, where properly indicated, or coverings for external use or for coverings with a structural function - **any covering treated with biocidal products** at any stage of the production process, except where those biocidal products are included in Annex IA to Directive 98/8/EC of the European Parliament and of the Council[41] and where the active substance is authorised for the use in question according to Annex V to Directive 98/8/EC.
Nordic Swan	**Floor covering for indoor use** and suitable for a concrete, timber joist or similar subfloor (e.g. bamboo floors, solid wood, parquet, laminate, linoleum and textile).	Excludes: - floor covering with a supporting function - floor covering with an integrated heating system - seamless floor covering applied as a curing liquid - carpets products Includes: - **bamboo flooring** in the latest revised version (2011) Requires: - **A minimum of 50% renewable raw** material should comprise into the floor covering
NF-Environnement Mark	Floor covering **made of solid elements** with grooves and/or tongues, elements of solid wood flooring collection, including English units, with guiding system, floors "to stick" (e.g. Lamparquet, clipboard elements and parquet mosaics), and laminated flooring with or without mechanical locking assembly.	Excludes: - The installation itself.

[41] OJ L 123, 24.4.1998, p. 1.

Blue Angel	**Ready-to-use final products for indoor use** (e.g. furniture, interior doors, panels, floorings with painted surfaces, laminate floorings, prefabricated parquet/linoleum) which are mainly made, i.e. **for more than 50 % by volume of wood and/or wood based materials** (chipboards, coreboards, fibreboards, veneer panels, each non-coated or coated).	Excludes: - **floor coverings made of Cork** (covered by RAL-UZ 120 "Resilient Floor Coverings")
Österreichisches Umweltzeichen	This category includes the following floor coverings: - elastic floor coverings according to ÖNORM EN 12466 - floor covering panels for floating installation - textile floor covering, excluding carpet products - **laminate floor covering in accordance with standards** ÖNORM EN 13329[42], ÖNORM EN 14978[43] and ÖNORM EN 15488[44]	
Environmental choice	This category includes floor coverings (such as parquet, wooden planks, composite wood panels, laminate and linoleum) that: - are fixed to the floor and laid on top of an underlying foundation and concrete or wood/beams - have a minimum of 50% by weight of a renewable raw material	Excludes: - **floor coverings applied in a liquid state** - **carpet products** Requires: A **minimum durability** is required for factory varnished wooden floorings and parquet floorings as well as laminate coverings in accordance with the respective standards

[42] ÖNORM EN 13329, Laminate floor coverings — Elements with a surface layer based on aminoplastic thermosetting resins — Specifications, requirements and test methods, available at: https://shop.austrian-standards.at/Preview.action;jsessionid=A264354590A86488E063A5DA8DF513E2?preview=&dokkey=513672&selectedLocale=en

[43] ÖNORM EN 14978 Laminate floor coverings — Elements with acrylic based surface layer, electron beam cured — Specifications, requirements and test methods available at: https://shop.austrian-standards.at/Preview.action;jsessionid=709EDE406B76B2400C847897F26D39E5?preview=&dokkey=510882&selectedLocale=en

[44] ÖNORM EN 15488

In addition, a review of the current criteria included into a selection of national labels is also provided in this section (See Table 5). This review highlights the different approaches taken to labelling and the level of detail employed by the different schemes.

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Table 5 - Comparison of the wood related criteria of the main national labels

EU Ecolabel	Nordic Swan (current version 5.2)	Nordic Swan (new proposed version 6.0)	Blue Angel (RAL-UZ 176)	Österreichisches Umweltzeichen
Wood and wood-based materials: minimum content and required information about source				
Floor covering must be made of at least 90% of wood. Minimum percentages of solid wood and wood-based materials from certified sustainably managed forests or recycled materials are 70 and 40% respectively. No GMO wood	Floor coverings should contain a minimum of 10% wood raw material by weight. including wood raw material but not bamboo. At least 30% (annual average) of the wood shall come from certified forests.	The requirement applies to flooring that comprises a total of at least 10% wood, manufactured board/fibreboard, cork and/or bamboo by weight. At least 70% (annual average) of the wood, 50% of bamboo and cork shall come from certified forests.	The products shall consist by more than 60% by volume of wood and/or wood- based materials. At least 50 percent of the wood or 50% of the primary raw materials for wood-based materials shall be sourced from sustainable forests which are managed in a verifiably economically viable, environmentally sound and socially responsible way.	-
Recycled wood and wood-based materials				
Post-consumer wood chips or fibres applied comply with the provisions in the EPF industry standards. No indication about a minimum required percentage of recycled material.	At least 50% by weight of the floor covering must comprise of renewable raw materials.	At least 80% by weight of the floor covering must comprise of renewable raw materials.	-	-
General requirement on chemical products				
Not impregnated No use of 1a and 1b WHO pesticides Wood surface treatment with substances, adhesives in accordance	Chemical products that are classified according to WHO classification, REACH regulation and EU Regulation (EC) No	After felling, the timber or bamboo must not have been treated with pesticides classified as type 1a and 1b by WHO.	Wood surface treatment with substances, adhesives in accordance with WHO classification, REACH regulation.	Use of chemical products and adhesives in accordance with CLP and REACH regulation.

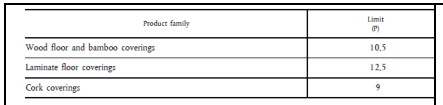
with WHO classification, REACH regulation and EU Regulation (EC) No 66/2010	66/2010 must not actively be added to the floor covering.	Chemical products used to manufacture Nordic Ecolabelled floor coverings must be classified in line with current legislation (CLP Regulation (EC) No 1272/2008 or the EU's Dangerous Preparations Directive 1999/45/EC as amended in 2008 or later).		
VOC, formaldehyde content in adhesives				
The VOC content of adhesives used in the assembly of the product shall not exceed 10 % by weight (w/w). The content of free formaldehyde in products or preparations used in the panels shall not exceed 0,3 % by weight.	-	Adhesives are permitted to contain no more than 3% by weight volatile organic (VOC) compounds.	-	-
Antibacterial substances and biocides				
Only biocidal products containing biocidal active substances included in Annex IA of Directive 98/8/EC, and authorised for use in floor coverings, shall be allowed for use.	Antibacterial substances and biocides in the form of pure active substances or as biocidal products must not be added to finished floor.	Antibacterial substances and biocides in the form of pure active substances or as biocidal products must not be added to finished floor.	The use of biocides shall not be permitted. Biocides exclusively could be used for in-can preservation in aqueous coating materials and glues or flame retardants only.	The use of biocides shall not be permitted.
Nanoparticles				
-	Nanometals, nanominerals, nanocarbon or nanofluorine compounds shall not be actively added to the floor covering.	Nanoparticles (from nanomaterial) must not occur in chemical products or in the finished Nordic Ecolabelled floor covering.	-	-
Surface treatments				

<table>
<tr>
<td>The applied quantity (wet paint/varnish) of environmentally harmful substances shall not exceed 14 g/m^2 surface area and applied quantity (wet paint/varnish) of VOC shall not exceed 35 g/m^2.

Formaldehyde emissions from substances and preparations for surface treatment liberating formaldehyde shall be less than 0,05 ppm.

Plasticisers and phthalates are not permitted to be used in the manufacturing of the product.</td>
<td>The emission of organic solvents must not exceed 2 g/m^2 floor covering.</td>
<td>VOC in surface treatment products must either:
a) be below 5% by weight in total, or
b) amount to a maximum of 2 g/m^2 treated surface in total.</td>
<td></td>
<td></td>
</tr>
<tr>
<td colspan="5">USE PHASE: Emissions from the floor covering (TVOC, formaldehyde, etc.)</td>
</tr>
<tr>
<td>
<table>
<tr><th>Substance</th><th>Requirement (after 3 days)</th></tr>
<tr><td>Total organic compounds within the retension range C6 — C16 (TVOC)</td><td>0,25 mg/m³ air</td></tr>
<tr><td>Total organic compounds within the retension range > C16 — C22 (TSVOC)</td><td>0,03 mg/m³ air</td></tr>
<tr><td>Total VOC without LCI (*)</td><td>0,05 mg/m³ air</td></tr>
</table>
(*) LCI = lowest concentration of interest; see 'Health risk assessment process for emissions of volatile organic compounds (VOC) from building products' (Federal Environmental Agency).

<table>
<tr><td>Formaldehyde (from the panels of cork, bamboo or wood fibres constituting the covering)</td><td>< 0,05 mg/m^3</td></tr>
</table>
</td>
<td>Formaldehyde emissions from the finished floor covering must be less than 0,13 mg/m^3 air.</td>
<td>
<table>
<tr><th>Substances or groups of substances</th><th>Limit value after 28 days in mg/m²h*</th><th>Limit val days in n</th></tr>
<tr><td>TVOC (C6-C16)</td><td>< 0.2</td><td>< 0.16</td></tr>
<tr><td>Formaldehyde in textile flooring
Formaldehyde in other flooring</td><td>< 0.005
< 0.05</td><td>< 0.01
< 0.04</td></tr>
<tr><td>Carcinogenic substances**</td><td>< 0.005</td><td>< 0.004</td></tr>
</table>
</td>
<td>
<table>
<tr><th>Compound or Substance</th><th>3rd Day</th><th>Final Value[8] (28th day)</th></tr>
<tr><td>Total organic compounds within the retention range of C_6 to C_{16} (TVOC)</td><td>≤ 3 mg/m³</td><td>≤ 0.3 mg/m³</td></tr>
<tr><td>Total organic compounds within the retention range of > C_{16} to C_{22} (TSVOC)</td><td>-</td><td>≤ 0.1 mg/m³</td></tr>
<tr><td>Carcinogenic substances[9]</td><td>≤ 10 µg/m³ total</td><td>≤ 1 µg/m³ per single value</td></tr>
<tr><td>Total VOC without LCI[10]</td><td>-</td><td>≤ 0.1 mg/m³</td></tr>
<tr><td>R value[11]</td><td>-</td><td>≤ 1</td></tr>
<tr><td>Formaldehyde</td><td>-</td><td>≤ 0.05 ppm</td></tr>
<tr><td>Ammonia[12]</td><td></td><td>0.1 mg/m³</td></tr>
</table>
</td>
</tr>
<tr>
<td colspan="5">Energy Consumption and waste management</td>
</tr>
<tr>
<td>The energy consumption shall be calculated as the process energy used for the production of the coverings.
The process energy, shall exceed the given limits
(P = scoring point)</td>
<td>The energy consumption shall be calculated as the process energy used for the production of the coverings.
The process energy, shall exceed the given limits (P = scoring point)</td>
<td>At least 95% by weight of the raw materials in the flooring must be included in the calculation of energy consumption.</td>
<td>-</td>
<td>-</td>
</tr>
</table>

 Product family / Limit (P) Wood floor and bamboo coverings 10,5 Laminate floor coverings 12,5 Cork coverings 9	**Solid wood and laminate floor coverings** Environmental parameter / Requirement A = Wood from certified, sustainable forest (%) / Min. 30% B = Proportion of recycled wood raw materials (%) / - C = Proportion of renewable fuels (%) / - D = Electricity consumption (kWh/m²) / Max. 20 kWh/m² E = Fuel consumption (kWh/m²) / Max. 50 kWh/m² $P = \frac{A}{25} + \frac{B}{25} + \frac{C}{25} + (4 - \frac{D}{5}) + (4 - \frac{E}{12,5})$ ***Requirement: P ≥ 8,5 for bamboo flooring*** ***P ≥ 11.5 for laminate flooring*** ***P ≥ 10.5 for wood flooring***	**Energy consumption for Nordic Ecolabelled floor coverings** An energy calculation is to be made, and the total must amount to at least: $E = \frac{A}{20} + (5 - \frac{B}{3}) + (5 - \frac{C}{7})$ • E shall be at least 11.0 for solid wood flooring and laminate flooring • E shall be at least 8.0 for linoleum flooring, parquet flooring, bamboo flooring and cork flooring • E shall be at least 8.5 for textile flooring and plastic flooring.		
Waste management				
The applicant shall provide an appropriated documentation on the procedures adopted for the recovery of the by-products originated from the process (type of disposal and recycling, etc.)	The applicant shall provide an appropriated documentation on the procedures adopted for the recovery of the by-products originated from the process (type of disposal and recycling, etc.)	The flooring manufacturer shall sort waste at source into the fractions that arise during production, including production waste. Furthermore, a plan for separating waste must be drawn up.	-	-
Functional requirements: Durability				
The product shall be fit for use. This evidence may include data from appropriate ISO, CEN or equivalent test methods, such as national procedures.	All Nordic Ecolabelled floor coverings must meet at least the requirements of Classification of resilient, textile and laminate floor coverings (EN 685:2007)	All Nordic Ecolabelled floor coverings must achieve at least (according to EN 14041 and ISO 10874 or EN 12104 (cork tiles): - class 22+ for floor coverings intended for private use - class 33 for floor coverings intended for professional/public use.	-	-
Functional requirements: Product information				
The product shall be sold with relevant user information, which provides advice on the product's proper and best general and technical use as well as its maintenance.	Product information have to be enclosed with the Nordic Ecolabelled floor covering such as recommended subfloor for the floor covering, cleaning method, etc.	Product information have to be enclosed with the Nordic Ecolabelled floor covering such as recommended subfloor for the floor covering, cleaning method, etc.	The product shall be sold with relevant user information, which provides advice on the product's proper and best general and technical use as well as its maintenance.	

Functional requirements: Wet room approval				
-	-	Floor coverings marketed and sold for wet rooms are to be approved for their intended use in wet rooms according to the national industry standard.	-	-
Packaging				
Packaging must be made out of easily recyclable material, or materials taken from renewable resource, or materials intended to be reusable.	-	-	-	-

gives an overview of the importance of each of the labels in the EU market. As seen, the label with the highest share into the market is the Blue Angel while the Österreichisches Umweltzeichen was awarded only to 6 companies.

However, this comparison should be carefully considered as the population in both countries is considerable different (Germany has a population of over 10 times Austria) and wooden floor covering is strongly related to the number of households and the population.

It is also remarkable that the most successful floor covering labels summarized in Table 6 are settled in medium and cold climate zones. This point may be related to the larger use of this product group in those climate zones as well as the larger demand for environmentally friendly products. Regarding the kind of products that are awarded with the label a predominance of solid wood floor coverings over the laminate floorings can be observed. These data are in line with the past market conditions where solid wood coverings were produced at most. No information has been found regarding the number of labelled products made of cork or bamboo.

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Table 6 - Number of labelled products and companies certified established for the most recognized European ecolabels

Ecolabel NAME	COMPANIES CERTIFIED	NUMBER OF ECOLABELLED PRODUCTS
Nordic ecolabel or Swan[45]	7	Laminate flooring (4) Linoleum flooring (16) Parquet flooring (43) Wood flooring (0)
NF-Environnement Mark	8	Solid parquet with grooves and/or tongues (12)

[45] http://www.svanen.se/en/Buyers/Svanenmarkta-varor/?categoryID=354

		Mosaic parquet and lamparquet (4) Parquet (glued) (6)
Blue Angel[46]	>50	Floor coverings made of wood (103) Laminate flooring (59)
Österreichisches Umweltzeichen	6	>70 including non-wooden floor coverings

2.6 European Standards

Standards, which in most of the cases also have a voluntary nature, are also an important aspect to take into account. The new European technical product standards published by CEN provide specifications for most common types of wood elements used in wooden floors. These standards define the terminology and set up safety issues (e.g. test methods on flammability and fire behaviour), test methods and requirements for the end products and their components. A summary of the main European standards of relevance for the wooden floor covering sector can be found in this section:

- UNI EN 13226[47] wood flooring - solid parquet elements with grooves and/or tongues
- UNI EN 13227[48] wood flooring – solid lamparquet products
- UNI EN 13228[49] wood flooring – solid wood overlay flooring elements including blocks with an interlocking system
- UNI EN 13488[50] wood flooring – mosaic parquet elements
- UNI EN 13489[51] wood flooring – multi-layer parquet elements
- UNI EN 13629[52] wood flooring – solid pre-assembled hardwood board
- UNI EN 13756[53] wood flooring – terminology
- UNI EN 14342[54] wood flooring – characteristics, evaluation of conformity and marking
- UNI EN 13990[55] solid softwood floor boards
- UNI EN 14354[56] wood based panels – wood veneer floor covering
- UNI EN 13329[57] laminate floor coverings – specifications, requirements and test methods

[46] http://www.blauer-engel.de/en/products_brands/search_products/produkttyp.php?id=155
[47] http://www.nqic.net/Uploadfiles/20101022095600526.pdf
[48] http://www.nqic.net/Uploadfiles/20120331145555431.pdf
[49] http://211.167.243.154:1012/file/gwbz/EN%2013228-2002.PDF
[50] http://211.167.243.154:1012/file/gwbz/DIN%20EN%2013488-2003.PDF
[51] http://211.167.243.154:1012/file/gwbz/DIN%20EN%2013489-2003.PDF
[52] http://211.167.243.154:1012/file/gwbz/DIN%20EN%2013629-2003.PDF
[53] http://211.167.243.154:1012/file/gwbz/DIN%20EN%2013756-2003.PDF
[54] http://211.167.243.154:1012/file/gwbz/BS%20EN%2014342-2006.PDF
[55] http://211.167.243.154:1012/file/gwbz/DIN%20EN%2013990-2004.PDF
[56] http://211.167.243.154:1012/file/gwbz/DIN%20EN%2014354-2005.PDF
[57] http://kronoloc.ipcoweb.com/user_images/European_Norm_Spec_EN13329.pdf

Regarding the definitions related to this product group in some of the standards listed above (e.g. EN 14342 or EN 13756) the following terms (Table 7) can be of interest:

Table 7 - Terminology of interest included in EN 13756 "Wood flooring – terminology"

Terms	Definition
Element	The smallest individual piece or the smallest piece as delivered prior to installation
Lamparquet element	Parquet element of small dimensions having flat edges
Multi-layer parquet element	Element of laminated construction consisting of a top layer of solid wood and additional layer(s) of wood, or wood-based materials, glued together
Parquet	Wood flooring with a top layer thickness of minimum 2.5mm prior to installation
Parquet panel	Pre-assembled laying unit made up from parquet elements
Wood flooring	Assembly of individual wood elements installed either on the primary structure on the sub-floor
Wood veneer floor covering	Rigid floor covering consisting of an assembly of elements with a core made from a wood based panel with a top layer of wood veneer
Laminate flooring	Laminate flooring is a multi-layer synthetic flooring product fused together with a lamination process. Laminate flooring simulates wood (or sometimes stone) with a photographic applique layer under a clear protective layer. The inner core layer is usually composed of melamine resin and fiber board materials.

2.7 Proposed definition and scope

As reported in this section, very few definitions or scope documents for wooden floor coverings or related products have been developed. However, the few which have been developed tend to define the product group in a similar way, but with differences. The preliminary outputs from the market analysis (section 3) and LCA (section 4) presented in this report have been taken into account when considering the proposed scope and definition. The proposed scope and definition one is as follows:

> ***The product group of 'wooden floor covering' shall comprise wood- and plant-based coverings: including wood and timber coverings, laminate floorings, cork coverings and bamboo floorings which are made, for more than 80 % in mass (in the final product), from wood, wood powder and/or wood/plant-based material. It does not apply to wall coverings, where properly indicated, or coverings for external use or for coverings with a structural function.***

The **proposed change** is focused on the wood and wood-based material content in the floor covering due to the current market conditions. Nowadays the dominant product in the European wooden floor covering market is the laminate. This product consists of several layers of wood-based materials along with other materials (as explained in detail in section 4.x.x). Its average wood or wood-based material content amounts to 80% w/w having no evidence that the higher the wood content in the product the better its environmental performance.

Apart from this proposed change, these product groups are proposed to remain within the same or similar characteristics as in the case of the current definition. These characteristics are

- they are intended to lay on top of an structural element of the building, it means that they do have a non-supportive function and to be used for indoor use
- they are expected to be produced in accordance with international standards that restrict the minimum durability and specify the minimum thickness

The new definition and scope will affect several criteria. The possible implications and consequences are intended to be analysed and assessed along this document. Among those current criteria that can be subjected to changes are those related to the minimum percentage of renewable material required, the use of hazardous substances in the raw materials and surface treatments or the minimum energy consumption level during the production stage.

3 MARKET ANALYSIS

3.1 Introduction

In order to characterise the relevant European market for the product group under study, a market analysis is conducted in this section. The objective of the market analysis is to identify significant changes in the market for wooden floor covering since the last revision of the EU Ecolabel criteria and investigate whether any such changes need to be reflected in the criteria, so that the 10-20% best environmentally performing products will be selected in accordance with Annex 1 of the EU Ecolabel Regulation.

The research in this section consists of a desktop study using a variety of available literature and statistical databases. The market analysis covers the period 2010-14 and includes a market forecast to 2015-2016 or even longer in the future. Data and information have also been collated on market structure, innovation, supply of raw materials and environmental labelling.

3.2 Economic indicators

This section analyses the economic data regarding the product group under study. The scope of the analysis includes the EU 27 countries, taking as reference period the last years with available data. Analysis of PRODCOM data categories compared with the current EU Ecolabel definition and scope indicates that the classification are irreconcilable as only two type of solid wood floor coverings are included in the Prodcom code[58] (Table 8)

Table 8 - PRODCOM classification for wooden floor covering products and parts

PRODCOM Code	Description
16.10.21	Wood, continuously shaped along any of its edges or faces (including strips and friezes for parquet flooring, not assembled, and beadings and mouldings)
16.21.11	Plywood, veneered panels and similar laminated wood, of bamboo
16.21.12	Other plywood, veneered panels and similar laminated wood
16.21.13	Particle boards and similar boards of wood or other ligneous materials
16.21.13.16	Orientated strand board (OSB) of wood
16.21.14	Fibreboard of wood or other ligneous materials
16.21.21	Veneer sheets and sheets for plywood and other wood sawn lengthwise, sliced or peeled, of a thickness ≤ 6 mm
16.21.22	Densified wood, in blocks, plates, strips or profile shapes
16.22.10.30	Parquet panels of wood for mosaic floors
16.22.10.60	Parquet panels of wood (excluding those for mosaic floors)

[58] Product classifications according to Eurostat PRODCOM (http://epp.eurostat.ec.europa.eu/portal/page/portal/prodcom/introduction)

16.29.21	Natural cork, debacked or roughly squared or in blocks, plates, sheets or strip; crushed, granulated or ground cork; waste cork
16.29.23	Blocks, plates, sheets and strips, tiles of any shape, solid cylinders, of agglomerated cork

According to NACE, the statistical classification of economic activities in the European Community (NACE) these products are included in the activity code 20[59]. This division includes the manufacture of veneer sheets, manufacture of plywood, laminate board, particle board, fibreboard and other panels and boards.

The Combined Nomenclature Code (CN code)[60] provides also an overview of the classification of this product group. This classification is used when declaring imported and exported goods and therefore it provides information about the international trading of this product (Table 9).

Table 9 - Wooden floor covering products and parts thereof classified in code 4403 to 4418

CN Code	Description
4403	Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared
4407	Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm
44079131	Blocks, strips and friezes of oak "Quercus spp." for parquet or wood block flooring, not assembled, of a thickness of > 6 mm, planed (excl. veneered or of plywood)
44079139	Oak "Quercus spp.", sawn or chipped lengthwise, sliced or peeled, of a thickness of > 6 mm, planed (excl. end-jointed and blocks, strips and friezes for parquet or wood block flooring)
4408	Sheets for veneering (including those obtained by slicing laminated wood), for plywood or for other similar laminated wood and other wood, sawn lengthwise, sliced or peeled, whether or not planed, sanded, spliced or end-jointed, of a thickness not exceeding 6 mm
4409	Wood, incl. strips and friezes for parquet flooring, not assembled, continuously shaped "tongued, grooved, rebated, chamfered, V-jointed beaded, moulded, rounded or the like" along any of its edges, ends or faces, whether or not planed, sanded or end-jointed
440910	Coniferous wood, incl. strips and friezes for parquet flooring, not assembled, continuously shaped "tongued, grooved, rebated, chamfered, V-jointed beaded, moulded, rounded or the like" along any of its edges, ends or faces, whether or not planed, sanded or end-jointed
44091018	Coniferous wood, incl. strips and friezes for parquet flooring, not assembled, continuously shaped "tongued, grooved, rebated, chamfered, V-jointed beaded, moulded, rounded or the like" along any of its edges, ends or faces, whether or not planed, sanded or end-jointed (excl. mouldings for frames for paintings, photographs, mirrors or similar objects)
44092100	Bamboo, incl. strips and friezes for parquet flooring, not assembled, continuously shaped "tongued, grooved, rebated, chamfered, V-jointed beaded, moulded, rounded or the like" along any of its edges, ends or faces, whether or not planed, sanded or end-jointed

[59] EUROSTAT NACE Rev. 2 – Statistical classification of economic activities in the European Community

[60] Combined nomenclature or CN: imported and exported goods have to be declared stating under which subheading of the nomenclature they fall. The CN is comprised of the Harmonized System (HS) nomenclature with further Community subdivisions.
(http://ec.europa.eu/taxation_customs/customs/customs_duties/tariff_aspects/combined_nomenclature/index_en.htm)

440929	Wood, incl. strips and friezes for parquet flooring, not assembled, continuously shaped "tongued, grooved, rebated, chamfered, V-jointed beaded, moulded, rounded or the like" along any of its edges, ends or faces, whether or not planed, sanded or end-jointed (excl. coniferous wood and bamboo)
44092991	Blocks, strips and friezes for parquet flooring, not assembled, continuously shaped "tongued, grooved, rebated, chamfered, V-jointed, beaded, moulded, rounded or the like" along any of its edges, ends or faces, whether or not planed, sanded or end-jointed, of wood (excl. coniferous wood and bamboo)
44092999	Wood, continuously shaped "tongued, grooved, rebated, chamfered, V-jointed beaded, moulded, rounded or the like" along any of its edges, ends or faces, whether or not planed, sanded or end-jointed (excl. coniferous wood and bamboo, and mouldings for frames for paintings, photographs, mirrors or similar objects, blocks, strips and friezes for parquet flooring)
4410	Particle board, oriented strand board (OSB) and similar board (for example, waferboard) of wood or other ligneous materials, whether or not agglomerated with resins or other organic binding substances
4411	Fibreboard of wood or other ligneous materials, whether or not bonded with resins or other organic substances
4412	Plywood, veneered panels and similar laminated wood
4413	Densified wood, in blocks, plates, strips or profile shapes
4418	Builders' joinery and carpentry, of wood, incl. cellular wood panels, assembled flooring panels, shingles and shakes, of wood (excl. plywood panelling, blocks, strips and friezes for parquet flooring, not assembled, and pre-fabricated buildings)
44187100	Flooring panels for mosaic floors, assembled, of wood
44187200	Flooring panels, multilayer, assembled, of wood (excl. for mosaic floors)
44187900	Flooring panels, assembled, of wood (excl. multilayer panels and flooring panels for mosaic floors)
441890	Builders' joinery and carpentry, of wood, incl. cellular wood panels (excl. windows, French windows and their frames, doors and their frames and thresholds, posts and beams, assembled flooring panels, wooden shuttering for concrete constructional work, shingles, shakes and prefabricated buildings)
44189080	Builders' joinery and carpentry, of wood, incl. cellular wood panels (excl. of glue-laminated timber, and windows, French windows and their frames, doors and their frames and thresholds, posts and beams, assembled flooring panels, wooden shuttering for concrete constructional work, shingles, shakes and prefabricated buildings)

3.2.1 Trade and production data, wooden floor covering market

According to the data provided by Eurostat[61] and Prodcom as well as the European federations of the parquet and laminated industries (EFPL)[62], the overall trade of wooden floor coverings has experienced and important increase in the last years, especially products such as wood and timber flooring and/or laminate flooring. However, and although all the sub-products considered in this

[61] EUROSTAT, 2014 – data come from EuroStat database: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

[62] Market statistics coming from EFPL website, available at: http://www.eplf.com/en/statistics/statistics.html. Last access: May 2014.

revision increased their production in absolute terms, their market shares or relative terms have significantly changed with respect to the last revision in 2008-2009. In this sense, while the solid wood and timber coverings dominated the market, nowadays laminate floorings hold the largest market share.

The EU wooden floor covering experienced substantial growth from 1997 to 2007, increasing the production value over 85%. After that period, the production decreased by 22% from 2007 to 2009 due to the economic recession. From 2009 to 2012 the production slightly recovered with a growth rate nearby 1%.

3.3 Market structure

3.3.1 Product overview and market segmentation

The wooden floor covering products on the European market can be broadly categorised into four different products (see Figure 1):

- solid wood and parquet
- laminate flooring
- cork flooring
- bamboo flooring

Among these products the laminate flooring is the most popular one from the consumption and production point of view. Solid wood and parquet group makes up the second position while cork and bamboo flooring are relatively small proportions. More accurate and detailed figures will be commented in the coming sections.

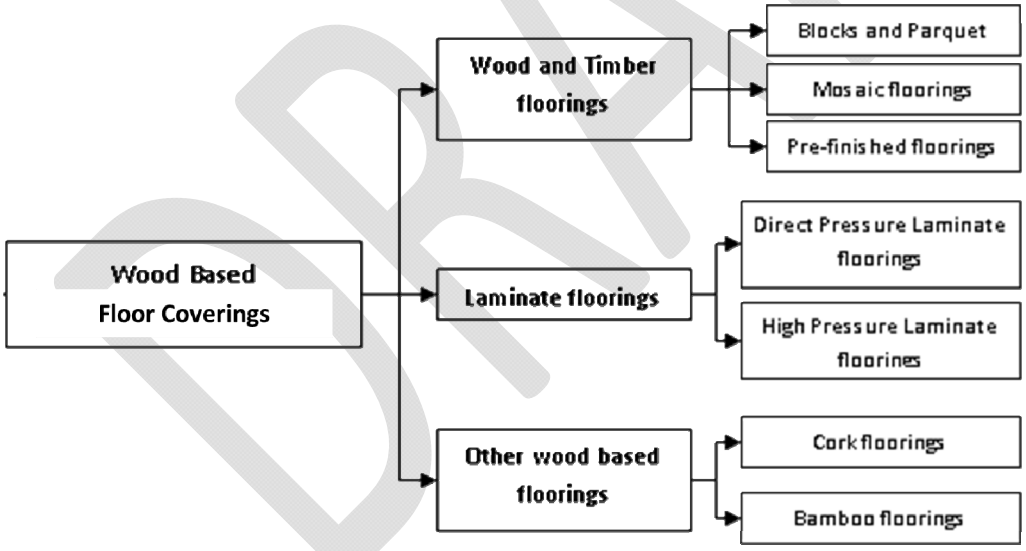


Figure 1 - Market segmentation of the European wooden floor covering product group

3.3.2 Mayor players, SMEs and relative market shares

Wood and wood products account for nearly 2% of manufacturing value added in the EU15 and feature among the top three most important industries in Austria, Finland, Portugal and Sweden[63]. Woodworking industries range from sawmilling, planning and pressure treatment, to the production of wood-based panels and boards, carpentry, joinery, pallets and packaging and furniture. They are very often located in remote, less industrialized or developed areas and consequently play a major role in rural development[64].

The European flooring sector is going through a major period of change, and it is also a good indicator of what is happening in the wider European timber industry. It's a valuable source of information on the latest economic and fashion trends, and one of the few sectors where it is possible to analyse directly the competitive position of wood in relation to non-wood materials.

The flooring sector clearly demonstrates that technological innovation in other material sectors continues to put enormous pressure on wood's market position. Then, the European wood sector is fighting back with initiatives focusing heavily on high product quality and strong environmental performance.

The sector is responding to weak and negative growth in domestic markets by targeting export markets in other parts of the world, notably China. In doing so, it is seeking to exploit its particular strengths in the fields of design, technical innovation, product quality, and environmental performance.

The sector, across Europe, is dominated either by well-known and globally recognised organizations and brands or by small medium enterprises (SMEs). These differences depend on the type of product under scope.

For example, **laminate flooring** is a booming market for MDF and in 2009 accounts for more than 35% of all applications[65]. The industry is increasingly dominated by top organizations such as PERGO, EGGER, MEISTER, etc. Most of them are located or were originally located in Germany and the Nordic countries. Following the early success in Scandinavia, other northern European countries, primarily Germany and the Benelux countries began to market laminate flooring. Distribution then spread quickly throughout the rest of Europe and continues today. Laminate flooring is growing in export markets outside Europe, especially in Northern-America (USA, Canada, Greenland, Bermuda) and in the Chinese emergent market.

Considering the production of **solid wood and parquet**, instead, it is dominated by SMEs that are spread across Europe and producing locally and according to the client desires. In fact, the vast

[63] CEI-bois, European Wood Factsheets, The Wood Working Industry (Industry Statistics, Industry Sectors, Wood products) available from (link to the document)

[64] CEI-Bois, the European Confederation of woodworking industries, was founded in 1952 and represents the interests of the European woodworking industry, which includes more than 380,000 companies generating an annual turnover of 204 billion euros and employing around 2.1 million workers in EU27. More information available at: www.cei-bois.org.

[65] CEI-Bois, 2011. Tackle Climate Change: Use Wood. Wood Products – Wood-based panels, pag. 78 (http://www.cei-bois.org/files/FINAL_-_BoA_-_EN_-_2011_text_and_cover.pdf).

majority of companies are SMEs, with only a few large groups, typically in the softwood sawmill, panel and parquet sectors, operating on a European or global scale. Some industries (e.g. the panels industry) are relatively consolidated and gain efficiencies through scale, horizontal and vertical integration, as well as 'clustering' and 'megasites', involving a range of related industries and manufacturing processes. The construction market is the most important end-user for plywood and OSB, followed by packaging[66].

Considering **cork and bamboo floor coverings**, they have a marginal role considering the whole wooden floor covering world but their market share is growing in importance, providing an overview of the newly emerging market as an alternative to traditional timber products.

Considering the market for bamboo, outside of China is in its infancy for a multitude of reasons[67]. A disconnect between agronomists, financiers and potential end users has resulted in the slow commercialization of this valuable species. Furthermore the unusual flowering pattern of bamboo requires careful consideration for commercial reforestation entities. Through the vertical integration of reforestation with adequate business and marketing expertise, such barriers can be overcome, and the market grown exponentially. The market share is characterized by globally recognised organizations and brands such as MOSO International. Cork flooring market is instead characterised by SMEs that are spread across Europe (especially in Spain and Portugal) and producing locally and according to the client desires, like so parquet and solid wooden floor covering.

3.4 EU market for solid wood floor covering and parquet

3.4.1 Production and consumption of solid wood floor covering and parquet

The production and consumption trend of parquet is shown in Figure 2. As seen wooden parquet production and consumption in Europe has steeply increased from 1990 to 2007 and experienced a decreased from 2007 to 2009 due to the financial crisis. From that point on, the production and consumption of parquet slowly recovers. The total EU parquet production in 2012[68] reached 75Mm^2. This figure rises up to 110Mm^2 when data from Eurostat[69] are considered.

Although the absolute production data of both databases differ, both statistics confirm the relevant increase in the production and consumption areas during the period 1990-2007 as well as its recovery during the period 2009 – 2012 (Figure 2). In addition, both databases point out Poland as the major European producer, followed by Sweden and Germany.

[66] CEI-bois, European Wood Factsheets, *The Wood Working Industry (Industry Statistics, Industry Sectors, Wood products),* available from (link to the document).

[67] Ecoplanet Bamboo, Bamboo Worldwide - The current market and future potential (http://www.ecoplanetbamboo.net/files/bamboo_worldwide.pdf)

[68] FEP, The Parquet Industry, 2013, pag. 2, available at: http://www.parquet.net/files/2013_-_The_parquet_industry_-_full.pdf

[69] Eurostat 2014 – data come from EuroStat database: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

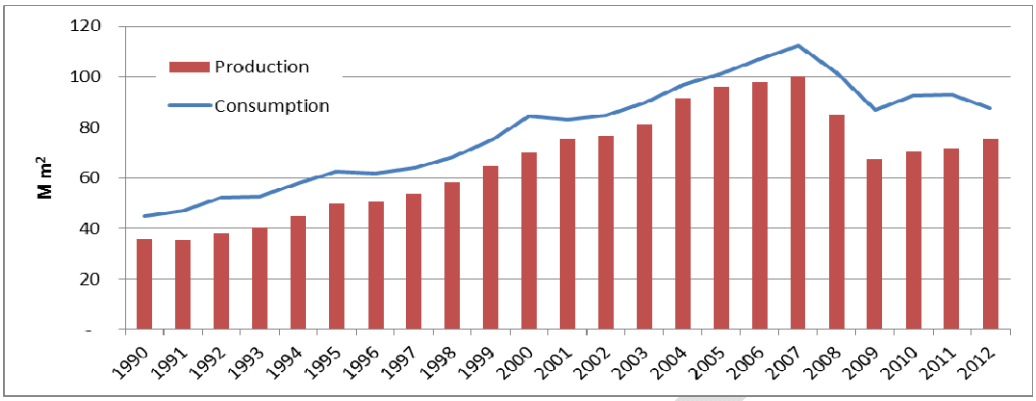


Figure 2 - Evolution of the parquet production and consumption in the EU-27 from 1990 to 2012

Regarding the type of products included into the solid wood floor covering category and according to the total EU production in 2008 , 2% of this value were mosaic parquets, 20% were solid wood coverings and 78% were multilayer (including lamparquet)[70].

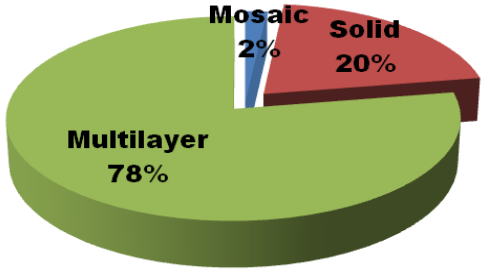


Figure 3 - Subdivision of European wooden flooring production according to FEP

Updated and more in detail data about the evolution of parquet in several Member States have been published. A short insight of these data for the recent years (2013-14) is provided in this section. In **Austria** the harsh weather conditions in Austria in the last year led to a 2% decline in wood flooring consumption in the first half of 2013 compared to the same period in 2012. A small increase is foreseen in consumption in the first quarter of 2014. **Belgium** experienced a stabilisation in the second quarter of 2014 after a falling first quarter. The total construction output fell by 1.3% in 2013, with non-residential construction being the only segment to improve both in the new (+2.2%) and the renovation subsectors (+1%). Parquet sales in **Denmark** remained flat in the first three months of 2014 when compared to the same period in 2013. When it comes to the annual evolution, a positive tendency of a few percent is forecast. **Finland** shows that the consumption of parquet remains stable in the first part of 2014. The market is relatively small at the moment, with an estimated 1.000.000m^2 being sold a year. In **France** the first quarter of 2014 showed a decrease of an estimated 8 to 10% in parquet sales. Consumer confidence is still lacking and traditional dealers do not necessarily see parquet as a priority. The **German** volume of consumption remains virtually unchanged. As in the past, the planks tend to become increasingly popular. The DIY stores are

[70] The European Parquet Industries, 2012 total parquet production per type (http://www.parquet.net/nl/the-industry)

moving towards new products, e.g. LVT. Despite the good economic situation in Germany, the parquet market remains stable at around 0% with more competition from other products. The **Italian** parquet market did not start too badly 2014, but soon lost some ground. The consumption is estimated to have decreased by 10% in Q1/2014 compared to the same quarter in 2013. Moreover, the yearly consumption for 2013 is expected to follow the same development compared to 2012. There are a lot of new competitors on the market and some confusion at the moment. **The Netherlands** witnessed a negative trend at the end of 2012 that was put to an end in 2013. The market remains now stable in terms of consumption. It is forecast the 2014 will be very comparable to 2013. In **Norway,** just like its Swedish neighbour, the Norwegian parquet market is estimated to have gained a couple percent in the first part of 2014 compared to the same period in 2013. Also worth mentioning is that the imports of building materials have increased by 18% in the first 3 months of 2014, which shows that there is an active market. **Spanish** parquet sales in the first quarter of 2014 went down by approximately 5% compared to the same period of last year. However, optimism seems to come back slowly. Some macroeconomic indicators are recovering but do not translate into reality at the microeconomic level. **Swedish** parquet consumption is slightly better in the first part of 2014 compared to the same period in 2013, with a small rebound of +/- 2%. The housing sector is also starting to recover, which makes the market a little more active than in the previous months and finally the mood in Switzerland remains sound. The non-existing winter enabled to record positive parquet sales in the order of +5 %[71].

Economic data regarding the product value are not easily available in the literature. Average selling prices for the parquet prices vary from 25 to 125€/m^2, depending on the manufacturer and specific parquet conditions.

3.4.2 Imports and exports of solid wood floor covering and parquet

The EU market of parquet and solid wood floor covering is mainly a domestic market where the products are produced and consumed without crossing the European borders. This fact is characteristic of construction products. However, there are always products that are bought or sold outside our borders. These data are reported in Figure 4 and Figure 5[72]. As shown, the amount of solid wood floor covering that has been exported in the last years has increased all over the period 2009-2012 while the imports have decreased during the last year.

[71] Global Wood Market, specific consideration about European countries (http://www.globalwood.org/market/timber_prices_2013/aaw20131102e.htm)

[72] Eurostat, 2014 – data come from Eurostat database: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

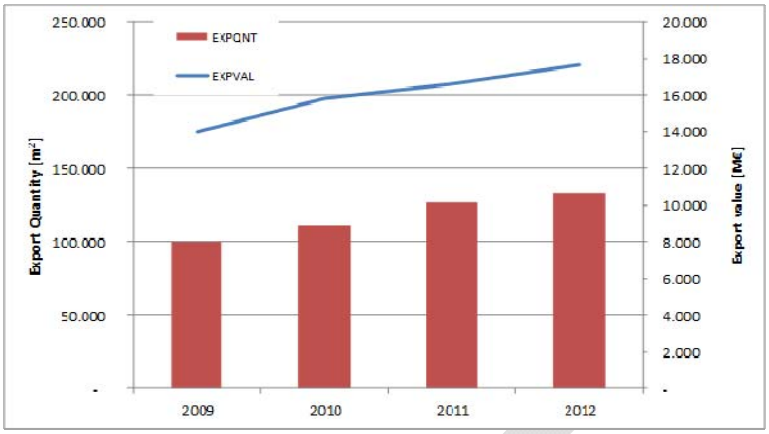


Figure 4 - Wood parquet exports (amount of m^2 and economic value), 2009-2012

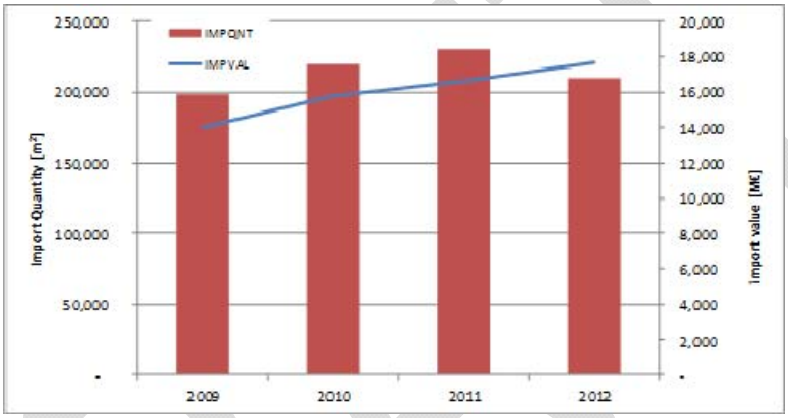


Figure 5 - Wood parquet imports (amount of m^2 and economic value), 2009-2012

3.4.3 Future market trends for solid wood floor coverings

The current unstable economic situation in which Europe is sunk makes difficult to predict a reliable market trend for this sub-product group in the coming years. This product is highly related to the construction sector and therefore there are a high number of economic aspects that affects the recovery of this market as for example the accessibility of the families to housing loans, the evolution of the employment rates, the consumer confidence or the development of the construction sector.

Nevertheless, since the start of the financial crisis in early 2007, the European parquet industry has proven to be resilient and able to cope with many adversities and to safeguard its market share amongst other flooring solutions. This reason leads to consider that the solid wood floor covering trade could remain stable or even increase in the coming years.

3.5 EU market for laminate floor covering

3.5.1 Production and consumption of laminate floor covering

Europe is the largest worldwide market for laminate floorings with Western European markets of Germany, France, UK and Poland dominating the production scenario. EPLF acts as observatory of the EU laminate floors market and trade. Its database, Figure 6, shows that laminate flooring market has seen a strong increase in sales over the past decade. Indeed the steep increase in this market was experience between 2000 and 2007, remaining stable or even decreasing due to the financial

crisis after this point. All in all, the laminate flooring market has increased in volume accounting in 2010 for 15% of the floor covering market, what was 12% more than in 1995[73].

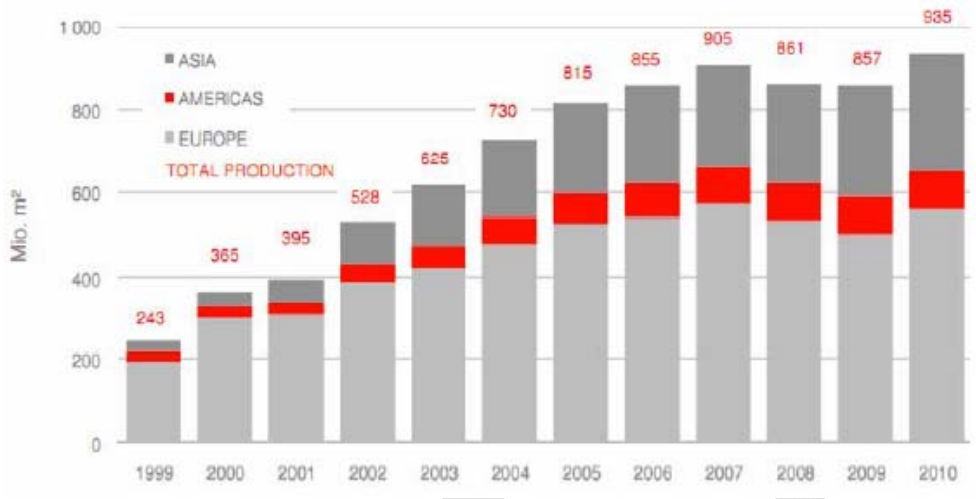


Figure 6 - World production of laminate flooring 1999-2010 (in M m^2)[68]

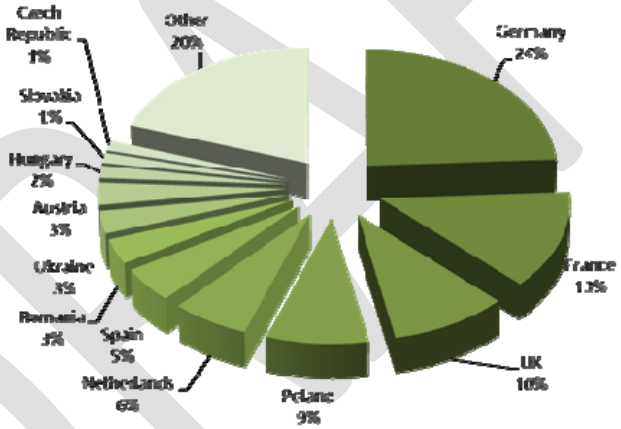


Figure 7 - EU 28 laminate flooring producers in 2013[68]

The top European producers of laminated flooring in 2013 were Germany, France and UK as shown in Figure 7. However, and although it is not graphically shown, the growth in production of laminate flooring has been remarkable in the emerging Eastern Europe countries, including Romania and Poland. These countries not only increased their domestic sales but also their exports to Asia and North America.

[73] HOMAG Group Engineering. World Flooring Production, not available date (http://www.stilesmachinery.com/assets/files/fl/2-worldflooringproduction_rolanddenglerv2.pdf).

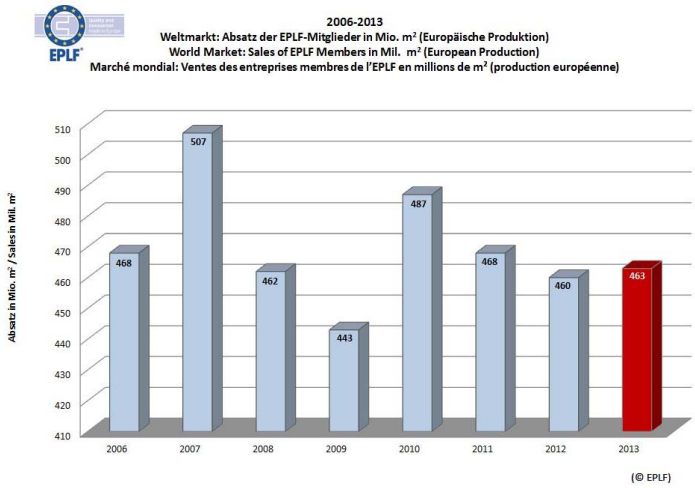


Figure 8 - World market sales 2006-2013 based on European production[74]

Figure 8 shows in detail the European sales of this sub-product and the production of 21 companies that are member of the EPLF association. These data, therefore, are a good representation of the European laminate flooring market but the values should be carefully treated as they are not absolute values. The laminate flooring market reached a peak of production in 2007 and decreased its production in the following years due to the unstable financial situation. In the last years, it seems that a faint recovery can be perceived although still not significant enough to predict a future full recovery

Economic data regarding the product value are not easily available in the literature. Average values for laminate prices vary from 8 to 10 $€_{2013}/m^2$, depending on the manufacturer and specific conditions.

3.5.2 Imports and exports of laminate floor covering

In 2013, the EPLF's 21 ordinary member companies[75] (manufacturers of laminate flooring) sold 463 Mm² of European-produced laminate around the globe (previous year: 460 Mm²), representing a global market sales increase of approximately 0,7%. In 2013, the western European core markets in the European laminate flooring industry experienced a slight decline of just under 3% overall. In absolute figures, western European sales fell from 298 Mm² in 2012 to 290 Mm² in 2013. European laminate flooring manufacturers sold 103 Mm² (previous year: 99M m²) in Eastern Europe, in 2013: an increase of 4% compared with the previous year. European exports of laminate flooring currently represent around 80% of the total production.

[74] Data coming from EPLF®, 2013 sales statistics (http://www.eplf.com/en/statistics/statistics.html)

[75] EPLF is based in Germany, is an organization which represents the leading producers of laminate flooring in Europe and their suppliers. The EPLF's member companies account for approx. 55% of the global market and approx. 80% of the EU market. At present a total of 21 laminate producers from ten EU countries, 33 suppliers to the laminate flooring industry, and four renowned testing institutes are members of the EPLF® (http://www.eplf.com/).

At world level the Asian market, driven by the rapid development of markets such as the Chinese or Indian one, is expected to surge ahead robustly through 2017. The Asian market is expected to be concentrated in China, becoming the world's largest market for floor covering (in terms of area) and some other low cost, high volume markets such as Vietnam, Thailand or Malaysia.

3.5.3 Future market trends of laminate floor covering

European laminate floorings market was severely challenged by the recent global financial crisis, resulting in a turning-point in its market trend. Although the financial crisis does not seem to be completely over, the international laminate flooring market is slowly recovering. For the time being, this recovery is too faint to trustfully predict which is going to be its market behaviour in the coming years.

According to the EPLF[76] manufacturers forecast for the laminate flooring industry in the next years is very motivating. European manufacturers especially believe the high-end segment of the Chinese market offers particular potential for European-made quality laminate flooring. European manufacturers are seeking to position themselves in the premium segment and EPLF believes there is a growing demand in China for genuine European-made flooring which is subject to strict EU norms, meeting very high standards of product quality, sustainability and eco-friendliness. According to some producers, it is possible to affirm that since Chinese customers are increasingly demanding these qualities, Chinese manufacturers will quickly attempt to catch up. EPLF is convinced that European manufacturers, with their production expertise, are well positioned to maintain the lead over Chinese competitors.

3.6 EU market for cork floor covering

3.6.1 Production and consumption of cork floor covering

World cork production was estimated to be about 210000 ton/y, being 86% of this quantity produced in Europe. The EU cork production market is concentrated in Portugal (holding around 50% of the world production) and Spain (covering the 31% of the world production)[77]. The absolute values of the cork production are displayed in Table 10.

Cork flooring has begun to re-establish itself as a viable floor covering option. Initially, cork became a popular and widely used resilient flooring material in the first half of the 20th century and today is considered as an interesting renewable interior product. The cork flooring market is enjoying a surge in popularity driven in large part by consumer demand.

Table 10 - Annual World and EU cork production in 2010[78]

Annual cork production average	Tons/a	[%]
Total annual cork production (world):	210,000	-
Europe	170,000	100%

[76] http://www.globalwood.org/market/timber_prices_2013/aaw20131102e.htm

[77] Portuguese Cork Association. *Cork 2013*, http://www.apcor.pt/userfiles/File/Publicacoes/APCOR ANUARIO 2013.pdf

[78] FAO, 2010 – data available from APCOR website: http://www.apcor.pt/artigo/cork-production.htm, last access May 2014.

Portugal	100,000	56%
Spain	61,500	34%
Italy	11,700	7%
France	5,200	3%

As a member of the beech family, the cork oak tree grows in coastal regions of the Mediterranean. Only seven countries account for the bulk of the world's cork: Portugal, Spain, France, Italy, Algeria, Morocco, and Tunisia with the majority of the production occurring in the first two. Relatively slow growing, cork trees survive harsh conditions in depleted soil that will often support little else of value. Unlike most trees where primary value is derived from the lumber of the trunk, cork is actually obtained from the renewable bark of the tree. This unusually thick bark is made up of millions of tiny prism-shaped air pockets which create a resilient, cushiony surface which offers several distinct advantages to the tree - and to us as consumers.

Today's cork floor is also created from the post-industrial by-product of the bottle-stopper industry. This "waste" material is ground up and formed into sheets using minimal adhesive to bind particles together under high pressure. The size, quantity and type of cork granule, in conjunction with varying degrees of pressure, determine the difference between "bulletin board" material and material suitable for flooring applications[79].

The basis for cork floor is agglomerated sheet material produced mainly in Portugal and Spain. To create different fashions, a thin veneer layer of decorative cork is laminated to the top of the core material. Lamination takes place at the time of original production, making the thin layer inseparable from the core and being the part that carries the pattern.

Data concerning the cork floor covering production and consumption are aggregated within other products related to the construction sector making impossible its estimation. For example, data reported by APCOR80 indicate that in Portugal the main target sector for cork is the wine industry that absorbs 68% of the total production followed by the construction sector with 32%. This sector consists of different products, for example floors, insulation and coatings, blocks, plates, sheets or strip. Some disaggregated data for this sector indicates that three product groups: flooring, insulation, floor and wall ceilings represent about 24% of the cork production (See Table 11).

Table 11 - Structure of cork sales (exports) per product type in value – Portugal 2012, APCOR, 2013

Cork product	%
Natural Cork Stoppers	42
Other Types of Stoppers	26
Flooring, Insulation, Floor and Wall Coverings, etc	24
Other Cork Products	7
Cubes, Plates, Sheets, Strips, etc	1

[79] Natural Cork – The Flooring option: http://www.usfloorsllc.com/products/natural-cork-collection/why-natural-cork/

[80] Portuguese Cork Association. Cork 2013, http://www.apcor.pt/userfiles/File/Publicacoes/APCOR ANUARIO 2013.pdf

Economic data regarding the product value are not easily available in the literature. Average values for cork flooring prices vary from 20 to 35 €/m^2, depending on the manufacturer and specific parquet conditions.

3.6.2 Imports and exports of cork floor covering

There are no available specific data about imports and exports of cork floor covering.

3.6.3 Future market trends of cork floor covering

Forecast regarding cork market are available only for the wine industry sector and consequentially the cork stopper production and trade. At the moment, data regarding the cork flooring market are too scarce to quantify the exports and imports that annually cross the European borders or to identify a clear future market trend of this sub-product.

3.7 EU market for bamboo floor covering

3.7.1 Production and consumption of bamboo floor covering

European bamboo production and consumption is marginal in comparison to the other sub-products under consideration. The European bamboo flooring market probably accounts for just 1 or 2% of the total EU wooden floor covering market. The EU consumption of bamboo flooring has increased from 0.7 Mm^2 in 2003 to 0.9 Mm^2 in 2005 and is expected to continue growing. The increase in the bamboo flooring demand is associated with the general perception of this material as a green commodity, being one of the reasons why its inclusion in this work can be of high interest. A proof of this increasing market demand is the recent inclusion of bamboo flooring in the revised Nordic label in 2011.

Economic data regarding the product value are not easily available in the literature. Average values for bamboo flooring prices vary from 35 to 90 €/m^2, depending on the manufacturer and specific conditions[81].

3.7.2 Exports and imports of bamboo floor covering

China is the biggest world bamboo producer and exported with a quoted range from 75 to 95% of the total world trade[82]. Other top bamboo producers are India, Myanmar or Nigeria. In general, markets related to bamboo products can be divided into the traditional market and the emerging markets. The demand remains strong in traditional markets such as handicrafts, blinds and bamboo shoots while the markets share in emerging markets are still low. Figure 9 shows the breakdown of bamboo product world markets.

[81] Confidential information from MOSO (March 2014)
[82] FAO and Customs General Administration of China, 2004

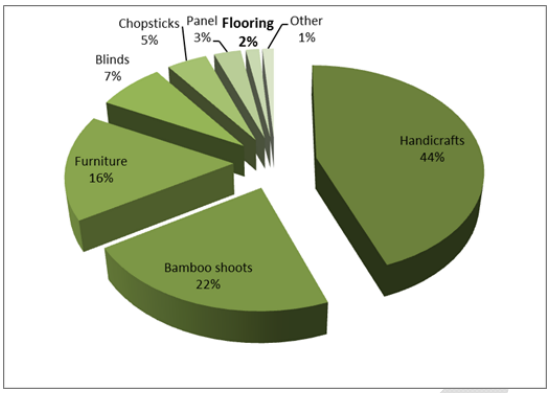
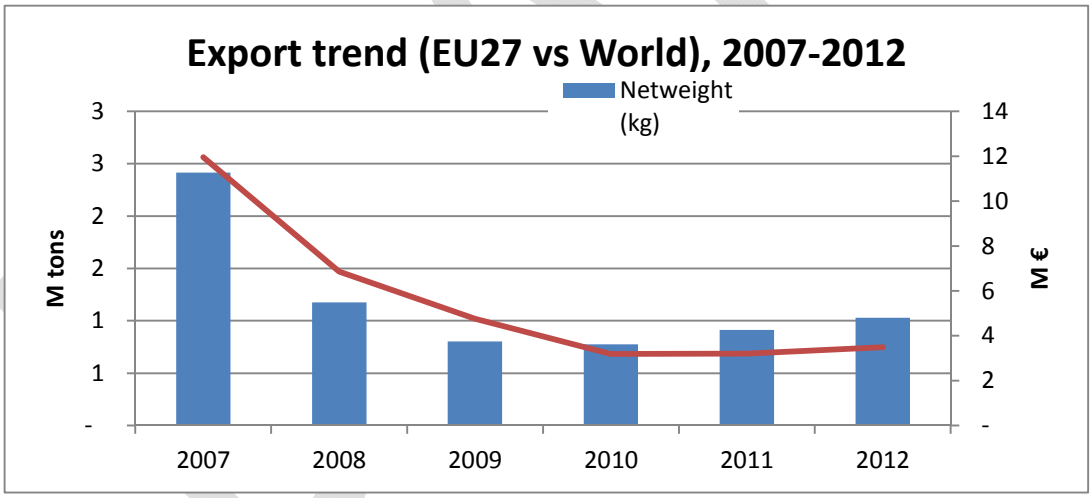


Figure 9 - Bamboo market products distribution[83]

The estimated annual production of bamboo flooring in China was 17.5 Mm^2 in 2004[84] and shows a clear growing trend. Forecast at world level estimate that the bamboo market will be doubled by 2015. Chinese exports account for some 65% of total production being US and Europe the main destinations that are taking around 80% of world trade[85]. The most recent and comprehensive information on international bamboo trade is collected in International Bamboo and Rattan Trade (INBAR) Database[86]. Figure 10 and Figure 11 show the trends of import and export quantities and values of bamboo flooring markets in the period 2007-2012. The exports data are referred to EU27 while the import ones to the entire Europa area (more detailed data are not available.



[83] Data come from Market Opportunity Research Enterprises®
[84] FAO and Customs General Administration of China, 2004
[85] ECOPLANET BAMBOO. Bamboo Worldwide, not available date
http://www.ecoplanetbamboo.net/files/bamboo_worldwide.pdf
[86] International Bamboo and Rattan Trade (INBAR) Database: http://www.inbar.int/knowledge/trade-database/

Figure 10 - Export trend in BAMBOO flooring (EU27 vs World), 2007-2012[87]

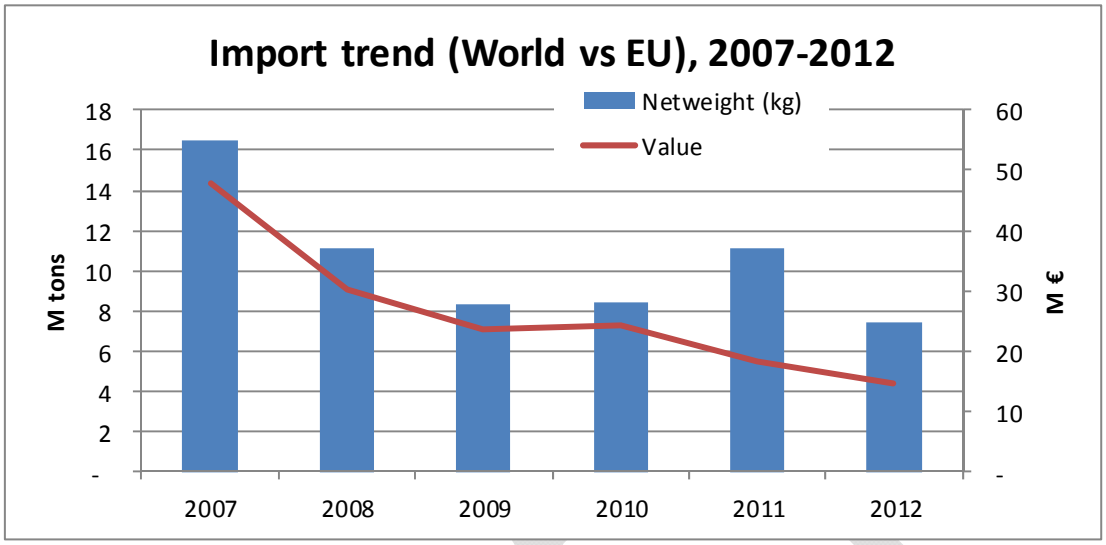


Figure 11 - Import trend in BAMBOO flooring (World vs EU), 2007-2012

The emerging bamboo markets, particularly those related to possible uses as a substitute for wood in flooring, panelling and furniture, represent one of the greatest opportunities of growth.. The increasing and strong demand of these products at world level, together with the outstanding production and export capacity of China have lead into structural changes in the wood industries. In addition, the ever-increasing restrictions on the supply of certified timber have accelerated the process and created a positive outlook for the bamboo market.

3.7.3 Future market trends of bamboo floor covering

Currently the European bamboo flooring market is, as mentioned, insignificant in comparison to the other products. In addition, this product is mainly imported and the own production remains very low. On the other hand, the demand of this product is expected to increase significantly due to the perception of bamboo flooring as a green commodity, being to a large extend satisfied by further imports from China.

3.8 Potential penetration in the market of the EU ecolabel

At present, there is no EU Ecolabelled product belonging to this group but, for the time being of this revision it seems two applicants have started the procedure. There are on the market, however, several products awarded by national Ecolabel (mainly The Blue Angel or the Nordic Swan). Availability of these products across Europe is varied being concentrated in the Nordic countries, Germany, Austria and France.

[87] International Network for Bamboo and Rattan (INBAR), 2014) http://www.inbar.int/

The main barriers identified by the Competent Bodies are the large bureaucracy for the application process, the delay and time required for the verification process as well as the lack of knowledge of existence of the EU Ecolabel from the consumer and retailer's side[88].

3.9 Conclusions and summary of the market analysis

This section summarizes the main findings of the market analysis on the European wooden floor covering sector. Market data have been disaggregated into the four main types of flooring considered in this study, providing the evolution of each sub-sector in the recent past. Finally, a research focused on the market distribution was performed too.

Data concerning production and consumption, imports and exports of each wooden flooring type are shown in Table 12

Table 12 - Summary of the EU market analysis for wood floor covering products

	Consumption	Production	Import	Export	Note
Wood and Timber coverings	~ 88 Mm^2 *FEP, 2013*	~ 75 Mm^2 *FEP, 2013* ~110 Mm^2 *EuroStat, 2012*	~ 27 km^2 *EuroStat, 2012*	~135 km^2 *EuroStat, 2012*	! Import/Export data comes from EuroStat. ! FEP data refers to EU-20 countries, EuroStat to EU-27
Laminate floorings	~ 270 Mm^2 *Intercontuft, 2005*	~ 580 Mm^2 *Homag Eng, 2010*	*n.a.*	~ 465 Mm^2 *EPLF, 2013*	Laminate flooring Export comes from EPLF and it is the European-produced laminate flooring sold around the world
Cork coverings	~ 14 Mm^2 *Intercontuft, 2005*	*n.a.*	*n.a.*	*n.a.*	At present it is not possible to extract data for the floor covering sector only about production, import and export quantities.
Bamboo floors	~1 Mm^2 *Ecoplanet, 2005*	There are no (marginal) bamboo flooring products produced in Europe. Most of them come from China.	7.5 kt ~2.1 Mm^2 *World vs EU* *INBAR, 2012*	7.1 kt ~2 Mm^2 *EU vs World* *INBAR, 2012*	Bamboo import and export data refers to Europe (not only to EU27).and those expressed in Mm^2 comes from a working group elaboration of INBAR *(International Network for Bamboo and Rattan).*

Laminate floorings accounts for the highest consumption, production and export values being at present the flooring type that dominates the market. Wood and timber coverings are placed in second position followed by cork and bamboo with much lower shares.

[88] Information orally provided by the Competent Bodies at the EUEB meeting in Brussels June 2014

Laminate flooring production, consumption and exports have grown exponentially in the last years getting the dominance in the three fields. On the contrary, the relative production and consumption of solid wood and parquet have decreased being placed in the second position. Cork and bamboo flooring demands are significantly increasing in the recent past due to the ecological perception of these products by the consumers. Bamboo flooring is mainly imported from Asia while cork flooring is mainly produced in Portugal and Spain[89].

Regarding the structure of the market, Table 13 summarizes the main aspects depending on the flooring type. As seem the main producers of wooden flooring are Western European countries, being led by Germany, the Nordic countries, Poland, France or UK. Portugal and Spain play also an important role in the production of cork flooring.

Each type of flooring is produced in a different way, laminates, cork and bamboo floorings are mainly produced from different types of wooden panels whereas solid wood is made of veneer. Regarding the market structure, solid wood and cork flooring sectors consist of SMEs and the product is largely tailored to the consumer's needs while laminate and bamboo flooring sectors consist mainly of large and well-known companies. These both facts are reflected in the average prices of the products being those based on wooden panels significantly lower.

Table 13 - Summary of the EU market aspects

Flooring	**Laminate**	**Solid wood**	**Cork**	**Bamboo**
Production 2010	580 Mm^2	100 Mm^2	-	1Mm^2
Production 2012-2013	53% globally in 2012[90]	75 Mm^2	40.8 Mton	-
Main producers	DE, FR, UK	PL, SE, DE	PT, SP	Asia
Type of companies	Int companies: Pergo, Hemmes, Meister	SMEs	SMEs	Int companies: Moso
Main wooden materials	MDF	Plywood, OSB	Cork bark	Bamboo
Types and Shares in the market	Direct pressure High pressure	Mosaic: 2% Solid: 20% Multilayer: 78%	Tiles: Laminate	
Average price	8-10 €/m^2	25-125 €/m^2	20-35 €/m^2	35-90 €/m^2

[89] Data and information coming from Global Flooring Alliance website: http://globalflooringalliance.com/news.html#GFA_FEP_may2014 and http://globalflooringalliance.com/news.html

[90] World market for laminate flooring continues to flourish, http://www.wbpionline.com/news/world-market-for-laminate-flooring-continues-to-flourish-270613/

4 TECHNICAL ANALYSIS: ENVIRONMENTAL ASSESSMENT OVERVIEW

4.1 Introduction

This section starts with a review of the technological aspects and user behaviour including the main features and uses, a description of the production processes and of the technologies, materials and relative consequences for the product performance and end-of-life. It is followed by a life cycle assessment (LCA) screening. The LCA screening includes a revision of the published literature as well as an assessment of its quality regarding a set of criteria that will be previously described. LCA studies allow the identification of potential environmental impacts of WFC products along all the life cycle stages. This analysis in particular aims at identifying the main environmental areas of concern and lifecycle hot-spots and at estimating the environmental improvement potential of measures applicable in the different lifecycle stages.

An additional section has been developed for the assessment of hazardous substances. Hazardous substances which may be contented in the products and their impacts include the substances used in processing of raw materials, manufacturing and packaging. A screening and analysis of the possibilities of substitution and/or prevention is also included.

The research in this section consists of a desktop study using a variety of available literature sources and inputs from the stakeholders gathered by the stakeholder's survey.

4.2 Technological aspects and user behaviour

Although all the product groups included in this study are quite different in characteristics, the production processes of all them have common steps. The general lifetime of a floor covering can be drawn as follows:

- *Upstream processes*: extraction, processing and transport of raw materials. In some studies, manufacturing of components are included in this stage;
- *Core processes*: manufacturing of wooden flooring. It could include manufacturing of the different flooring component. Packaging may be also included in this stage.
- *Downstream processes*: distribution, use and end-of-life stages.

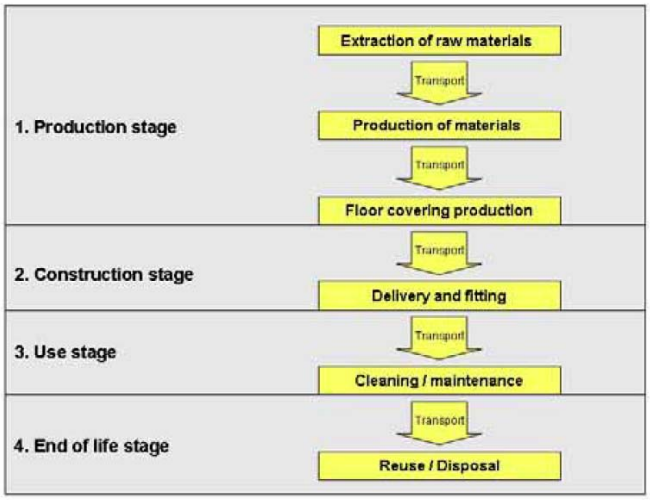


Figure 12 – Wooden Floor covering production system boundaries (source: PCR - Floor Coverings, IBU system)

In this section each of the upstream, core and downstream processes for each of the four product types under consideration are described (Figure 12). The aim is to get deeper insight of the

technology available on the market, the needed raw materials as well as the other hints and aspects of importance from the technological viewpoint. Main features and uses of the products from the technological viewpoint are summarized in this section.

4.2.1 Description of the production processes

4.2.1.1 Description of the production process: solid wood flooring and parquet

The solid wood flooring consists of three main products: multilayer, lamparquet and mosaic floor. The main differences among them are:

- *Multilayer parquet* consists of two or three wood layers glued together. The top layer is made of hardwood and it usually has a face protection made of gloss or matt lacquer. There is a the middle layer composed in a way that gives stability to the parquet board and at the end the backing balancing layer – in order to stabilize the board by giving it necessary dimensional stability. The multilayer parquet is lacquered in the factory and ready to be installed immediately after purchasing.
- *Lamparquet* is the small-format floorboard that is made of small-sized solid-wood boards, 8-10 mm thick, 250 to 300 mm long, 45 to 65mm large, without jointing but with the counterface planed and/or lined. These dimensions are determined by Standard UNI 4375[91]. *Mosaic flooring* is a parquet made of different wooden tiles, usually supplied unfinished, the parquet mosaic must be fully adhered to the subfloor adhesives, then lightly sanded and finished with customers' choice of either hard wax oil or lacquer.

Figure 13 summarizes the flow chart of a wooden flooring production process. The system boundaries do not include the fixing phase. The production process accounts for:

a) *Extraction of materials:* the main material is timber of different trees. Among the most used trees are oak, beech, spruce, pine but also walnut, cherry, lime, maple etc. Timber is harvested along the year by using machines such as chainsaws or by hand and then transported to sawmill with vehicles. Timber harvesting is usually controlled by producers. Virgin wood is important being harvested from certified forests, where harvest and growth are sustainable.

b) Manufacturing of the product: Logs are transported form forest to the industry. An intermediate storage can take place. If not*, l*ogs are transported to the production facilities where they are boiled in water at a certain temperature or they are kept at a low humidity level and dried slowly. Then the wood is peeled by using a blade. It works its way around the log toward the centre, creating a wood veneer. This veneer is then pressed flat with high pressure to make the veneer flat. Two different products are made in this way: the

[91] http://en.berti.net/faq/faq/general-faq/what-is-the-difference-between-parquet-and-lamparquet#sthash.f2OOu6tz.dpuf

"multilayer modular floor covering"[92], made of wood slabs matched whit pressure and glue, and a "block floor covering", made of a one-piece layer of solid wood.

According to Gunther and Langowsky[93], wood floorings (multilayer) are usually made for the 95% of wood slabs and the 5% of adhesive. It has been considered a material consumption of 12,6 kg/m^2.

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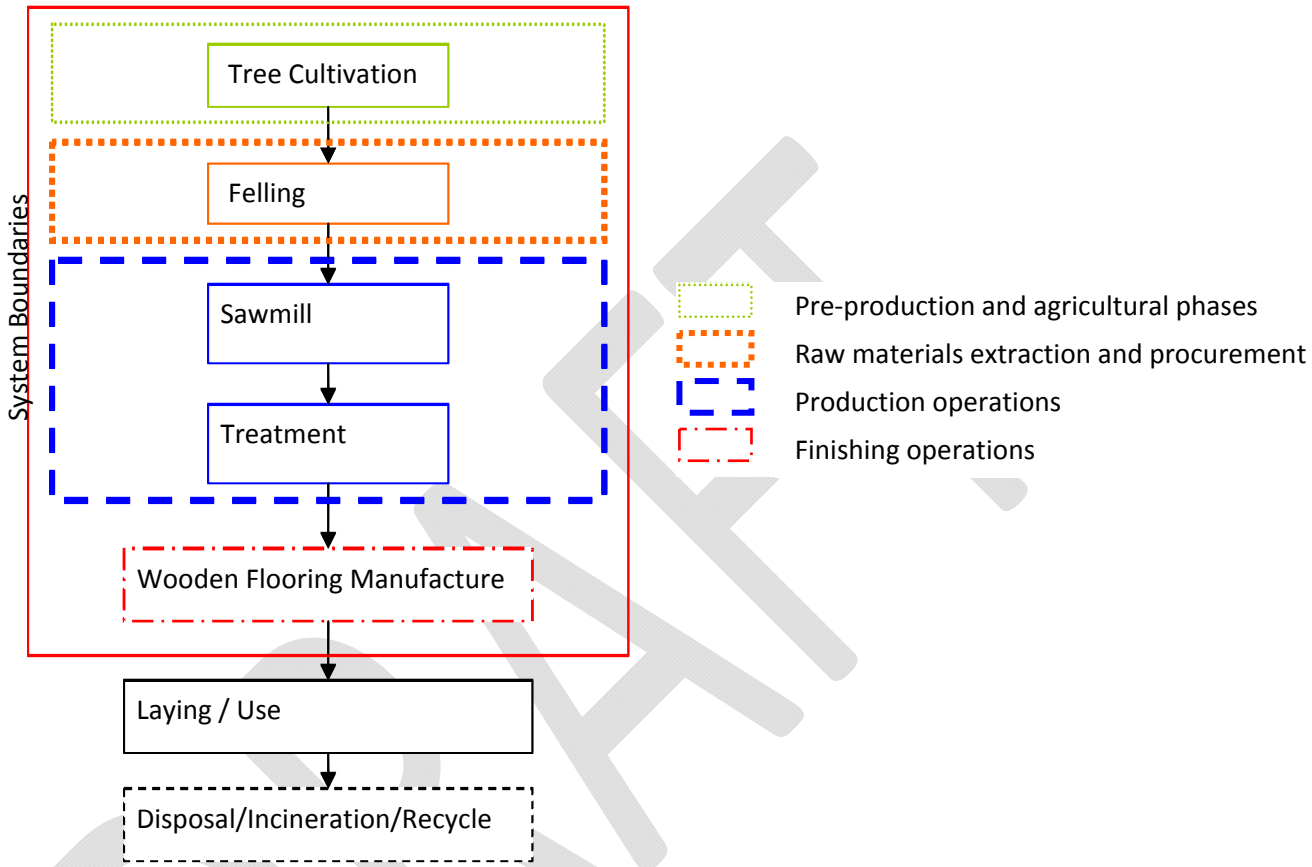


Figure 13 - Flow chart diagram of the extraction of materials and production of solid wood and parquet

[92] Multilayer Modular Floor Covering is defined as floor panel: semi-rigid decorative floor covering – typically in a plank or tile format – having a multiple layer product structure consisting of a wear-resistant top layer, a decorative surface layer, a substrate and usually a backer, the planks/tiles having worked edges that allow the product to be joined together to form a larger integral unit".

[93] Gunther, A., Langowsky, H. C., 1997. Life Cycle Assessment Study on Resilient Floor coverings, The Int. Journal of LCA, 2 (2) 1997, 73-80

4.2.1.2 *Description of the production process: laminate flooring*

There are two main types of laminate products: high pressure laminate floor covering (HPL) and direct pressure laminate floor coverings (DPL).

DPL flooring is the most prevalent in the consumer laminate flooring market (domestic and office use). There are generally four separate layers which are all pressed together at the same time during production: the wear layer, the decorative sheet, the high density fibreboard and then the balancing layer on the bottom[94]. DPL laminate floors are typically priced lower among laminates and they are available in more colours and styles.

HPL is constructed a bit differently than DPL, creating a tougher laminate floor and offering maximum durability. HPL is created with the same materials as DPL but with the use of additional kraft paper sheets treated with a phenolic resin, which makes the kraft paper stiffer during the manufacturing process. HPL is fused together using a combination of heat and pressure and the layers of HPL are put together in multiple stages rather than all at once like the DPL. High Pressure Laminate floors are often recommended in commercial use because of their maximum durability and stronger construction.

Figure 14 – The two typologies of laminate flooring: DPL and HFLF flooring

As shown in Figure 15, four layers are assembled in DLP floorings. The bottom layer, or backing, is a melamine plastic layer that lends dimensional stability to the planks and also helps guard against moisture from the sub-floor. The next layer is a core board, generally made from high-density fiberboard or particle board which may also contain melamine plastic resins that help improve the moisture resistance of the core. Then a decorative layer or print film is adhered on top of the core board giving the floor its hardwood or tile look. This decorative layer is a printed high-resolution photo-reproduction of wood grain pattern. On the top of them is a durable wear layer, providing

[94] http://www.hoskinghardwood.com/Department/Laminate-Floors/All-About-Laminate-Flooring.aspx?dId=9&pageId=38

protection and stain resistance. The overlay may contain aluminium oxide, as well as melamine resin. All four layers are then combined in a high-pressure process.

As described, before assembly the layers, it is needed to produce the particleboard. Several boards can be used for the production of laminate floorings as shown in the Figure 14. However, the main panels in Europe are particleboard, which figures for approximately 65% of the total panel production and MDF that accounts for 20%.

The particleboard is a panel made from small discrete wood elements and a binder. There are two main sources of wood raw material: forest thinning and sawmill residues such as slab wood, hacked or pulp chip, dockings, planer shavings and sawdust as pointed out by *Rivela et a*l in 2006[95]. Regardless the source of wood used, it should be pre-treated through debarking, shaving, chipping, etc in order to get the needed size. Afterwards, the wood is dried and forming being ready to be mixed with the binder.

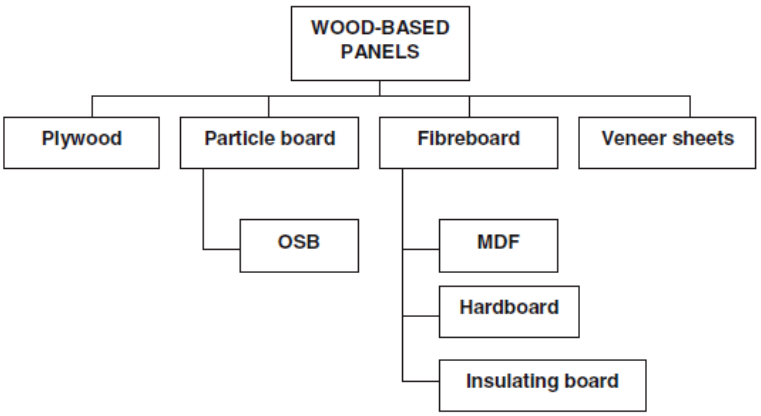


Figure 15 – Wooden Floor covering production system boundaries

There are several types of binders that can be used depending on the type of particleboard to be produced. Among the most common ones are melamine formaldehyde resins, phenolic formaldehyde resins, urea-formaldehyde resins and methylene-diphenol diisocyanate. These resins are mixed with the chips and wood materials and pressed under high pressures and high temperatures. Some other chemicals can be added during these production steps such as glues, adhesives, etc. A scheme of the process chain for particleboard manufacture is reported in

Figure 16.

The particleboard should be assembled within the other three layers of raw materials in large sheets. This typically takes place on a production line, where the technology enables each layer to be stacked on top of another with accuracy and precision. The backing layer is first on the line, with the core board placed directly on top of that. Next, the printed decorative layer is stacked on top of the core board. The final layer to be stacked on is the wear layer.

[95] Rivela, B., Hospido, A., Moreira, M.T., Feijoo, G., 2006. *Life cycle inventory of particleboard: a case study in the wood sector*. Int. J. Life Cycle Assess. 11, 106-113.

Once the four layers have been stacked, they are ready for pressing. The stacks of layers are pressed at high temperatures reaching about 200°C, with up to 5 kg/m^2 of pressure for 20 to 30 seconds. Time and temperature during pressing influence the curing and bonds in the stacks into a single sheet of finished decorative laminate. If the laminate is designed to have a textured surface, the press has specialized plates that imprint the textured pattern onto the sheets. After the sheets are pressed they are left to cool to ensure that they fully cure and to prevent any surface imperfections. Then the sheets are stacked and stored for a time so that they can continue to acclimate, thereby enhancing the stability of the boards.

Once the boards are fully acclimated, they are milled, or cut into planks. The freshly cut planks then move on to be profiled. Multiple profiling saws create the tongue and groove edges on the sides of the planks that enable the floor to lock together with ease. The finished planks then go through a quality inspection and are checked for colour, texture, finish, size and correct interlocking capabilities. Once approved, the planks are then stacked, packaged and loaded onto trucks for distribution.

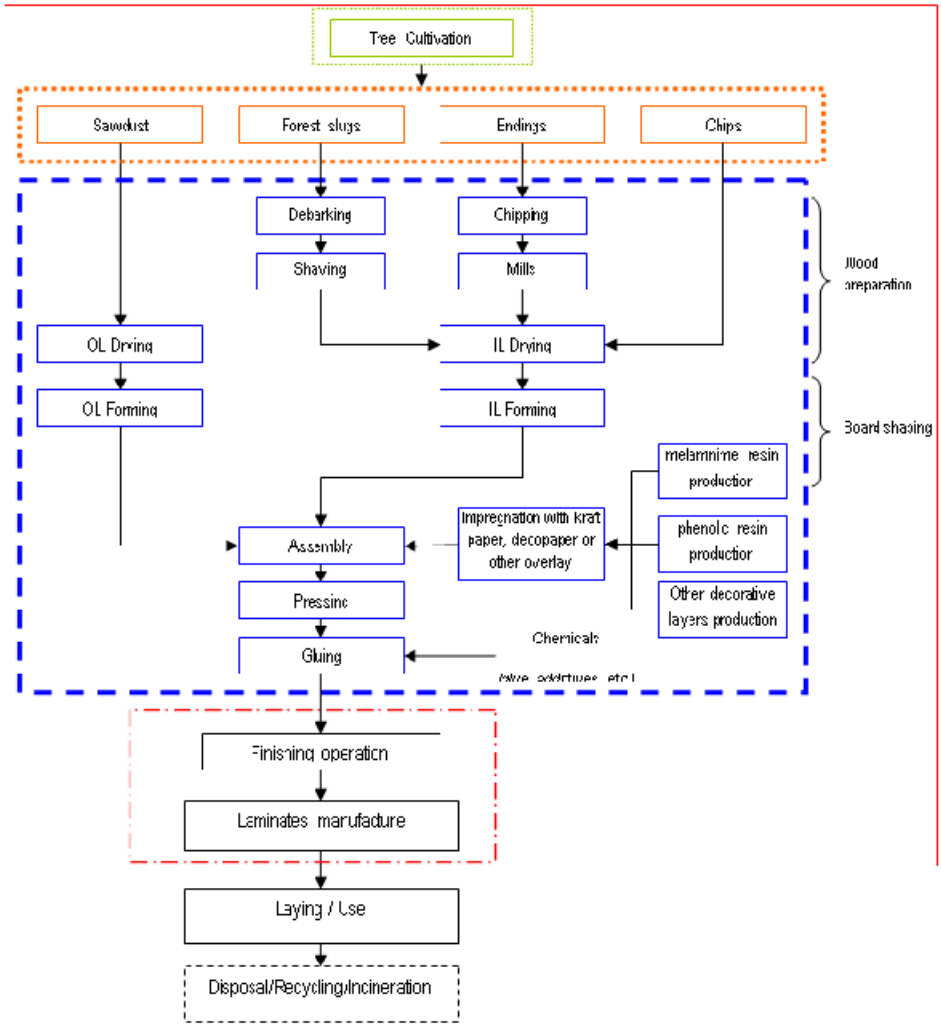


Figure 16 – System boundary and process chain of laminates production

4.2.1.3 *Description of the production process: cork flooring*[96]

There are several types of finished cork flooring products such as cork tiles, planks and rolls[97]. Cork most commonly comes in tile form, and is usually sold in standard 300x300mm or 300x600mm sizes. Cork planks instead, have bigger dimension and usually come in standard 600x900mm boards[98]. Cork rolls are agglomerated cork made of cork granules of specified dimensions with the addition of a binder (granulated cork usually 90% and binder, for example a polyurethane cork one, 10%[99].

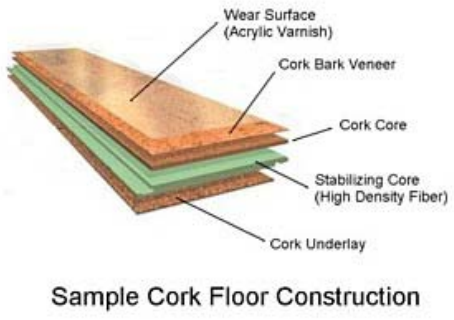


Figure 17 - Composition or layers of cork flooring[100]

The production of cork floorings is slightly different depending on the final product that wants to be achieved. Figure 18 represents the main steps of the production of agglomerate cork layer and backing cork layer.

The production of cork flooring consists of:

a) *Extraction of raw materials:* Cork flooring is manufactured from cork made from is the bark of cork oak tree (Quercus Suber) which is an evergreen that grows in the Mediterranean region of Southern Europe and Northern Africa, with a honeycomb structure of 60-100 million air cells/in^3. This bark can only be harvested if the cork oak tree is at least 25 years old. This harvesting or stripping of the bark process can be repeated every 9 - 12 years, and is done by hand. The older the tree is the better quality of cork it can produce, as the bark becomes smoother every time it re-grows after the harvest. Cork Oak Trees are grown primarily in only seven countries around the Western Mediterranean basin: Spain, Portugal, France, Italy, Morocco, Algeria and Tunisia. Portugal with 30% of the cork trees in the world is the largest producer of cork today (50% of the world's cork production).

   The harvesting of cork is a standardized process that is done in the summer months, and performed by means of hand-held equipment to make sure that the bark will grow back. Cork flooring is also made from the cultivated waste of the cork wine-stopper manufacturing

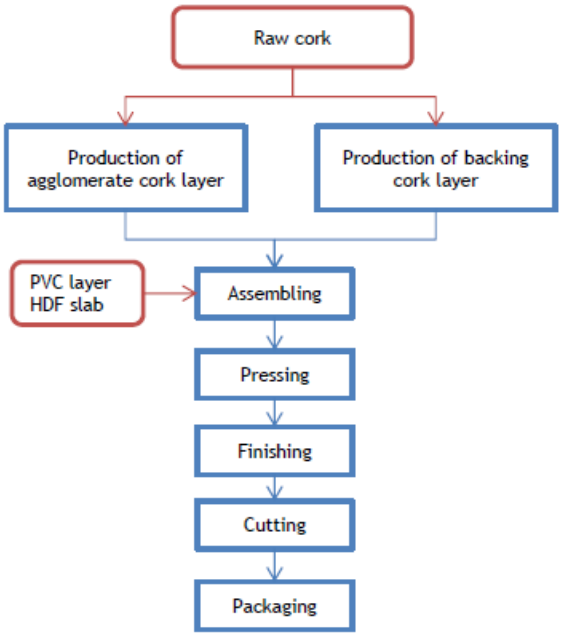
[96] http://www.builddirect.com/Cork-Flooring/Cork-Floors-Articles/Cork_Composition_and_Production.aspx
[97] http://flooring.about.com/od/types-of-flooring/u/Cork-Flooring-Tiles-Planks-And-Rolls.htm
[98] http://flooring.about.com/od/types-of-flooring/a/A-Complete-Guide-To-Natural-Cork-Flooring.htm
[99] http://www.bubinga.com.tr/images/dosyalar/granorte/cork-roll-teknik-spects.pdf
[100] http://homerepair.about.com/od/interiorhomerepair/a/Resilient-Flooring-Cork-Planks-Panels-Interlocking.htm

process so it is a recycled product. After the planks/slabs of cork bark are harvested, they are then sorted and stacked for a good 6 months. Exposure to air, sun, rain and wind triggers chemical shifts resulting improvements in cork's quality.

b) *Manufacturing of the flooring:* The next stage is to clean, boil and strip the rough outer surface. This makes it easier to convert the cork into a variety of forms. Bottle stopper "corks" are then punched from the best material in the slabs. The remaining scraps are then ground into small granules, mixed with a resin binder, molded into large blocks and baked in specialized ovens. This process enables production of cork underlayment, cork planks, cork tiles and cork sheets in both unfinished and pre-finished types.

Cork flooring is manufactured as tiles or planks in various thicknesses. The baking process increases cork's durability. After being cut to standardized dimensions, it is then sorted by colour, and sealed with polyurethane, or wax.

The varied colours of cork flooring do not depend on stains or dyes. Prior to compression, baking the cork and varying the granule size allows for the creation of light, medium and dark colours. The longer it bakes, the darker it becomes. Also, unfinished cork can be painted or stained as well. Stains for custom colours are applied just prior to the application of acrylic finish. The factory finish, however, protects the cork flooring surface from moisture, harmful chemicals, dirt and other damaging elements. Cork flooring can be screened and recoated many times yet, sanding and refinishing can be done only a limited number of times.



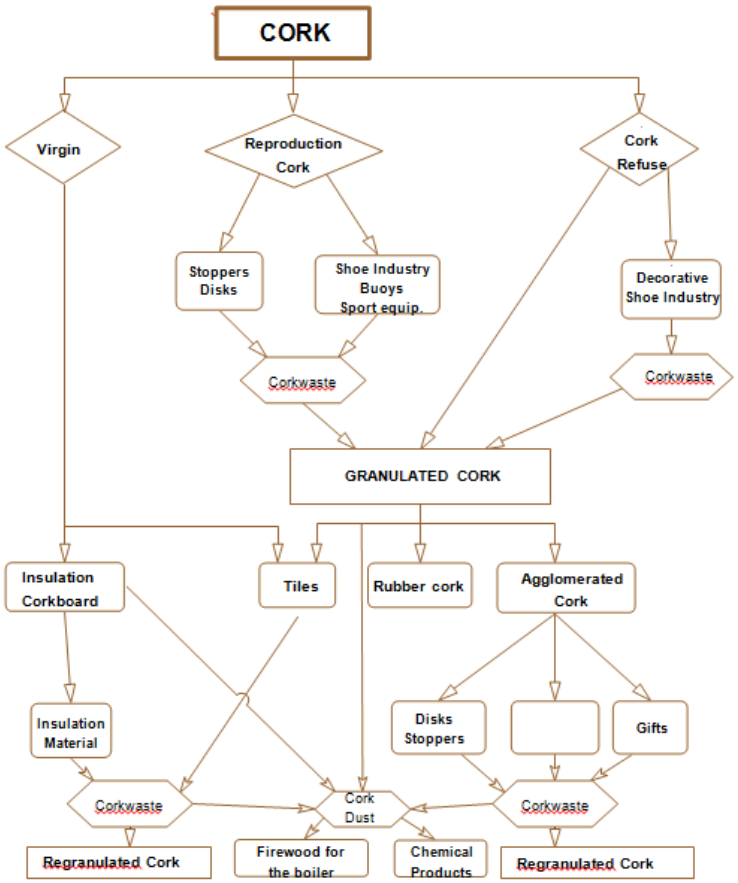


Figure 18 - System boundary and process chain of cork parquet production

4.2.1.4 Description of the production process: bamboo flooring[101]

There are three main types of bamboo floorings: vertical grain, horizontal grain, and strand-woven grain. However, the production processes of all of them are quite similar and therefore a unique general description is given. The properties of each type of bamboo flooring are also commented.

a) *Extraction of raw materials:* Bamboo is technically a grass, a plant that grows quite quickly, up to 1,2m/day, and is able to grow well in soil of poor quality. Some of the largest varieties of bamboo can grow to have a diameter of 33cm and a height of about 40m within three years. The most common form of bamboo found in Asia is self-propagating and does not need to be treated with herbicides or pesticides to flourish. While bamboo is usually found in

[101] http://learn.builddirect.com/flooring/bamboo-flooring/how-bamboo-flooring-made/#ixzz33YOiknzh

Asia, it is becoming a more common crop throughout the world. With about 1,000 different species thriving in a variety of soils and climates, bamboo has a presence in many areas. As the popularity and demand for this versatile crop increases, the areas where it can be found will also likely increase. Unlike most hardwood, trees that take decades to be harvestable, bamboo can be harvested in a sustainable way as little as 6 years, without damaging the grass. Bamboo harvests begin in the fall or winter, as this is when the moisture level is lower. Summer harvests can cause the bamboo to fracture during the curing process.

b) *Manufacturing of the flooring:* Once harvested, the green outer hull of the bamboo is removed and the stalk is cut into long strips (fillets) that retain the natural curve of the plant. Milling the bamboo along the outer sides creates a flat strip more suitable for future flooring. The strips are then dried and boiled to remove moisture as well as natural sugars and starches. There are two reasons for boiling: a) it makes the finished product less desirable to insects and b) boiling the bamboo makes it less likely to suffer expansion and contraction in humid climates.

After the boiling process, the strips are again dried in a kiln and then glued together into an either vertical grain or horizontal grain. The narrow edges of several strips of bamboo are glued together to create the vertical bamboo flooring. The finished product has a smooth uniform look, much like traditional hardwood flooring.

By gluing the wider surfaces together, facing up, horizontal bamboo flooring is created. This style of flooring also uses lamination. The laminating process makes the thickness of the flooring uniform throughout. The finished horizontal flooring randomly displays the knuckles, or growth rings, of the stalk.

After the boiling and drying are completed it is then possible to darken the bamboo through a process of carbonization, if a color more similar to hardwood flooring is required. Once the initial refinements are completed, the bamboo is then inspected.

During the milling stage of the bamboo processing, the strands that remain are trimmed from the long bamboo fillets. This byproduct of processing are used to create intricate patterns by weaving the thin strands together and compressing them with a resin. The strand-woven flooring is strong, durable, scratch resistant, UV resistant, moisture resistant, and is about twice as hard as other forms of bamboo flooring.

With all three types of bamboo flooring, vertical grain, horizontal grain, and strand-woven grain, the final stage involves milling the boards to refine the flooring. The tongue and groove system traditionally used in wood flooring is used with bamboo as well. Several coats of finish with aluminum oxide are applied to the flooring to make the durable material even more resistant to damage.

4.2.2 Technologies, materials used, user patterns and relative consequences for product performance and end of life. Innovations

Although wooden flooring is a well-established industry, innovation focused in achieving new products with new characteristics that fulfil the expectations of the clients for each specific application.

4.2.2.1 New technologies and innovation in the laminate flooring sector

Some examples of the new technologies achieved or under development are summarized and classified in this section in accordance with the life cycle of the product:

a) Extraction of materials and production stage

Broaching and Milling: This technology permits the finer cuts often desired to manufacture today's innovative joints. Depending upon the particular joint geometry, by utilizing a broaching step during the formation of the joining elements, greater efficiencies and precision can be achieved. Broaching can also be used to greatly increase efficiency of the machines used to form the joint itself.

Titan X™/Lustergard®: The best multi-layer protective floor finish on the market, providing a level of wear resistance that far exceeds accepted standards even for heavy commercial use. This technology also provides the material with a scratch resistance not otherwise available

Digital Printing: This technology relates to a method of printing a décor sheet using a digitized design. By digitizing the décor at some point during formation of the décor, for example, during development of the cylinder or instructing print heads during direct printing, increased control of the final décor is possible. This technique also permits greater realization when combined with Embossed-in-Register products

Embossed-in Register Laminate: This technology permits the manufacture of laminates having an embossed texture which accurately corresponds to the underlying décor by pressing. The resulting product more closely resembles the look and feel of hardwood planks, stone or ceramic tiles, rather than the smooth surface of traditional laminates.

End Block Matching: This technology relates to a method of printing a décor sheet using a repeating design, e.g., from a printing cylinder. Because the rollers used to print the design have a continuous, yet repeating pattern, cutting the décor paper (after being bonded to the core), produces a sheet having edges which have matching designs on opposite side edges. This technique permits laminates to have an Embossed-in-Register surface, without complicated and expensive manufacturing process.

b) Installation and use stage:

SoftTech™, **New acoustic and ergonomic properties:** The SoftTech technology includes a soundproofing layer between the hard laminate surface and the core, giving an improved impact absorption. The result is a significantly better ergonomic product, compared with ordinary laminate floors.

Laminate Molding Decorative Laminate moldings: This technology covers transition moldings, such as T-moldings, end moldings, and reducers, having a laminate surface atop a core, as well as methods for making them. By providing the moldings with a laminated surface, the moldings can be made to match exactly with the flooring, both in décor and surface properties.

4-in-1 Molding Snap together four different profiles from just one package of molding: The 4 in 1 molding is a great innovation from Pergo. It is an all-purpose accessory that allows use of the same product for four different applications, irrespective of the core/décor materials. The different parts are simply snapped together to achieve the required profile. This technology saves the trouble and the cost of buying several different moldings.

Smartlock®: This joint technology permits a strong connection between adjacent panels. This joint limits separation of the panels, as well as prohibits relative movement. Joining can be accomplished by angling or by horizontal sliding. By incorporating Smartlock, panels can be assembled to produce a tight joint without gaps at the seams between the panels.

Proloc® Triple locking system: Extra strong and tight joint; This technology is very similar to the Smartlock joint technology, but the inclusion of additional locking elements in the joint provides even greater joint strength than conventional horizontally joined or angled-in joint systems.

Vertical Push: The vertical push technology allows for simple drop-in installation, thereby avoiding the need for complicated angling motions required by other joints. This technology is today typically used on the short side of rectangular panels, but can also be used in other manners.

Top-Lock for Angled-In Joint: This technology permits joining of panels using an angled or rotated method, having a snapping lock on the top of the joint. In contrast to other joints, by having a top-lock, formed in conjunction with a bottom lock, a stronger and more secure joint can be realized.

Vertical Push with Joining Profile: By incorporating a joining profile into the construction, greater tolerances and increased joint strength can be achieved. This technology permits panels to be installed by a simple vertical motion, eliminating the need for tapping blocks and additional parts to hold adjacent panels at awkward angles to ensure a strong and rigid joint. These systems can be used on either or either the long side or the short side, providing significant variability and customization depending upon manufacturing, installation and use demands.

Vertical Push with Flexible Tongue: Separate flexible tongue to enable installation in one single action. It may be combined with all other locking systems and enables installation in one single action. It reduces installation time for all floorings.

Preglue; By providing a glue at the factory, a precise amount of material can be applied during manufacture. As a result, no extra step of spreading the glue is required during installation. The presence of the pre-glue permits stronger and more rigid joints than possible without a pre-glue.

4.3 Life cycle analysis screening of wooden floor covering

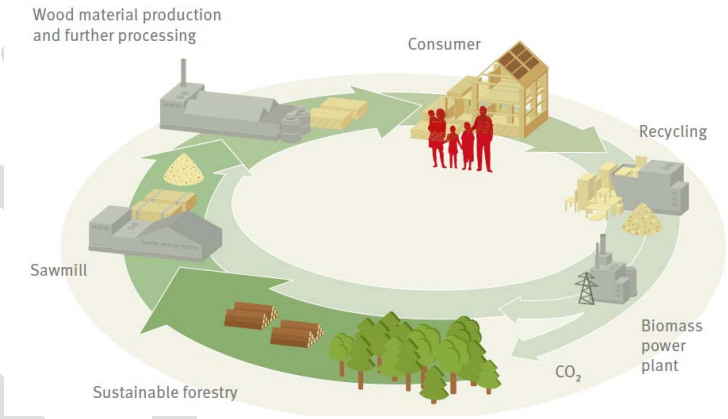


Figure 19 - Life cycle's steps of wooden floor coverings' production (source: Egger, 2013[102])

The same upstream, core and downstream processes introduced in section 4.1 are followed to carry out a life cycle analysis of wooden floor covering.

[102] Egger, 2013 (http://gardenrouteflooring.co.za/wp-content/uploads/2011/11/enviroment-21.jpg)

The LCA studies of every product follows the standards and rules described in ISO 14040 and 14044 and aims at analysing and evaluating the environmental performance of the products from the environmental point of view. Figure 19 shows the main steps related to the entire life cycle of wooden floor covering that should be considered in the LCA to be analysed in this section.

4.3.1 Life Cycle Assessment review: sources and methodology

In accordance with the Regulation 1980/2000[103], "*the voluntary Community Eco-label award scheme is intended to promote products with a reduced environmental impact during their entire life cycle and to provide consumers with accurate, non-deceptive and scientifically based information on the environmental impact of products themselves*". As stated in the Annex II of the same Regulation, these key environmental aspects have to be investigated with life cycle considerations methods and standards internationally recognized, such as the EN ISO 14040 and the EN ISO 14024 series.

When the existing criteria of WFC were set in 2009[104], other environmental studies were analysed. From that analysis it resulted that the main environmental issues of relevance for WFC are the energy consumption and sourcing of wood. Besides key environmental impacts were identified such as*:*

- Loss of biodiversity and soil erosion and degradation, as a result of unsustainable forest management and illegal logging;
- Consumption of non-renewable resources such as fossil hydrocarbons for energy and material production;
- Water and energy consumption for the production of several materials;
- Use and release of hazardous substances during production, use and end-of-life;
- Use of organic solvents and further generation of VOC emissions;
- Packaging.

For the current revision of the EU Ecolabel, a comprehensive review of available LCA studies for WFC products has been done. The goal of the LCA screening was to select those studies that comply with methodological and quality standards in order to establish a robust basis for the criteria revision process.

The literature is scarce of studies that deal with the LCA of WFC. The documents revised are environmental assessments carried out by independent parties and/or flooring associations, publications in international scientific journals and EPD on wood-based panels[105].

LCA studies are either original studies or reviews of previous studies that have been developed in accordance with the ISO 14040 guidelines. Not all of them are complete LCA studies referring to real case studies and the majority are attributional LCA. They quantify the environmental impacts generated during the life cycle of $1m^2$ or $1m^3$ of flooring without taking into account for rebound effects. In general, the LCA comparisons of flooring alternatives by research groups around the world

[103] Regulation (EC) No 1980/2000 of the European Parliament and of the Council of 17 July 2000 on a revised Community eco-label award scheme available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000R1980:en:HTML
[104] COMMISSION DECISION of 26 November 2009 on establishing the ecological criteria for the award of the Community Ecolabel for wooden floor coverings (2010/18/EC)
[105] BREF on wooden-based panels, draft available at: http://eippcb.jrc.ec.europa.eu/reference/BREF/WBP30072013D1.pdf

show that environmental impacts associated with producing and using floorings such as cork or solid wood can be lower than those of non-wooden alternatives[106], e.g. ceramic tiles, textile coverings, etc.

4.3.1.1 Number and type of publications / LCA studies analysed

The information gathered includes:

- Papers and reports on the environmental performance of different pieces of furniture;
- Environmental Product Declarations (EDP) and Product Category Rules (PCRs);
- Eco-design or sectorial guidelines based on LCA approaches.

21 articles and studies and 6 EPDs have been collected and analysed: those chosen for the scope of this report are in bold characters (Table 14)

Table 14 - Summary of studies and LCA papers gathered

Type	Type of report and number	Comments
WOODEN FLOORING	AHEC (American Hardwood Export Council), PE International, 2012. Life Cycle Assessment of Rough-sawn Kiln-dried Hardwood Lumber, Final Report.	Complete LCA study "cradle to gate" on wood timber
	Cobut, A. l., 2013. Using life cycle thinking to analyse environmental labelling: the case of appearance wood products, Int. J Life Cycle Assess 18, 722–742	Report on life cycle thinking for domestic wooden products
	Hubbard S., et al., 2008. Life-Cycle Inventory of Solid Strip Hardwood Flooring in the Eastern United States, CORRIM: Phase II Final Report.	Life-Cycle Inventory of Solid Strip Hardwood Flooring in the Eastern United States
	He Z., et al., 2012. Formaldehyde and VOC emissions at different manufacturing stages of wood-based panels. Building and Environment 47, 197-204	Tests on emissions of VOC and formaldehyde
	Garcia R., et al., 2014. Carbon footprint of particleboard: a comparison between ISO/TS 14067, GHG Protocol, PAS 2050 and Climate Declaration. J Clean Prod 66, 199–209	Legislation and Guidelines comparison on particleboard
	Jönsson, A., et al, 1997. Life Cycle Assessment of Flooring Materials: Case Study.	Environmental comparison between linoleum, vinyl flooring and solid wood flooring
	Jönsson, A., et al, 1999. Including the Use Phase in LCA of Floor Coverings. Int. J, LCA 4 (6), 321 – 328.	VOC emissions in different flooring materials
	Salem, M.Z.M., et al., 2012. Evaluation of formaldehyde emission from different types of wood-based panels and flooring materials using different standard test methods. Building and Env 49, 86-96	Tests on emissions of formaldehyde from different types of wooden flooring
	Werner, F., et al., 2007. Wooden Building Products in comparative LCA. Int. J, LCA 12 (7), 470 – 479.	Analysis of different building products

[106] J Bowyer, S. Bratkovich, K. Ferholz, A. Lindburg, 2009. LCA of flooring materials, A guide to intelligent selection, available at: http://www.dovetailinc.org/report_pdfs/2009/dovetailfloors0809.pdf

	Gunther, A., et al., 1997. Life Cycle Assessment Study on Resilient Floor Coverings. Int. J. LCA 2 (2) 73 – 80.	Comparative LCA between different flooring solutions
	Nebel, B., et al., 2006. Life Cycle Assessment of Wood Floor Coverings - A Representative Study for the German Flooring Industry. Int J LCA 11 (3) 172 – 182.	LCA study of different wooden floor covering It is the first public LCA study
	European Commission, Centre for Strategy & Evaluation Services (CSES), 2012. Evaluation of the Ecodesign Directive (2009/125/EC) – Draft final report, Appendix B4, Case Study 4: Floor Coverings[107].	LCA and Ecodesign study to examine the feasibility of developing Ecodesign requirement for floor coverings
LAMINATE FLOORING	**Rivela, B., et al., 2006. Life Cycle Inventory of Particleboard: A Case Study in the Wood Sector. Int J LCA 11 (2) 106 – 113.**	Environmental analysis of particleboard, as it is one of the most common wood based materials.
	Rivela, B., et al., 2007. Life Cycle Inventory of Medium Density Fibreboard. Int J LCA 12 (3) 143 – 150	Environmental analysis of MDF from an LCA point of view
	Environmental Product Declaration (EPD) of Direct Pressure Laminate Floor Covering (DPLF) produced by EPLF (European Producers of Laminate Flooring e.V.), Number of declaration EPD-ELF-2009111-E, valid 3 years since 2012, August 11	Environmental Analysis (IBU PCR compliant) of DPFL laminate flooring
	Environmental Product Declaration (EPD) of Direct Pressure Laminate Floor Covering (DPLF) produced by MeisterWerke Schulte GmbH, Number of declaration EPD-MWS-2011111-E, valid 3 years since 2011, May 20	Environmental Analysis (IBU PCR compliant) of DPFL laminate flooring
	Environmental Product Declaration (EPD) of Direct Pressure Laminate Floor Covering (DPLF) produced by UNILIN bvba - division FLOORING, Number of declaration EPD-QST-2011111-E, valid 3 years since 2011, July 20	Environmental Analysis (IBU PCR compliant) of DPFL laminate flooring
	Environmental Product Declaration (EPD) of Laminate Flooring produced by Egger, Number of declaration EPD-EHW-2008211-E, valid 3 years since 2012, April 9	Environmental Analysis (IBU PCR compliant) of laminate flooring
CORK FLOORING	**Althaus, 2001. Life cycle analysis (LCA) of different cork floorings. EMPA Activities 2011, Material and Systems**	LCA of different cork flooring products
	Bowyer, J., et al., 2009. Life Cycle Assessment of Flooring Materials – A guide to intelligent selection.	LCA of flooring materials (9 from tyles to linoleum and cork) developed with BEES method
	González-García, S., et al., 2013. Life-cycle assessment of typical Portuguese cork oak woodlands. Science of the Total Environment 452–453, 355–364	LCA of cork
	Mahalle L., et al., 2011. A comparative Life Cycle Assessment of Canadian Hardwood Flooring with alternative Flooring Types. FPI Innovations.	Comparative LCA LCA (cradle to gate) for different flooring materials
	Rives, J., et al., 2012. Environmental analysis of cork granulate production in Catalonia – Northern Spain. Resources, Conservation and Recycling 58, 132– 142.	Life cycle inventory (LCI) of white and black granulate production

[107] http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/review/files/ecodesign_evaluation_report_appendixes_en.pdf

	Rives, J., 2013. Integrated environmental analysis of the main cork products in southern Europe (Catalonia e Spain). J of Cleaner Production 51, 289-298.	LCA analysis of Champagne cork stopper and natural cork ones.
	Environmental Product Declaration (EPD) of Cork floor tiles according to EN 12104 produced by ERFMI (European Resilient Flooring Manufacturers' Institute), EPD-ERF-2013911-E, valid 5 years since 2013, April 1	Environmental Analysis (IBU PCR compliant) of cork floor tiles
	Environmental Product Declaration (EPD) of Corkcomfort Floating HPS produced by Amorim Revestimentos S. A., EPD-AMO-2013121-E, valid 5 years since 2013, July 1	Environmental Analysis (IBU PCR compliant) of cork floor tiles
BAMBOO FLOORING	**Vogtländer, J. et al., 2010. The sustainability of bamboo products for local and Western European applications. LCAs and land-use. Journal of Cleaner Production 18, 1260-1269**	LCA analysis on bamboo with Eco-costs calculation method and Land-use consideration
	Vogtländer, J. et al., 2011. Life Cycle Assessment and Carbon Sequestration. Bamboo Products of MOSO International (Confidential LCA study from MOSO Int.)	Cradle to gate analysis on bamboo products and carbon sequestration

4.3.1.2 Screening of the quality of LCA studies

An analysis of the quality and the applicability of the above mentioned LCA and environmental studies have been carried out. A general methodology was defined for the LCA screening in order to select the studies and gather the information that would be used in the technical analysis. This methodology includes:

a) *Preliminary identification of key environmental issues*: a set of key environmental indicators of relevance for this product group have been identified based on the observation of relevant documents of reference, available PCRs and studies where impacts have been normalized[108]. These features have been briefly evaluated to understand if: a) the functional unit is properly defined and informed by market knowledge and/or PCR's and b) the system boundary is cradle-to-grave. For each selected study LCA the main characteristics are shown in a summarizing table.

b) Screening of studies: studies that do not satisfy minimal cut-off requirements (scope, impacts, outcomes) were disregarded. In addition the functional unit (FU) and system boundaries of EPDs and LCAs studies have been checked to ensure that FU is properly defined and informed by market knowledge and/or PCRs and that the system boundary includes at least a "cradle-to-grave" system. In addition, a parameter called "comprehensiveness" has been assessed.

[108] References for the evaluation of broadness and appropriateness of impact assessment metrics have been defined in the Product Environmental Footprint (PEF) Guide. The document proposes a set of 14 environmental impact categories to take into account to perform a coherent LCA of a product. Recommended impact categories and related assessment methods are provided in accordance with ILCD Handbook. The PEF guide also indicates that, depending on the product system and on the intended application, it is possible to narrow the number of impact categories considered. Such exclusions should be supported for instance by: international consensus processes; previous studies of similar systems; PCR from other initiatives/ schemes; normalization of results.

c) Findings related to the key environmental issues identified: Outcomes from studies of satisfactory quality were grouped by product analysed. These studies allowed gaining relevant information for one or more environmental areas and they permit to focus the attention on the most important phases on which it could be worth to intervene.

d) Filling information gaps: Additional research would be necessary to fill any potential gap of information.

4.3.1.3 Summary of selected LCA studies

From all listed studies, LCA studies have been screened to identify those that satisfy minimal requirements for quality and robustness and to select the most relevant ones. As a general rule the EPDs are not analysed through this scoring methodology, since they are verified studies and documents, and they all comply the requirements of PCRs (see next section).

The scientific criteria to be taken into consideration are: *completeness of the study*, *environmental relevance*, *scientific robustness and certainty*, *documentation*, *transparency* and *reproducibility*, *applicability* and *overall scientific acceptance* (based on the other single scientific criteria).

The minimal cut-off requirements have been set for:

- *scope:* function unit properly defined and relevant for the revision, scope coherent with goal analysis, respect of ISO 14040 standard
- *impact assessment*: satisfactory broadness or quality of the indicator(s) considered in the analysis and
- *outcome*s (relevant and applicable outcomes).

The recommendations of the ILCD Handbook[109] have been consulted to evaluate which assessment methods and impact categories are more appropriate to quantify the impacts for each of the environmental categories identified in Figure 20 starting from the list provided by EU PEF[110] methodology. Usually less than half of the 14 impact categories suggested to be analysed by EU PEF are usually taken into account in LCA studies

A first selection on their feasibility to be used in the environmental assessment for the criteria revision has been done. LCA studies shown in

Table 16 are those that passed the thresholds. The quality of the studies passing the first level of screening has been evaluated through a scoring system. Six parameters have been taken into account: scope, data, impact assessment, outcomes, robustness of the study and critical review. For each parameter a score from 1 to 5 has been assigned as described in Table 15. Quality of the studies has been considered satisfactory when the sum of the scores is higher than 15.

[109] European Commission - Joint Research Centre - Institute for Environment and Sustainability: *International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance.* First edition March 2010. EUR 24708 EN. Luxembourg. Publications Office of the European Union; 2010

[110] EUR LEX 2013/179/EU, p. 24. Recommendation on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations.

EF Impact Category	EF Impact Assessment Model	EF Impact Category indicators	Source
Climate Change	Bern model - Global Warming Potentials (GWP) over a 100 year time horizon.	kg CO_2 equivalent	Intergovernmental Panel on Climate Change, 2007
Ozone Depletion	EDIP model based on the ODPs of the World Meteorological Organization (WMO) over an infinite time horizon.	kg CFC-11 (*) equivalent	WMO, 1999
Ecotoxicity for aquatic fresh water	USEtox model	CTUe (Comparative Toxic Unit for ecosystems)	Rosenbaum et al., 2008
Human Toxicity - cancer effects	USEtox model	CTUh (Comparative Toxic Unit for humans)	Rosenbaum et al., 2008
Human Toxicity – non-cancer effects	USEtox model	CTUh (Comparative Toxic Unit for humans)	Rosenbaum et al., 2008
Particulate Matter/Respiratory Inorganics	RiskPoll model	kg PM2,5 (**) equivalent	Humbert, 2009
Ionising Radiation – human health effects	Human Health effect model	kg U^{235} equivalent (to air)	Dreicer et al., 1995
Photochemical Ozone Formation	LOTOS-EUROS model	kg NMVOC (***) equivalent	Van Zelm et al., 2008 as applied in ReCiPe
Acidification	Accumulated Exceedance model	mol H+ eq	Seppälä et al.,2006; Posch et al., 2008
Eutrophication – terrestrial	Accumulated Exceedance model	mol N eq	Seppälä et al.,2006; Posch et al., 2008
Eutrophication – aquatic	EUTREND model	fresh water: kg P equivalent marine: kg N equivalent	Struijs et al., 2009 as implemented in ReCiPe
Resource Depletion – water	Swiss Ecoscarcity model	m^3 water use related to local scarcity of water	Frischknecht et al., 2008
Resource Depletion – mineral, fossil	CML2002 model	kg antimony (Sb) equivalent	van Oers et al., 2002
Land Transformation	Soil Organic Matter (SOM) model	Kg (deficit)	Milà i Canals et al., 2007

(*) CFC-11 = Trichlorofluoromethane, also called freon-11 or R-11, is a chlorofluorocarbon.
(**) PM2,5 = Particulate Matter with a diameter of 2,5 µm or less.
(***) NMVOC = Non-Methane Volatile Organic Compounds

Figure 20 - Default EF impact categories (with respective EF impact category indicators) and EF impact assessment models (according to EU PEF)

Table 15 - Cut-off and scoring criteria for LCA studies evaluation

Item	*Cut-off (minimal requirements) Scoring*	*Cut-off (minimal requirements) Scoring*
title		-
authors		-
reference and year		-
type of study **scope** **functional unit** **system boundaries (see description below)** **assumptions (e.g. allocation)**	QUALITY OF SCOPE: - Functional unit properly defined and relevant for this revision. - Scope coherent for the goal of the study - Assumptions of the study shall respect ISO 14040 standard.	S_{SCOPE} 5 = coherent LCA for broad group of products of interest. Scope from cradle to grave. 3 = coherent LCA for some products of interest 1 = streamlined LCA for some products of interest
data sources and quality **1. Raw materials** **2. Manufacturing** **3. Distribution/ tte** **4. Use phase** **5. Packaging** **6. End of Life** **TOTAL**		S_{DATA} I) Temporal, Geographical and Technological representativeness, evaluated for each stage: 5 = High quality - -Data refers to less than 3 years ago. - -Data for specific country of interest and relevant for the EU Ecolabel. - Data for specific technology used and of relevance for the EU Ecolabel 3 = Average quality - -Data refers to 3–5 years. - -Average data at continental level and relevant for the EU Ecolabel. - -Data reflecting the average technologies used 1 = Low quality - -Data refers to more than 5 years ago. - -Average data at World level. - -Data related to technologies not often used. II) The overall score for data is the average of the points assigned to each single stage.
Impact assessment categories/methods	Satisfactory broadness (at least one indicator is of interest with respect to the indicators identified earlier) AND quality of all the indicator(s) of interest used is	$S_{IMPACTS}$ 5 = satisfactory broadness (with respect to the impact categories identified earlier) AND all indicators of interest are evaluated 3 = at least one indicator is of interest (with respect to the indicators identified earlier) AND all

	classified.	indicators of interest are evaluated 1 = at least one indicator is of interest (with respect to the indicators identified earlier) AND all the indicators used evaluated.
Conclusions (e.g. most important LC phases; drivers to impacts, process or material; improvement options)	The outcomes of the study must be relevant and applicable to the revision process.	$S_{OUTCOMES}$ 5 = The outcomes of the study are of high relevance for the criteria revision and they can be directly used to address some key-issues. 3 = The outcomes are somehow of relevance for the criteria revision and they can be directly used to address some key-issues. 1 = The outcomes are somehow of relevance for the criteria revision and they can be partially used to address some key-issues.
Strengths and weakness, general comments	-	$S_{ROBUSTNESS}$ = The overall quality of the study is considered 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 considered good (in terms of modelling, assumptions, data gaining, impacts assessment, presentation and discussion of results, findings). 1 = Minimal requirements of quality are satisfied.
Subject to independent review?	-	S_{REVIEW} 5 = independent 3rd-party review (e.g. certification) 3 = independent review (e.g. paper) 1 = no review

Table 16 - Summary LCA papers that passed the first screening

Reference	Kind of flooring	Inventory data	Impact results	Geographic scope	Short description
Gunther, A., et al., 1997. LCA on Resilient Floor Coverings. Int. J. LCA 2 (2) 73 – 80.	Wooden flooring	X	√	Regional, Germany	Examination of European resilient floor products in a LCA perspective. PVC, polyolefin, rubber and linoleum are considered, with one reference example from textile and parquet.
Nebel, B., et al., 2006. LCA of Wood Floor Coverings - A Representative Study for the German Flooring Industry. Int J LCA 11 (3) 172 – 182.	Wooden flooring	√	√	Regional, Germany	The goal of the study is a LCA for wood floor coverings (solid parquet, multilayer parquet, solid floor board and wood blocks). The representative study covers approximately 70% of all wood flooring production in Germany.
Rivela, B., et al., 2006. LCI of Particleboard: A	Laminate	√	√	Regional,	Scope of the study is to generate a comprehensive LCI database for the

Reference	Kind of flooring	Inventory data	Impact results	Geographic scope	Short description
Case Study in the Wood Sector. Int J LCA 11 (2) 106 – 113.	Flooring			Spain	manufacture of resin-bonded wood particle boards considered to quantify the potential environmental impact associated to the system under study.
Rivela, B., et al., 2007. LCI of Medium Density Fibreboard. Int J LCA 12 (3) 143- 150	Laminate Flooring	√	√	Regional, Spain	It is the follow-up to the previous Rivela's study. The main focus of this study is to provide comprehensive data of one key wood board industry: the Medium Density Fibreboard (MDF).
Althaus, 2001. LCA of different cork floorings. EMPA Activities 2011, Material and Systems.	Cork Flooring	X	√	-	A "cradle to grave" life cycle assessment (LCA) done for 14 different cork flooring systems. The objective of the study was to compare these floorings in terms of environmental impacts of their production and life cycle and identify ecologically weak spots and the potential for their improvement.
Vogtländer, J. et al., 2010. The sustainability of bamboo products for local and Western European applications. LCAs and land-use. J. of Cleaner Prod. 18, 1260-1269.	Bamboo Flooring	√	√	Bamboo production (China) Bamboo producer (NE)	It is a LCA study made to compare the environmental impact of bamboo materials, shipped to Western Europe, with commonly used materials such as timber.

In complementation with these LCA, other studies for specific materials or processes related to the floor coverings (such as forestry, VOC or formaldehyde emission, end of life treatments) have been gathered and used in the technical analysis (Table 14).

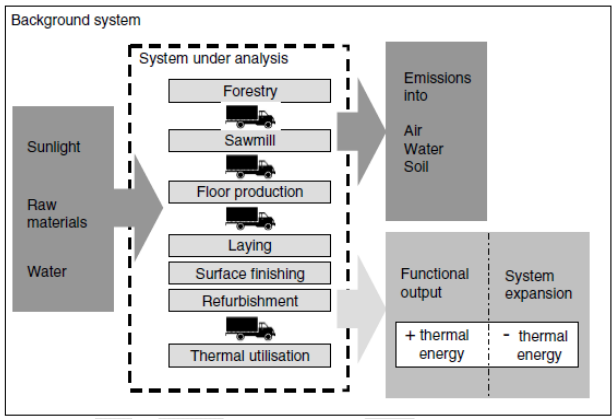
4.3.2 Life Cycle Assessment review: solid wood flooring and parquet

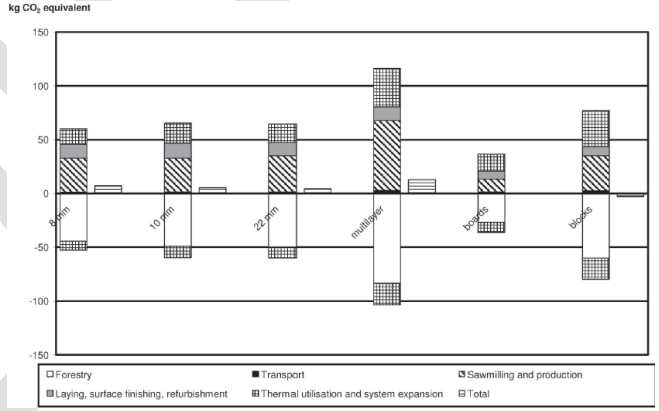
In 2006 the first study that included solid wood floorings was published by Nebel et al[111] and focused on the German industry. This study is about four types of WFC; **solid parquet** (of different thickness), **multilayer solid parquet**, **solid floor boards and wood blocks.** The main information about this study is summarized in Table 17.

Table 17 - Main information of LCA study of some solid wooden flooring by Nebel *et al.*, 2006

S_{SCOPE}= 5 S_{DATA}= 6 $S_{IMPACTS}$= 3 $S_{OUTCOMES}$ = 5 $S_{ROBUSTNESS}$= 5 S_{REVIEW}= 3		S_{TOTAL}= 27
Item	***Observation***	***Scoring***
title	Life Cycle Assessment of Wood Floor Coverings - A Representative Study for the German Flooring Industry.	-
authors	Nebel, B., et al.	-
reference and year	2006	-
type of study	Cradle to grave	S_{SCOPE} = 5
scope	The main focus was a hot spot analysis to help the involved industry partners to improve their environmental performance and to use the results for marketing purposes and to use the results for marketing purposes.	
functional unit	1m^2 of laid wood floor covering installed	
system boundaries (see description below)	- forestry, transport and sawmill - transport of sawn timber, floor production and floor transport - installation and use phase - end-of-life assuming thermal utilization	

[111] B. Nebel, B. Zimmer and G. Wegner, LCA of wood floor coverings, LCA case studies, Int J LCA 11 (3) 172-182 (2006)

	 **Figure 21 - Life cycle of wood floor coverings**	
assumptions (e.g. allocation)	Gabi software (PE Europe 2000) 50 years until the next refurbishment Solid wood floorings useful life of 25-50 years depending on the thickness	
data sources and quality	Data provided by the producers and measured on site, data for "forestry" and "thermal utilization" are based on the literature, generic data based on the libraries of Gabi.	
1. Raw materials	Literature: GaBi software (PE Europe 2000) for LCI data. The sources give sufficient detail about the origin of the data and meet the requirements of the present study.	*1*
2. Manufacturing	Primary data: they have been measured on site.	*1*
3. Distribution/ tte	Primary data: they have been measured on site.	*1*
4. Use phase	Primary data: they have been measured on site.	*1*
5. Packaging	Primary data: they have been measured on site.	*1*
6. End of Life	Literature: The sources give sufficient detail about the origin of the data and meet the requirements of the present study.	*1*
TOTAL		$S_{DATA} = 6$
Impact assessment categories/methods	- Primary energy [MJ] - Global Warming Potential (GWP): IPCC 2007 [kg CO_2-equivalent] - Ozone Depletion Potential (ODP): [kg R11-equivalent] - Acidification Potential (AP): [kg SO_2-equivalent]	$S_{IMPACTS} = 3$

	- Photochemical Oxidant Chemical Potential [kg C_2H_4-equivalent] - Eutrophication potential (EP) [kg PO_4^{3-}equivalent]	
Conclusions	It was concluded that energy consumption and the use of solvents influence the environmental impacts of the systems under analysis. The most relevant stages for the energy consumptions are *production* and for photo-oxidant formation *laying, surface finishing and refurbishment*. These are therefore the unit processes with the greatest potential for improvement. *Differences between the three types of solid parquet are not significant*, although the thinner ones have to be produced more often but for the thicker ones more wood is needed. This is due to the dependency of the energy consumption in the production phase on the mass of wood, especially for kiln drying. The results for solid floor boards are lower due to the more intensive use of open air drying in the production phase. These results clearly show that *more efficient drying of timber would improve the environmental performance of wood products*. Regarding the use of *solvents*, and particularly their contribution to photo-oxidant formation, *a remarkable improvement can be achieved in the unit process of laying, surface finishing and refurbishment.* The choice of a different kind of glue can reduce the POPC by 70%. Two important issues are highlighted in this report: a) the *provision of energy from post-consumer wood can substitute fossil fuels and makes a difference of up to 52%* to the final results and b) WFC functions as a net storage of CO_2 during their useful life. Therefore the *production and use of wood products counteracts climate change* in two ways: substitution of fossil energy and storage of carbon. The impact assessment results are shown in Figure 22.  **Figure 22 - Impact assessment results for climate change**	$S_{OUTCOMES} = 5$

Strengths and weakness, general comments	The *functional unit chosen should be careful regarded* when comparing the products as its *thickness allows for different useful lives and longer life products should not be automatically penalized.* A shorter service time of the floor covering would significantly change the results for the different floorings. Results in the *cleaning stage* confirm the *importance of including the use phase*, especially in the long-lived products which have relatively low energy consumption in their production stage.	$S_{ROBUSTNESS}$ = 5
Subject to independent review?	Yes Int. J. LCA 11 (3) 172 – 182.	S_{REVIEW} = 3

The life cycle was divided into the following stages:

a) Extraction of the raw materials

- ***forestry:*** this stages includes the formation of wood by the process of photosynthesis but also planting of the trees, several thinning and finally the harvest of the wood using chainsaws and several vehicles. Species covered in the study include oak, beech, spruce and pine. Other species are assumed to be equivalent to the species with the most similar silvicultural treatment and habit.
- ***transport of the logs to the sawmill*** was assumed to be done by lorries transport 98% of the logs over a distance of 171km and cannot take a load on the return trip.

b) Production and manufacturing of the wooden flooring

- ***sawmill***: in the facility, logs are cut into timber and then prepared for further operations;
- ***transport*** of sawn timber was neglected as the average distance for the transport of sawn timber for solid parquet is relatively short.
- ***floor production* data** resulted from an average of 15 manufacturers. The most energy consuming process is kiln drying the timber. Green timber processed in a sawmill has a humidity of ca. 80% by mass and should achieve a humidity of 9%. Down to around 40 to 25% humidity the drying is achieved by air drying, using solar and wind energy. The remaining humidity kiln drying is usually applied. The thermal utilisation of residual wood provides all the heat required for kiln drying and heating the production plants. Between 34% (solid floorboards) and more than 51% of the total energy consumption over the whole life cycle is supplied by the energy from the residual wood (excluding the end of life scenario).

- ***transport of floor coverings***: distances for the delivery of the final products are assumed as follows: solid parquets 340km, multilayer parquet 500km, solid floorboards 259km and wood blocks 300km. solid parquet is produced by a greater number of smaller companies which are regionally distributed, whereas there are only a few big companies producing multilayer parquet.

c) Installation and use stage

- ***laying and surface finishing***: on average three journeys of 17km with a van to the building site are necessary. The loss at this stage is mainly due to leftovers in packages, it ranges from 1.5 to 4%
- ***use phase***: this stage is divided into refurbishment and cleaning. Solid wood floorings are supposed to have a useful life of 25-50 years depending on the thickness. The useful life of multilayer parquet is more complex as it depends on the laying of the parquet. If glued to the ground over the whole area a realistic useful life of 20 years is assumed. If the single boards are glued together around their sides but not glued to the ground (floated laying) then a realistic useful life of 10 years is attributed.
- A refurbishment of all floor types takes place on average every 15 years, it includes sanding of the surface and a new finish. For the cleaning of WFC no hard data are available. An estimation of the impact is based on vacuuming the floor once a week using an average vacuum cleaner. This amounts to a consumption of 8.6kWh$_e$ in 50 years

d) End-of-life stage

- ***thermal utilization at end-of-life***: after a useful life of 50 years the wood floor coverings are dismantled and collected for thermal utilization. The BAT is chosen for the provision of thermal energy from fossil fuels, assuming that this technology will be widely available in the future. The thermal energy from gas with an efficiency of 100% is assumed to substitute thermal energy.

A second study that passed the first screening was carried out by Gunther et al. the main information is shown in Table 18

Table 18 - Main information of LCA study of some solid wooden flooring by Gunther, *et al.*, 1997

S_{SCOPE}= 3 S_{DATA}= 6 $S_{IMPACTS}$= 3 $S_{OUTCOMES}$ = 3 $S_{ROBUSTNESS}$= 5 S_{REVIEW}= 3		S_{TOTAL}= 23
Item	***Observation***	***Scoring***
title	Life Cycle Assessment Study on Resilient Floor Coverings	-
authors	Gunther., et al.	-
reference and year	1997	-
type of study	Cradle to grave	S_{SCOPE}= 3

scope	The goal of the study is a LCA for wood floor coverings (solid parquet, multilayer parquet, solid floor board and wood blocks). The representative study covers approximately 70% of all wood flooring production in Germany.	
functional unit	The typical use of 1m^2 of wooden parquet over a period of twenty years.	
system boundaries	Cradle to grave (in compliance with Impact Assessment ISO 14042) including: - forestry, transport and sawmill - transport of sawn timber, floor production and floor transport - installation and use phase - end-of-life.	
assumptions (e.g. allocation)	Estimated lifetime: 20 years Use of Gabi software	
data sources and quality	Data come from producers, in particular the authors use the Life Cycle Inventories for the 32 different floorings.	
1. Raw materials		*1*
2. Manufacturing		*1*
3. Distribution/ transportation		*1*
4. Use phase		*1*
5. Packaging		*1*
6. End of Life		*1*
TOTAL	4 on 14 PEF impact categories	S_{DATA} = 6
Impact assessment categories/methods	- Gross energy [MJ] - Global Warming Potential (GWP): IPCC 2007 [kg CO_2-equivalent] - Acidification Potential (AP): [kg SO_2-equivalent] - Chemical waste [kg] - Municipal waste [kg] - Water demand [m^3]	$S_{IMPACTS}$ = 3
Conclusions	Wooden parquet shows the lowest share of not-renewable energy - due to the relatively high mass of wood - and the highest fraction of renewable energy. Furthermore the lifetime of parquet could be longer than twenty years, comparing it with other type of flooring, such as textile, analysed with the same LCA study. Concerning the different basic materials, there is no material specific ranking for 'best' or 'worst' environmental performance, whereas relative advantages concerning specific categories are to be found.	$S_{OUTCOMES}$ = 3
Strengths and weakness, general comments	Significant improvement options are to be found for all floorings and in all parts of the life cycles. For example the Global warming potential is dominated by carbon dioxide emissions (energy supply) and methane emissions, the latter predominantly for native materials (landfill of organic, biodegradable substances). Also here, the huge improvement opportunities due to efficient recovery schemes are to be emphasised in which, however, energy recovery leads only to a reduction in the Global warming potential if natural	$S_{ROBUSTNESS}$ = 5

	substances are to be treated. In the case of fossil raw materials, energy recovery does not reduce the Global warming loads in comparison to landfilling.	
Subject to independent review?	Yes Int. J. LCA 2 (2) 73 – 80.	S_{REVIEW} = 3

4.3.3 Life Cycle Assessment review: laminate flooring and other wood-based panels

Only two studies passed over the first LCA screening. Both studies are going to be looked in more detailed in this section. They were selected for the analysis even if none of them have the laminates as the scope, for two reasons: the most part of the environmental burden related to laminate floor is related to the production of fibreboard and wood-based panels (usually the core layer in laminates) and no LCA studies were found on laminate flooring specifically.

The first one corresponds to the LCA of particleboard while the second one focuses on MDF panels (Table 19).

Table 19 - Main information of the environmental assessment presented in the LCA study of Rivela, *et al.*, 2006

S_{SCOPE}= 3 S_{DATA}= 1 $S_{IMPACTS}$= 3 $S_{OUTCOMES}$ = 3 $S_{ROBUSTNESS}$= 3 S_{REVIEW}= 3		**S_{TOTAL}= 16**
Item	***Observation***	***Scoring***
title	Life cycle inventory of particleboard: a case study in the wood sector.	-
authors	Rivela, B*., et al.*	-
reference and year	2006	-
type of study	Cradle to gate	S_{SCOPE}= 3
scope	The main focus of this study is to generate a comprehensive LCI database for the manufacture of resin-bonded wood particleboards.	
functional unit	1m^3 of particleboard	
system boundaries	- wood preparation - board shaping and - board finishing.	

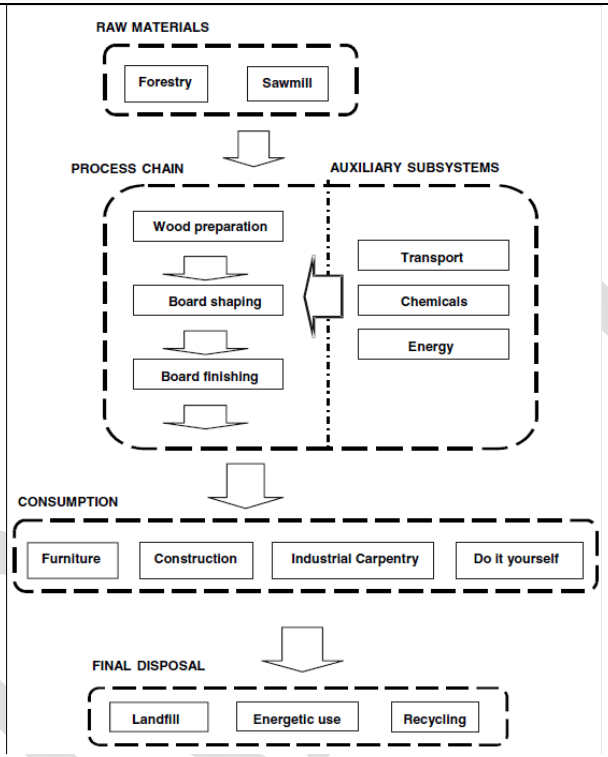
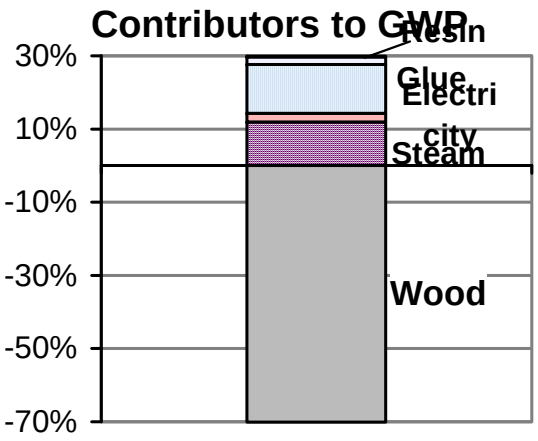


Figure 23 - System boundaries and process chain under study

assumptions (e.g. allocation)		
data sources and quality	Data from a particleboard factory under study with a production capacity of 680 m^3 of finished particleboard per day Generic data from Pre consultants database for the cogeneration and UF resin production.	
1. Raw materials	Primary data about forestry and sawmill	*1*
2. Manufacturing	Primary data coming from on-site measurements in a Spanish factory	*1*
3. Distribution/ t	Primary data coming from a Spanish factory	*1*
4. Use phase	-	-

5. Packaging	Not considered	-
6. End of Life	Primary data on final disposal: landfill, energetic use, recycling	*1*
TOTAL		S_{DATA} = 1
Impact assessment categories/methods	Characterisation and Damage Assessment of particleboard manufacture/Eco-indicator 99: Human Health ✓ Carcinogens [DALY·10^6] ✓ Respiratory organics [DALY·10^8] ✓ Respiratory inorganics [DALY·10^5] ✓ Climate change [DALY·10^5] ✓ Ozone layer [DALY·10^9] Ecosystem quality	$S_{IMPACTS}$ = 3

	✓ Ecotoxicity [PAF·m^2yr] ✓ Acidification/Eutrophication [PDF·m^2yr] ✓ Land use [PDF·m^2yr] Resources ✓ Minerals [MJ surplus] ✓ Fossil fuels [MJ surplus] Damage assessment ✓ Human health [DALY·10^6] ✓ Ecosystem quality [PDF·m^2yr] ✓ Resources [MJ surplus] Units: DALY: Disability Adjusted Life Years. PDF: Potentially Disappeared Fraction. PAF: Potentially Affected Fraction. MJ surplus: surplus energy for the future mining of the resources.	

Conclusions	 **Figure 24 - Contributors to GWP of the main raw materials and energy** GWP of the different process phases are reported in Figure 24. The main impacts are related to energy use and glue production and use. CO_2 credit related to biological tree growth is included in this study. Special attention was paid to the inventory analysis stage of the particleboard industry because of its relevance as a primary transformation process in the wood sector. The results of the detailed quantification of particleboard manufacture may serve as a basis to evaluate products, their use, recycling and disposal in such a way that the environmental burdens are minimised and reduced to levels that are competitive and may even outperform potential substitutes.	$S_{OUTCOMES}$= 1
Strengths and weakness, general comments	Lifetime of the product is not considered. In this work, particleboard was the product analysed, as it is the one of the most common wood-based materials. Future work will focus on the study of another key wood board: Medium Density Fibreboard (MDF). Moreover, factors with strong geographical dependence, such as the electricity profile and final transport of the product, will be analysed. In addition, the definition of a widespread functional unit to study the use of wood wastes at the end-of-life stage may be another issue of outstanding interest.	$S_{ROBUSTNESS}$= 3

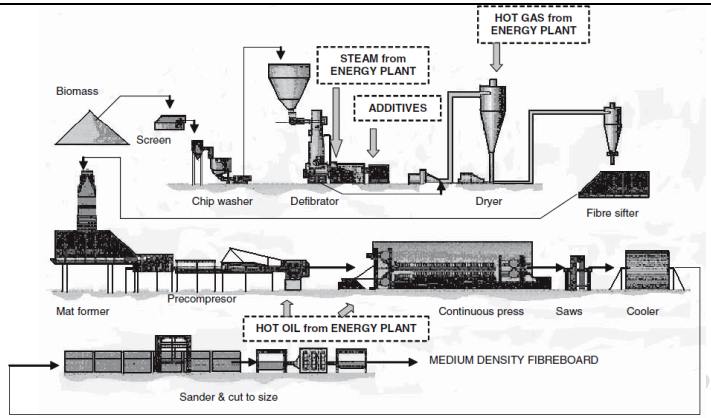
Subject to independent review?	Yes Peer-reviewed publication Int. J. Life Cycle Assess. 11, 106-113	S_{REVIEW} = 3

The second study that passed the first LCA screening was published by Rivela et al[112] reported in 2007. It reports a LCI of medium density fibreboard (MDF) which data are summarized in Table 20.

Table 20 – Main information of the environmental assessment of medium density fibreboard (MDF) by Rivela *et al.*, 2007

S_{SCOPE}= 3 S_{DATA}= 1 $S_{IMPACTS}$= 3 $S_{OUTCOMES}$ = 3 $S_{ROBUSTNESS}$= 3 S_{REVIEW}= 3		**S_{TOTAL}= 16**
Item	***Observation***	***Scoring***
title	Life Cycle Inventory of Medium Density Fibreboard	-
authors	Rivela, B*., et al.*	-
reference and year	2007	-
type of study	Cradle to gate analysis: the system boundaries included all the activities taking place into the factory (wood preparation, board shaping and finishing) as well as the activities linked to the production of the main chemicals used in the process, energy inputs and transport.	S_{SCOPE}= 3
scope	It is the follow-up to the previous Rivela's study (published in 2006). The main focus of this study is to provide comprehensive data of one key product in wood board industry: the Medium Density Fibreboard (MDF).	
functional unit	1m^3 of finished MDF (Medium Density Fibreboard)	
system boundaries	The same of the previous study Rivela et. al, 2006. In particular, below, there is the flow sheet of MDF manufacture	

[112] B. Rivela, MT Moreira, G Feijoo (2007), Life cycle inventory of medium density fibreboard, Int. J. LCA 12 (3) 143-150

		
assumptions (e.g. allocation)	International Organization for Standardization standards (ISO 14040-43) and Ecoindicator 99.	
data sources and quality	Data are from on-site measurements over a period of one year, coming from three factories, considered representative of the 'state of art': two Spanish factories and a Chilean one, with a process production of around 150,000 m^3 per year. Generic data from Pre consultants database for the UF resin production, from ETH-ESU 96 database for the cogeneration plant and for transport from BUWAL 250 database	
1. Raw materials	Primary data about forestry and sawmill.	*1*
2. Manufacturing	Primary data coming from on-site measurements in a Spanish factory and a Chilean one.	*1*
3. Distribution/ tte	Primary data coming from a Spanish factory and a Chilean one.	*1*
4. Use phase	-	-
5. Packaging	Not considered.	-
6. End of Life	Primary data on final disposal: landfill, energetic use, recycling.	*1*
TOTAL		S_{DATA} = 1
Impact assessment categories/methods	3 on 14 PEF impact categories Characterisation and Damage Assessment of particleboard manufacture/Eco-indicator 99: Human Health	$S_{IMPACTS}$ = 3

	✓ Carcinogens [DALY·10^{6}] ✓ Respiratory organics [DALY·10^{8}] ✓ Respiratory inorganics [DALY·10^{5}] ✓ Climate change [DALY·10^{5}] ✓ Ozone layer [DALY·10^{9}] Ecosystem quality ✓ Ecotoxicity [PAF·m^{2}yr] ✓ Acidification/Eutrophication [PDF·m^{2}yr]	

	✓ Land use [PDF·m^2yr] Resources ✓ Minerals [MJ surplus] ✓ Fossil fuels [MJ surplus] Damage assessment ✓ Human health [DALY·10^6] ✓ Ecosystem quality [PDF·m^2yr] ✓ Resources [MJ surplus] Units: DALY: Disability Adjusted Life Years. PDF: Potentially Disappeared Fraction. PAF: Potentially Affected Fraction. MJ surplus: surplus energy for the future mining of the resources.	
Conclusions	Results demonstrated that the *primary emissions sources at MDF manufacture are from fibre dryers and press vents*. Emissions from the drying process consist mainly of CO_2 and filtered matter while emissions from board hot presses are related to the type and amount of resin used to bind the wood fibres together. When the press opens, vapours with formaldehyde content are released. The other main emission source is the boiler, which can be fed with several fuels. If the boiler is fed with the waste from the subsystems of board shaping and finishing no allocation is needed. However, it is noteworthy that the combustion of wood under a sustainable wood production may be CO_2 neutral, but not CO_2 free and that only in a 50 years scenario the carbon cycle might be closed. In order to detect the hot-spots, *the results showed that the wood preparation exhibits the highest contributions to all the categories analysed.* Board finishing subsystem shows a significant contribution to cancer, Eco-toxicity and mineral categories, which accounts for 5,8% of the damage to the category "human health" and 5,5% of the damage to category "resources". The main contribution to these categories is related to energy consumption. Thus wood preparation has the largest impacts on the mentioned categories as this subsystem is the most dependent on the use of electricity. On the other hand, damage to category "ecosystem quality" is mainly caused by the UF used in the subsystem of the wood preparation. As stated the energy consumption during the wood preparation of	$S_{OUTCOMES}$ = 3

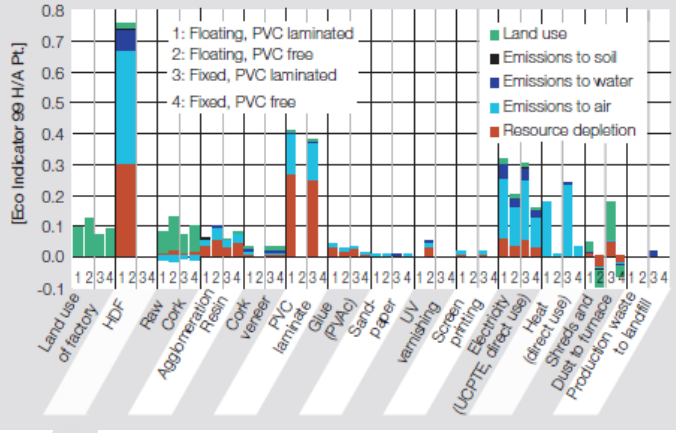
	the panel is the larger environmental aspect.	
Strengths and weakness, general comments	Research continues to be conducted to identify the environmental burdens associated to the materials of extended use. In this sense, future work can be focused on the comparison of different materials for specific applications. A comprehensive study on one of the most important application for MDF, in laminate flooring, may be an important issue of interest, considering that are not available LCA study on laminate flooring production up to now.	$S_{ROBUSTNESS}$ =3
Subject to independent review?	Yes, Int. J. LCA 12 (3) 143 – 150	S_{REVIEW} 3

4.3.4 Life Cycle Assessment review: cork flooring

Only one study from the initial list of studies and focused on the cork floorings passed the preliminary screening. This study includes a "cradle to grave" LCA for 14 different cork flooring systems and aims to identify ecologically weak spots and the potential for their improvement. Among the products there were products for fixed and floating laying. Some of the floorings are laminated with PVC sheeting to protect the cork surface while other are either varnished in the factory of after lying. Further details of the study are shown in Table 22.

Table 21 - Main information of the environmental assessment of cork flooring by Althaus, *et al.*, 2001

S_{SCOPE}= 5 S_{DATA}= 2 $S_{IMPACTS}$= 1 $S_{OUTCOMES}$ = 3 $S_{ROBUSTNESS}$= 3 S_{REVIEW}= 1		**S_{TOTAL}= 15**
Item	***Observation***	***Scoring***
title	Life cycle analysis (LCA) of different cork floorings.	-
authors	Althaus H-J. and Richter K.	-
reference and year	2001	-
type of study	cradle to grave for 14 different cork flooring systems	S_{SCOPE} = 5
scope	The goal of the study was to identify ecologically weak spots and the potential for their improvement.	
functional unit	1m^2 of laying flooring	
system boundaries	The system boundaries include the entire production chain of the cork, from the plant grazing to the manufacturing process; also the cogeneration for the production of electricity and steam has been considered.	
assumptions (e.g. allocation)	The cork floorings without PVC are sanded and newly varnished every 10 years while the PVC covered floorings need no refurbishing during the 30 years of average lifetime.	
data sources, quality		

1. Raw materials	Cork floor tiles made from a cork sheet made from a combination of recycled cork waste and urethane binder.	*1*
2. Manufacturing	The binder is a moisture-cured urethane, produced from a reaction between polyisocyanate and moisture present in the atmosphere. Cork waste is ground and blended with the urethane binder, then cured. Electricity and an on-site boiler are used to blend and cure both products. The boiler uses cork powder generated during the production process to produce steam and electricity.	*3*
3. Distribution/ tte	No specific information available	-
4. Use phase	No specific information available	-
5. Packaging	No specific information available	-
6. End of Life	No specific information available	-
TOTAL		S_{DATA} = 2
Impact assessment categories/methods	CML 92 impact categories are used as well as the Ecoindicator 99 methodology	$S_{IMPACTS}$ = 1
Conclusions (e.g. most important LC phases; drivers to impacts, process or material; improvement options)	The results (see Figure 25) showed that the *floating flooring are causing significantly higher ecological impacts that the fixed flooring.* This is true to the high-density fibreboard (HDF) that triples the weight of the flooring. The damage to the ecosystem caused by *land use seems to be relevant at least for fixed PVC free floating.*  **Figure 25 - Typical impacts of the production of different cork flooring systems**	$S_{OUTCOMES}$ = 3

Strengths and weakness, general comments	The methodology to assess the impacts of land use lacks data about biodiversity in different habitats. Thus, there might be an overestimation of the effects. The final LCA report is not publicly available, so any in-depth analysis could be done.	$S_{ROBUSTNESS}$ = 3
Subject to independent review?	EMPA Activities 2011, Material and Systems Association study	S_{REVIEW} = 1

When considering the environmental impacts caused by the cork floorings in comparison to other kind of floorings (wooden and non-wooden), in 2009 Bowyer et al[113] found out that wood and cork floorings were the top best environmental performers. Among the types of cork floorings the lower environmental impacts was achieved by the natural cork, followed by the natural cork floating floor and natural cork with PVC coating.

Also Mahalle[114] in his study presents a cradle-to-grave environmental profile for pre-finished hardwood flooring manufactured in eastern Canada and compares this to profiles for alternative flooring products such as carpets, ceramic tiles, vinyl, cork, and linoleum flooring in a typical residential application through a LCA study. He found out that flooring manufacturing is the dominant life cycle stage in terms of both energy and environmental flows as it consumes 72% of the total energy and emits 30-76% of environmental emissions in the chosen impact categories. Compared to all other alternative floorings, hardwood shows the best performance in the global warming impact category. Cork also exhibits a net climate change benefit, but it is smaller compared to hardwood flooring. Both Boyer's and Mahalle's LCA study's conclusions are in agreement with the previous commented results.

4.3.5 Life Cycle Assessment review: bamboo flooring

No independent studies were found on the environmental performance of bamboo floor coverings. However, producers of bamboo floorings undertook LCA studies along with leading research organizations. As an example, MOSO provides the information related to the official LCA of bamboo floorings.

[113] J Bowyer, S. Bratkovich, K. Ferholz, A. Lindburg, LCA of flooring materials, available at: http://www.dovetailinc.org/report_pdfs/2009/dovetailfloors0809.pdf
[114] Mahalle, 2011. A comparative Life Cycle Assessment of Canadian Hardwood Flooring with Alternative Flooring Types, available for download at: http://hardwoodinitiative.fpinnovations.ca/files/publications-reports/reports/project-no1-flooring-comparison-lca-final-report.pdf

The official LCA[115] shows that bamboo is an important CO_2 fixator. This means that bamboo absorbs during its growth and life until harvest a relative large amount of CO_2 from the air/atmosphere. After the harvest this CO_2 will remain locked in the material and will only be released when the material is discarded or burnt in the end-of-life stage. If burnt in electrical or heat power plants it can substitute the use of carbon intensive fossil fuels and can thus be perceived as additional carbon credit following LCA methodology. The official LCA concludes, that although CO_2 is released from the production and transportation of the materials, the bamboo floorings are CO_2 neutral or better over the full life cycle.

Differences from the environmental footprint of the bamboo products arisen due to the production technology in place. In this sense, the short production process, high efficiency and low resin content makes flattened bamboo boards to show the lowest environmental burden. On the contrary, the relatively high energy consumption because of the thermal modification and the higher resin content makes the outdoor SWB perform worse than indoor SWB.

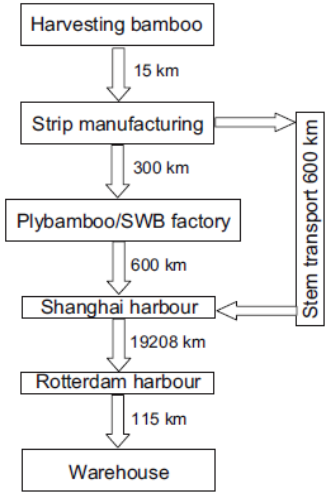
For the interest of this project, a deeper insight of the environmental burdens caused by the production process steps was carried out by Vogtlaender *et al.*[116] and it is summarized in Table 22.

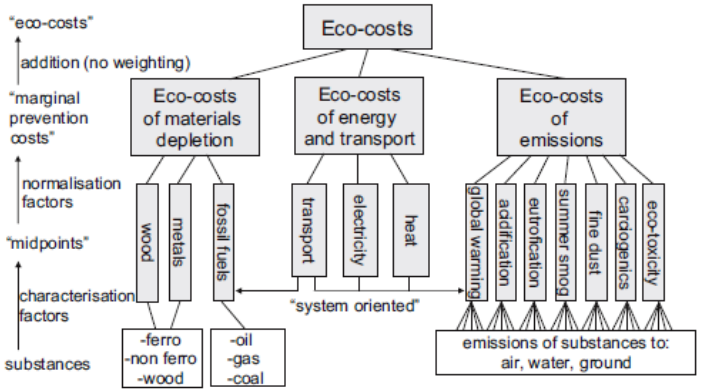
Table 22 - Main information of the environmental assessment of bamboo flooring by Vogtländer, J. *et al.*, 2010

S_{SCOPE}= 5 S_{DATA}= 3 $S_{IMPACTS}$= 1 $S_{OUTCOMES}$ = 1 $S_{ROBUSTNESS}$= 3 S_{REVIEW}= 3		**S_{TOTAL}= 16**
Item	***Observation***	***Scoring***
title	The sustainability of bamboo products for local and Western European applications. LCAs and land-use	-
authors	Vogtländer, J. *et al*	-
reference and year	2010	-
type of study	from cradle to site (actual chain of a bamboo importer in the Nederland)	S_{SCOPE} = 5
scope	LCA is used in this paper to compare the environmental impact of bamboo materials, shipped to Western Europe, with commonly used materials such as timber.	
functional unit	5.33 m-long bamboo stem with a diameter of 10 cm at bottom, 7 cm at top, and a dry weight of 7.65 kg	

[115] Official LCA & Carbon footprint available from Moso website: http://www.moso-bamboo.com/files/EN_MOSO%20Official%20LCA%20-%20Carbon%20footprint.pdf

[116] J. Vogtlaender, P. van der Lugt, H. Brezet, The sustainability of bamboo products for local and Western European applications, LCAs and land-use, J. of Cleaner Production 18 (2010) 1260-1269

system boundaries	The considered system boundaries are: - Plantation, harvesting and first processing in the Anji region, the province of Zhejiang, China; - Final processing (Plybamboo, SWB, veneer) at Huangzhou plant, in the province of Zhejiang; - The bamboo product is shipped via Shanghai and Rotterdam to a warehouse in The Netherlands (Zwaag)  **Figure 26 - The production system of bamboo (cradle to gate)**	
assumptions (e.g. allocation)		
data sources / quality		
1. Raw materials	Primary data of plantation, harvesting and first processing	*3*
2. Manufacturing		*3*
3. Distribution/ tte		*-3*
4. Use phase	Not considered	-
5. Packaging	Not considered	-
6. End of Life	Not considered	-
TOTAL		S_{DATA} = 3
Impact assessment categories/methods	0 on 14 PEF impact categories (Eco-cost study) The calculations for the LCAs have been made with the computer program Simapro, applying LCI databases of Ecoinvent v2 (2008) and	$S_{IMPACTS}$ = 1

	Idemat 2008 (a database of the Delft University of Technology, partly based on EcoinventUnit data). Applied calculation method: Eco-cost 2007. The Eco-costs model is based on the sum of the marginal prevention costs during the life cycle of a product for toxic emissions, material depletion, energy consumption and conversion of land, see Figure 27.  **Figure 27 - Calculation structure of the eco-costs 2007.** The advantage of eco-costs is that it is expressed in a standardised monetary value which appears to be easily understood "by instinct", published in this journal (Vogtländer et al., 2002). The calculation is transparent and relatively easy compared to damage based models which have the disadvantage of extremely complex calculations with subjective weighting of the various aspects contributing to the overall environmental burden	
Conclusions	The *energy consumption* in processing the industrial bamboo provides the largest contribution to the environmental impact. However, the environmental impacts due to the energy consumption could be lower if a CHP would be installed in the production facility. In addition, this environmental impact would be further decreased if renewable energy sources such as solar or biomass would be implemented. After energy consumption the *international sea transport* is the second largest impact on the environmental profile. In the case of local consumption, this additional burden can be removed. Obviously, this is no a possibility on the European market, but the closer the sourcing the lower this environmental impact contribution. Finally there are two further issues that significantly contribute to the environmental impact caused by this product: *the local transport and the use of resin*. The first one can be dismissed by opting for larger trucks or using more efficient ones (e.g. Euro 5) and the second one by increasing the use of formaldehyde free resins such as EPI because of the relative low environmental impact.	$S_{OUTCOMES}$ = 1

Strengths and weakness, general comments	Data assumed for transportation and production in modern China are similar to that in Western EU. Transport is an important issue in LCA of wood and non-wood forest products, which also applies to bamboo materials, and in particular a high volume per mass product such as the bamboo stem. Yield of land is a specific aspect of sustainability, related with the fact that land is becoming scarce, especially when current materials (metals, fossil fuels) will be replaced by renewable materials like wood and non-wood forest products like bamboo. A third issue of sustainability which is important, but not dealt with in this paper, is the issue of the social aspects of production systems. An advantage of Plybamboo (board material consisting of laminated strips) and StrandWoven Bamboo (compressed bamboo composite material) is that the value of the product is added locally. Therefore, these industrial bamboo materials can make a **good contribution** in terms of **local employment**.	$S_{ROBUSTNESS}$ = 3
Subject to independent review	Yes, it is a peer-reviewed publication Journal of Cleaner Production 18, 1260-1269	S_{REVIEW} = 3

4.4 Product Category Rules and Environmental Product Declaration for Wooden Floor Covering

In order to select a set of key indicators for this product group, Product Construction Rules (PCR) (from the German system IBU, Institut Bauen und Umwelt e.V.) for Wooden Flooring[117] (WFC) has been analysed. The PCR document refers to some common impact categories, whose quantification must be shown in EPDs compulsorily and shown in Table 23. All PCRs prescribe the use of the IPCC method for the assessment of the impact on climate change, and the CML 2002 method for the characterization of other impact categories, as indicated in the table below.

Table 23 - Information to provide following PCRs requirements for wooden flooring

Information to provide following PCRs requirements for wooden flooring	*Suggested method*	*Unit of measure*

[117] Product Category Rules (PCR) for Floor coverings:
http://construction-environment.com/download/CY3e2aa70X1402f0e04c8X74fe/PCR_floorcovering.pdf

Impact categories common for all PCRs	Greenhouse warming potential	$GWP_{100\ years}$	IPCC	kg CO_2 equiv
	Acidification potential	AP	CML 2002	kg SO_2 equiv
	Eutrophication potential	EP	CML 2002	kg PO_4 equiv
	Photochemical ozone creation potential (Emission of gases that contribute to the creation of ground-level ozone)	POCP	CML 2002	kg C_2H_4 equiv
Optional impact categories for all PCRs	Ozone depletion potential	ODP	CML 2002	kg CFC11 equiv
Impact categories specific for some product group	Heavy metals	-	EcoIndicator 99	kg Pb equiv
	Depletion of abiotic mineral and resources (Abiotic Depletion Potential)	ADP	CML 2002	kg Sb equiv kg Antimony eq.
	Human toxicity potential	HPT		kg DCB equiv
Information related to the consumption of resources	Non-renewable sources: -material resources -energy resources (used for energy conversion purposes)	-	-	kg MJ
	Renewable resources: - material resources -energy resources (used for energy conversion purposes)	-	-	kg MJ
	Secondary resources (recycled material) - material resources - energy resources (used for energy conversion purposes)	-	-	kg MJ
	Recovered energy flows (such thermal)	-	-	MJ

	Water use (including direct and indirect water consumption): - total amount of water[118] - direct amount of water used by the core process	-	-	l
	Waste production: - hazardous waste - non-hazardous waste.	-	-	kg

Several EPDs are available on-line on the website of the producers. The EPD analysed are based on the PCR document "floor coverings" year 2008-01[119]. These declarations usually give detailed information of product definition and relevant system-physics-related information, raw materials and origin of the raw materials, descriptions of the product manufacture, information on product processing, information on the use stage, extraordinary influences and end-of-life stage and results of the LCA.

The list of EPDs analysed in detail in this section is shown in Table 24. As seem EPDs were found for two different types of laminate floorings and cork floorings.

Table 24 - Summary EPDs gathered and information related

FLOORING	Product
LAMINATE	EPD of Direct Pressure Laminate Floor Covering (DPLF) produced by EPLF® (European Producers of Laminate Flooring e.V.), EPD-ELF-2009111-E, valid 3 years since 2012, August 11th
	EPD of High Pressure Laminate Floor Covering (DPLF) produced by EPLF® (European Producers of Laminate Flooring e.V.), EPD-ELF-2009311-E, valid 3 years since 2009, August 11th
	EPD of Printed Décor Laminate Floor Covering (PDL Floor Covering) produced by EPLF® (European Producers of Laminate Flooring e.V.), EPD-ELF-2009211-E, valid 3 years since 2009, August 11th
	EDP of Direct Pressure Laminate Floor Covering (DPLF) produced by MeisterWerke Schulte GmbH, EPD-MWS-2011111-E, valid 3 years since 2011, May 20th

[118] For closed loop processes (such cooling system) and power generation only the net water consumptions (such as reintegration of water losses) should be considered

[119] http://www.nsf.org/newsroom_pdf/flooring_pcr-new.pdf

FLOORING	Product
	EDP of Direct Pressure Laminate Floor Covering (DPLF) produced by UNILIN bvba, division FLOORING, EPD-QST-2011111-E, valid 3 years since 2011, July 20th
	EDP of Laminate Flooring produced by Egger, EPD-EHW-2008211-E, valid 3 years since 2012, April 9th
	EPD of Direct Print Laminate Flooring (DPR®) produced by Egger, EPD-EHW-2008221-E, valid 3 years since 2012, April 9th
CORK	EDP of Cork floor tiles according to EN 12104 produced by ERFMI (EU Resilient Flooring Manufacturers' Institute), EPD-ERF-2013911-E, valid 5 years since 2013, April 1st
	EDP of Corkcomfort Floating HPS produced by Amorim Revestimentos S. A., EPD-AMO-2013121-E, valid 5 years since 2013, July 1st

4.4.1 Environmental product declaration for laminate flooring

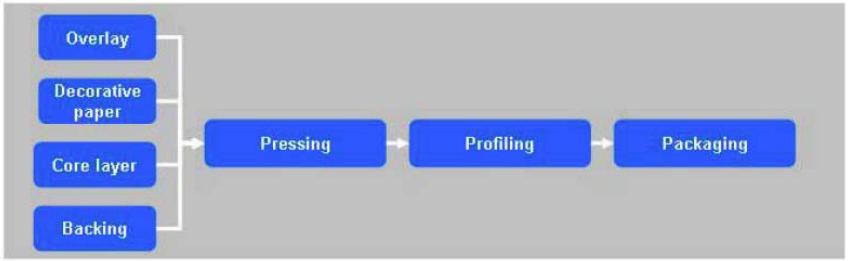
The EPDs for laminate flooring[120] were investigated considering the EPDs (from the German system IBU, Institut Bauen und Umwelt e.V.) of the average European laminate floorings. Laminate floorings are mainly divided into direct pressure laminate floorings (DPLF) and high pressure laminate flooring (HPLF). Briefly these floorings differs in the number of layers, binders and resins used as well as how the core boarding is pressed and assembled. Both floorings are calculated as an average level of use of 90% domestic and 10% commercial floorings, according to the market shares of distribution. The main differences in the composition and technologies employed for their manufacturing were commented in detail in section 4.2.1.2. The main information provided in the environmental assessment of these two products is shown in Table 25and Table 26. These products are calculated as average products at European level.

Table 25 - Main information of the environmental assessment for EPD of Direct Pressure Laminate Floor Covering[121] produced by EPLF® (European Producers of Laminate Flooring e.V.)

Item	*Observation*
title	Environmental Product Declaration EPD of Direct Pressure Laminate Floor Covering (DPLF)

[120] The EPDs about laminate flooring, analyzed in this section, are available at the following link: http://construction-environment.com/hp3622/Floor-coverings.htm

[121] Direct Pressure Laminate Floor Covering (DPLF) produced by EPLF® (European Producers of Laminate Flooring e.V.): http://construction-environment.com/download/CY6684b91dX139fabcce4fX7926/EPD_ELF_2009111_E.pdf

authors	EPLF® (European Producers of Laminate Flooring e.V.)
reference and year	2012
type of study	Cradle to factory gate
scope	Calculate the environmental performance of DPLF produced by EPLF®
functional unit	1m^2 of direct pressure laminate (DPLF) floor covering installed, with a minimum thickness of 6 mm and a maximum thickness of 12 mm.
system boundaries	The installation includes the delivery of the laminate floor covering to the point of installation and its fitting but not the underlayment necessary for the fitting. It includes: - the production of raw materials - production of the floor covering - packaging and transport - installation - use and cleaning - end-of-life  **Figure 28 - Direct Pressure Laminate (DPL) production process**
assumptions (e.g. allocation)	Thermal recycling of post-consumer laminate flooring waste in a WIP (waste incineration plant) 15 year reference service life
data sources, quality	Specific data from member companies of the EPLF as well as data from the "GaBi 4" LCA software were used as the data base.
1. Raw materials	Data about production of the materials useful for the product (HDF (high density fibreboard), paper, resins, corundum)
2. Manufacturing	Production process: pressing and profiling
3. Distribution/ transportation	In general the delivery of laminate floor coverings is carried out on the road by trucks (14-20t truck, 85% load). The average transport distance for the delivery of DPL floor coverings to the end consumer in Europe is approx. 250 km.
4. Use phase	Laminate floor coverings are generally installed floating. This means the floor covering is not fixed to the sub floor using glue, nails etc. The use stage includes the cleaning of the laminate floor covering for the 15 year reference service life.
5. Packaging	Laminate floorings are generally unit-packed and edge-protected using ribbed cardboard and shrink-wrapped in foil.
6. End of Life	The laminate floor coverings should be recycled or re-used. Post-consumer laminate floor covering waste can be recycled as wood based products. When appropriate recycling facilities do not exist, laminate floor coverings shall be thermally recycled. A reinstallation of laminate floor coverings

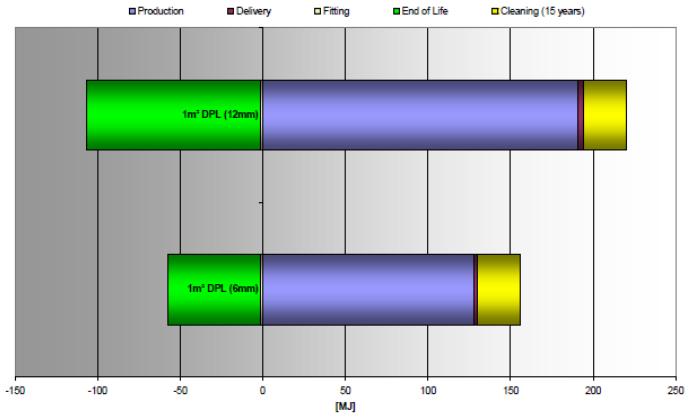
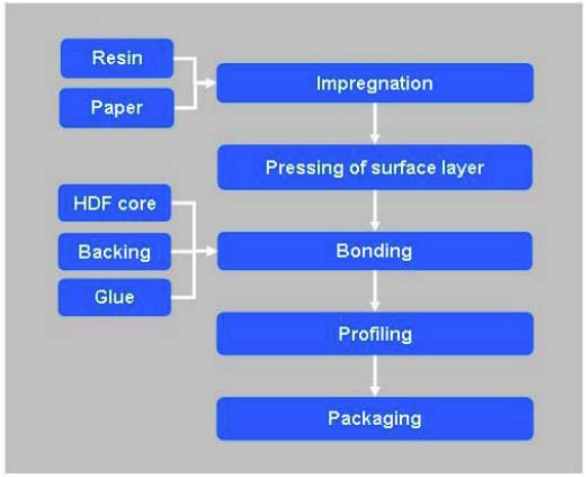
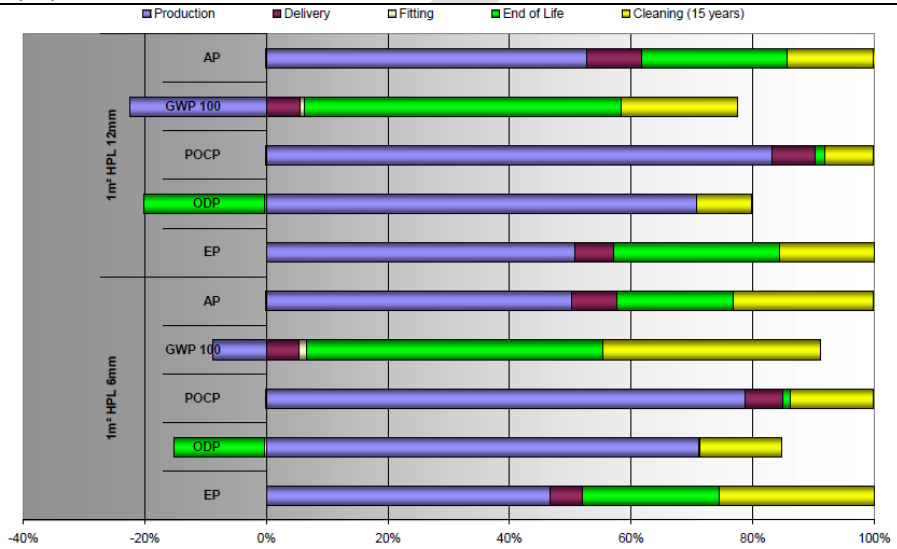
	is possible.
Impact assessment categories/methods	Impact assessment method: CML 2002 Impact categories considered: - Global Warming Potential (GWP 100) -Acidification Potential (AP) - Ozone depletion potential (ODP) - Photochemical ozone creation potential (POCP) - Eutrophication Potential (EP)
Conclusions (e.g. most important LC phases; drivers to impacts, process or material; improvement options)	 **Figure 29 - Consumption of non-renewable primary energy for the whole life cycle** The balance shows credits for GWP 100 and ODP. The greenhouse gas carbon dioxide is locked in from the air in the course of the tree growth via photosynthesis and stored during the use stage. This carbon dioxide is not released until the end of life through thermal utilisation in e.g. a WIP. Due to the fact, that the core board of laminate flooring is wood based the CO2 fixation results in a credit for GWP. The credit for ODP results from the thermal recycling and the respective substitution of energy generation from fossil resources. The impacts of delivery and fitting are of little importance. The contribution of cleaning over a 15-year reference service life period is more relevant.

Table 26 - Main information of the environmental assessment for High Pressure Laminate Floor Covering (HPLF) produced by EPLF® (European Producers of Laminate Flooring e.V.)[122]

Item	*Observation*
title	High Pressure Laminate Floor Covering (HPLF)
authors	EPLF® (European Producers of Laminate Flooring e.V.)
reference and year	2012
type of study	Cradle to factory gate
scope	Calculate the environmental performance of HPLF produced by EPLF®
functional unit	1m^2 of high pressure laminate (HPLF) floor covering installed, with a minimum thickness of 6 mm and a maximum thickness of 12 mm.
system boundaries	The installation includes the delivery of the laminate floor covering to the point of installation and its fitting but not the underlayment necessary for the fitting. It includes - the production of raw materials - production of the floor covering - packaging and transport - installation - use and cleaning - end-of-life

[122] High Pressure Laminate Floor Covering (HPLF) produced by EPLF® (European Producers of Laminate Flooring e.V.): http://construction-environment.com/download/CY6684b91dX139fabcce4fX792e/EPD_ELF_2009311_E.pdf

	 **Figure 30 - High Pressure Laminate Floor Covering (HPL) production process**
assumptions (e.g. allocation)	Thermal recycling of post-consumer laminate flooring waste in a WIP (waste incineration plant) 15 year reference service life
data sources, quality	Specific data from member companies of the EPLF as well as data from the "GaBi 4" LCA software were used as the data base.
1. Raw materials	Data about production of the materials useful for the product (HDF (high density fibreboard), paper, resins, corundum). The main material for the production of HPL floor coverings is the core board with a percentage of more than 80%. The HDF board production is included in the LCA, it is usually purchased and sometimes produced by the laminate flooring manufacturer himself.
2. Manufacturing	Production process: pressing and profiling
3. Distribution/ transportation	The delivery of laminate floor coverings is in general carried out on the road by trucks (14-20t truck, 85% load). The average transport distance for the delivery of HPL floor coverings to the end consumer in Europe is approx. 1300 km.
4. Use phase	Laminate floor coverings are generally installed floating. This means the floor covering is not fixed to the sub floor using glue, nails etc. The use stage includes the cleaning of the laminate floor covering for the 15 year reference service life.
5. Packaging	Laminate floorings are generally unit-packed and edge-protected using ribbed cardboard and shrink-wrapped in foil.
6. End of Life	The laminate floor coverings should be recycled or re-used. Post-consumer laminate floor covering waste can be recycled as wood based products.When appropriate recycling facilities do not exist, laminate floor coverings shall be thermally recycled. A reinstallation of laminate floor coverings is possible.
Impact assessment categories/methods	Impact assessment method: CML 2002 Impact categories considered:

	- Global Warming Potential (GWP 100) -Acidification Potential (AP) - Ozone depletion potential (ODP) - Photochemical ozone creation potential (POCP) - Eutrophication Potential (EP)
Conclusions (e.g. most important LC phases; drivers to impacts, process or material; improvement options)	 **Figure 31 – Breakdown of LCA impact categories for all life cycle stages** The balance shows credits for GWP 100 and ODP. The greenhouse gas carbon dioxide is locked in from the air in the course of the tree growth via photosynthesis and stored during the use stage. This carbon dioxide is not released until the end of life through thermal utilisation in e.g. a WIP. Due to the fact, that the core board of laminate flooring is wood based, the CO_2 fixation results in a credit for GWP. The credit for ODP results from the thermal recycling and the respective substitution of energy generation from fossil resources. The impacts of delivery and fitting are of little importance. The contribution of cleaning over a 15-year reference service life period is more relevant.

According to the data, it is obvious that the background data for the production of the core board and the resin impregnated papers determine the impact categories in both types of laminates. For the environmental impact of the impregnated paper the used resin is mainly responsible, with a percentage of >90%. The production related energy consumption has a share of 2-19% for DPLF and of 1-6% for HPLF, except for ODP where the electricity consumption is responsible for 30-40% due to the background data for Swedish electricity mix. The recycling of production waste has a share of 1-8% for DPLF and of 1-4% for HPLF in the different impacts categories. Packing, supply and corundum have in both cases only marginal effects on the environment. Other EPDs from particular European producers were also analysed in this section. The main information is summarized in the following tables

Table 27 - Main information of the environmental assessment Direct Pressure Laminate Floor Covering (DPLF) produced by MeisterWerke Schulte GmbH[123]

Item	*Observation*
title	Environmental Product Declaration (EPD) on Direct Pressure Laminate Floor Covering (DPL Floor Covering)
authors	MeisterWerke Schulte GmbH
reference and year	2011
type of study	Cradle to factory gate
scope	Calculate the environmental performance of DPL Floor Covering produced by MeisterWerke Schulte GmbH
functional unit	1m^2 of direct pressure laminate (DPLF) floor covering installed, with a thickness of 7 - 9 mm for a reference service life of 15 years.
system boundaries	The installation includes the delivery of the laminate floor covering to the point of installation and its fitting but not the underlayment necessary for the fitting. It includes: - the production of raw materials - production of the floor covering - packaging and transport - installation - use and cleaning - end-of-life For all stages the respective energy consumption and transport data are considered. 

[123] MeisterWerke Schulte GmbH EPD on Direct Pressure Laminate Floor Covering (DPLF), available at: http://construction-environment.com/download/C1a520724X13335d27c9dXY6d4/EPD_MWS_2011111_E.pdf

	Figure 32 - Direct Pressure Laminate Floor Covering (DPL) production process
assumptions (e.g. allocation)	Thermal recycling of post-consumer laminate flooring waste in a WIP (waste incineration plant) 15 year reference service life (the technical service life of MeisterWerke laminate flooring can be longer).
data sources and quality	Specific data from MeisterWerke Schulte GmbH, data from the average EPD of DPL floor coverings developed by EPLF e.V. as well as data from the "GaBi 4" LCA software were used as the data base. For thermal and electric energy average German background data are used for the foreground processes.
1. Raw materials	Data about production of the materials useful for the product (HDF (high density fibreboard), paper, resins, corundum). The core board is an HDF board (density approx. 890 kg/m3 ± 3%) composed of wood fibres and a thermosetting resin, mainly MUF (melamine-urea-formaldehyde).
2. Manufacturing	Production process: pressing and profiling
3. Distribution/ transportation	The delivery of MeisterWerke laminate floor coverings is carried out on the road by trucks (34t - 40t truck, 85% load). The average transport distance for the delivery of DPL floor coverings to the end consumer is approx. 300 km.
4. Use phase	MeisterWerke laminate floor coverings are generally installed floating. This means the floor covering is not fixed to the sub floor using glue, nails etc. The use stage includes the cleaning of the laminate floor covering for the 15 year reference service life.
5. Packaging	Laminate floorings are generally unit-packed and edge-protected using ribbed cardboard and shrink-wrapped in foil.
6. End of Life	The laminate floor coverings should be recycled or re-used. Post-consumer laminate floor covering waste can be recycled as wood based products. When appropriate recycling facilities do not exist, laminate floor coverings shall be thermally recycled. A reinstallation of laminate floor coverings is possible.
Impact assessment categories/methods	Impact assessment method: CML 2002 Impact categories considered: - Global Warming Potential (GWP 100) - Acidification Potential (AP) - Ozone depletion potential (ODP) - Photochemical ozone creation potential (POCP) - Eutrophication Potential (EP)

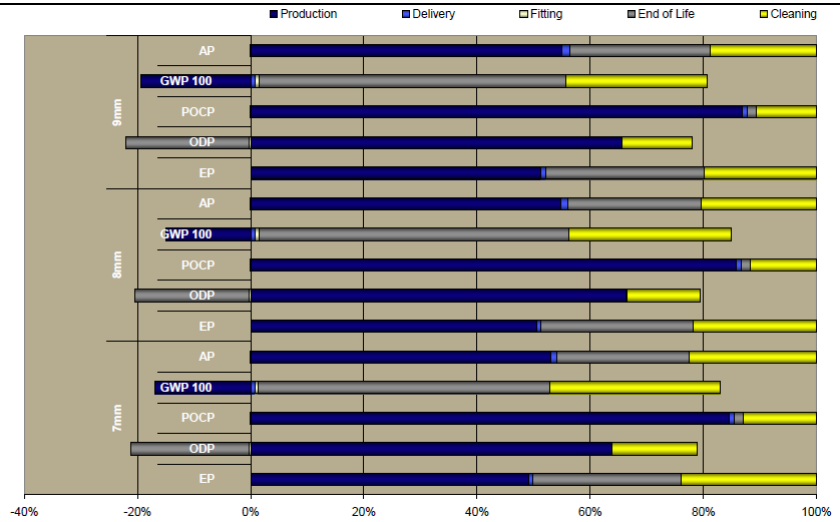
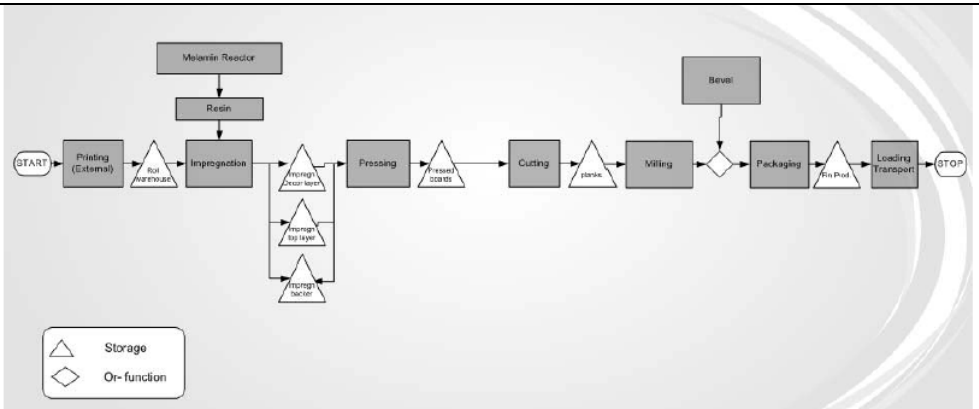
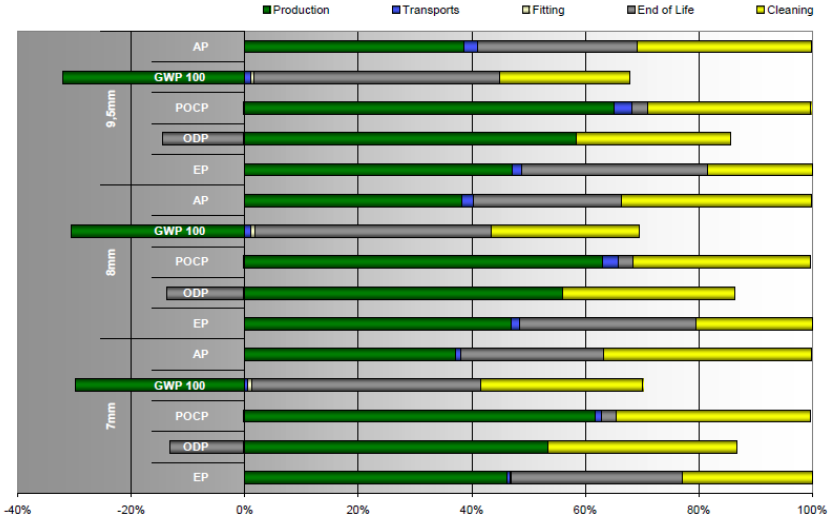
Conclusions (e.g. most important LC phases; drivers to impacts, process or material; improvement options)	 **Figure 33 – Breakdown of LCA impact categories for all life cycle stages: percentages of all life cycle stages of 1m² DPL floor covering related to the different impact categories** The balance shows credits for GWP 100 and ODP. The greenhouse gas carbon dioxide is locked in from the air in the course of the tree growth via photosynthesis and stored during the use stage. The impacts of delivery and fitting are of little importance. The contribution of cleaning over a 15-year reference service life period is more relevant. If we consider the percentage of production parameters for the production stage, it could be possible to say that production of the core board and the resin impregnated papers determine the most part of the impact categories. For the environmental impact of the impregnated paper the used resin is mainly responsible. The production related energy consumption has a share of 2% to 14% and the recycling of production waste has a share of 1% to 5% in the different impact categories. Packaging, supply and corundum have only marginal effects on the environment.

Table 28 - Main information of the environmental assessment for Direct Pressure Laminate Floor Covering (DPLF) by UNILIN bvba - division FLOORING[124]

Item	*Observation*
title	Environmental Product Declaration (EPD) for Direct Pressure Laminate Floor Covering (DPLF)
authors	UNILIN bvba - division FLOORING
reference and year	2011
type of study	Cradle to grave
scope	Calculate the environmental performance of DPL Floor Covering produced by UNILIN bvba - division FLOORING.
functional unit	$1m^2$ of direct pressure laminate (DPL) floor covering installed (thickness of 7-9,5 mm) – named *Quick-Step laminate floors* for a reference service life of 20 years.
system boundaries	The installation includes the delivery of the laminate floor covering to the point of installation and its fitting but not the underlayment necessary for the fitting. the production of raw materials. The boundaries include: - production of the floor covering - packaging and transport - installation, - use and cleaning - end-of-life stages.

[124] UNILIN bvba - division FLOORING : Direct Pressure Laminate Floor Covering (DPLF) available, at: http://construction-environment.com/download/CY3f3a2b98X1324e1f7c5cXY2ed3/EPD_QST_2011111_E.pdf

	 **Figure 34 - Direct Pressure Laminate Floor Covering (DPL) production process** For all stages the respective energy consumption (including energy recuperation) and transport data are considered.
assumptions (e.g. allocation)	Thermal recycling of post-consumer laminate flooring waste in a WIP (waste incineration plant). 20 year reference service life.
data sources and quality	The used background data are the International Reference Life Cycle Data System (ILCD) integrated in the GABI software and the /GABI 4/ background database. For the HDF production French electric energy background data are used. For the DPL production Unilin bvba uses electric energy from renewable resources, mainly from biomass.
1. Raw materials	The main materials for the production of DPL floor coverings are paper, resins and, with a percentage of more than 93%, the HDF core board. The core board is an HDF board composed of wood fibres and a thermosetting MUF (melamine-urea-formaldehyde) resin. For the production of laminate floor coverings, Unilin bvba – division Flooring uses home-grown wood from regional forests, which is PEFC certified.
2. Manufacturing	Production process: impregnation & resin production, pressing, cutting and milling.
3. Distribution/ transportation	Within Europe the delivery of laminate floor coverings is mainly carried out on the road by trucks (>20t trucks). Overseas, the transport is done by containers (20 and 40ft). The environmental impact for the delivery and installation is given for a transport distance of 100km.
4. Use phase	Laminate floor coverings are generally installed floating. This means the floor covering is not fixed to the sub floor using glue, nails etc. Underlay material is needed when installing laminate floor coverings in order to achieve a levelling effect, thermal or acoustical insulation or protection against rising dampness. The use stage includes the cleaning of the laminate floor covering for the 20 year reference service life. The technical service life can be longer.
5. Packaging	Laminate floorings are generally unit-packed and edge-protected using ribbed cardboard and shrink-wrapped in foil.
6. End of Life	The laminate floor coverings should be recycled or re-used. Post-consumer laminate floor covering waste can be recycled as wood based products. When appropriate recycling facilities do not exist, laminate floor coverings shall be thermally recycled. A reinstallation of laminate floor coverings is

	possible.
Impact assessment categories/methods	Considered 5 on 14 PEF impact categories. Impact assessment method: CML 2002 Impact categories considered: - Global Warming Potential (GWP 100) -Acidification Potential (AP) - Ozone depletion potential (ODP) - Photochemical ozone creation potential (POCP) - Eutrophication Potential (EP)
Conclusions (e.g. most important LC phases; drivers to impacts, process or material; improvement options)	 **Figure 35 - Breakdown of LCA impact categories for all life cycle stages: the percentage of all life cycle stages of 1m² DPL floor covering related to the impact categories** The balance shows credits for GWP 100 and ODP. The greenhouse gas carbon dioxide is locked in from the air in the course of the tree growth via photosynthesis and stored during the use stage. This carbon dioxide is not released until the end of life through thermal utilisation in e.g. a WIP. Due to the fact, that the core board of laminate flooring is wood based the CO2 fixation results in a credit for GWP. The credit for ODP results from the thermal recycling and the respective substitution of energy generation from fossil resources. The impacts of delivery and fitting are of little importance. The contribution of cleaning over a 20-year reference service life period is more relevant. Considering energy consumption in laminate flooring production, it is possible to say that more than 82% of renewable primary energy consumption results from the core board. This is mainly due to the sunlight energy locked into the wood by photosynthesis. The use of renewable resources for energy generation varies from 10% to 13%. Depending on the thickness of the laminate floor covering, 70% to 77% of the non-renewable primary

	energy consumption results from the production of the core board. The production of the layer accounts for 20% to 25% of the consumed energy. This share depends on the resin used for the impregnation.

Table 29 - Main information of the environmental assessment presented in the EPD for laminate flooring by Egger[125]

Item	*Observation*
title	Environmental Product Declaration (EPD) for laminate flooring by Egger
authors	Egger
reference and year	2012
type of study	Cradle to factory gate
scope	Calculate the environmental performance of laminate floor covering produced by Egger
functional unit	$1m^2$ of average finished and installed laminate flooring (product mix). The raw density of the laminate flooring is 900 kg/m³ (+/- 20 kg, 5-7 % moisture).
system boundaries	Cradle to factory gate including: - the production and transport of raw materials - production of the floor covering (manufacturing phase) - packaging and transport - installation, - use and cleaning - end-of-life stages
assumptions (e.g. allocation)	The laminate flooring manufacturing system in question and the associated energy supply do not require any allocations; waste materials are utilised as a source of energy. The combustion is accounted for using GaBi 2006 and, similar to end of life, energy credits are assigned. It is calculated as thermal utilisation in a waste incinerator (wet method) with energy recovery.
data sources and quality	To model the life cycle for the manufacturing and disposal of Egger Retail Products, the software system for comprehensive accounting "GaBi 4" was used (GaBi 2006).

[125] Egger, EPD on laminate flooring, available at: http://construction-environment.com/download/C74729484X13d335053b9X3e60/EPD_EHW_2008211_E.pdf

	All background data sets relevant to the manufacturing and disposal were taken from the GaBi 4 software database. The upstream chain for the harvesting was accounted for according to Schweinle & Thoroe 2001.
1. Raw materials	HDF coreboard with thicknesses between 6 and 8 mm with an average density of 880kg/m³ consisting of (specified in mass % per 1 m³ of production): - Wood fibres, primarily spruce and pine wood, approx. 82% - Water approx. 5-7% - UMF glue (melamine urea resin) approx. 11% - Paraffin wax emulsion <1% Wood from indigenous, predominantly regional forest stands is used in the production of Egger Retail Products laminate flooring. The wood is sourced from forests within a radius of approx. 250 km from the production site.
2. Manufacturing	Production process: manufacturing of the rawboard, impregnating substances, laminated master boards, finished laminated flooring planks.
3. Distribution/ tte	Transport of the raw materials and secondary materials used is included in principle.
4. Use phase	The usage condition and possible associated unusual effects were not researched in the life cycle assessment. For system comparisons, the lifespan must be accounted for under consideration of the stress and loading aspects and care/maintenance of the flooring.
5. Packaging	Wood pallets, paperboard, PET strapping and recyclable PE film are used to envelop the final product.
6. End of Life	Laminate flooring laid without glue can easily be separated and used again for the same application. Egger Retail Products laminate flooring can be processed and used again in a wood-based material manufacturing process.
Impact assessment categories/methods	Impact categories considered: - Global Warming Potential (GWP 100) - Ozone depletion potential (ODP) - Eutrophication Potential (EP) - Primary energy PE non-renewable -Acidification Potential (AP) - Photochemical ozone creation potential (POCP) - Primary energy PE renewable

Conclusions (e.g. most important LC phases; drivers to impacts, process or material; improvement options)

	PE non-renewable	PE renewable	Global warming potential GWP 100	Ozone depletion potential (ODP)
Unit	MJ	MJ	kg CO_2 eqv.	kg R11 eqv.
Raw materials	98.47	-27.5	-7.27	2.28E-07
Production	22.38	147.4	4.05	2.21E-07
Transportation	1.76	0.002	0.13	2.12E-10
Packaging	2.57	0.87	0.00	5.97E-09
Σ Manufacturing	**125.2**	**120.8**	**-3.09**	**4.55E-07**
End of Life	-57.3	-0.94	6.14	-1.97E-07
Total	**67.8**	**119.9**	**3.05**	**2.58E-07**

	Acidification potential (AP)	Eutrophication potential (EP)	Photochemical oxidant formation potential (POCP)
Unit	kg SO_2 eqv.	kg PO_4 eqv.	kg ethylene eqv.
Raw materials	0.012	0.0048	0.00214
Production	0.009	0.0013	0.00585
Transportation	0.001	0.0001	0.00009
Packaging	0.0003	0.0001	0.00004
Σ Manufacturing	**0.022**	**0.0063**	**0.00810**
End of Life	0.015	0.0032	0.00045
Total	**0.037**	**0.0095**	**0.00857**

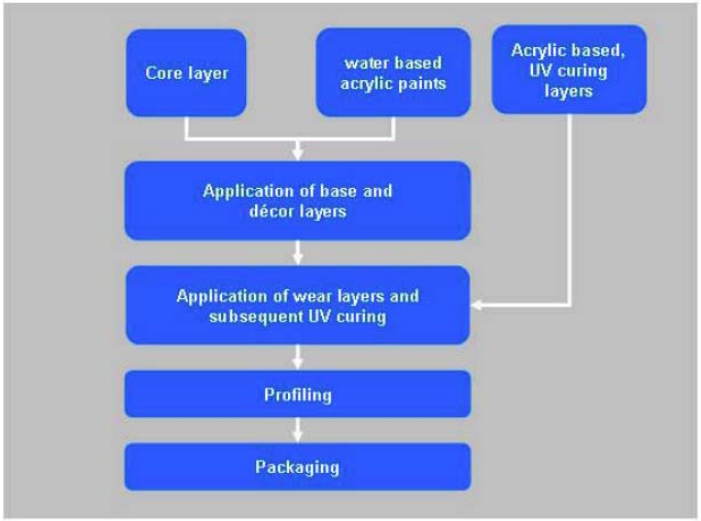
Figure 36 - Absolute contributions of manufacturing and end of life per m^2 of finished laminate flooring mix to PE ne, PE reg, GWP $_{100}$, ODP, AP, EP and POCP.

The table in Figure 36 shows the absolute contributions from the production and combustion of 1 m^2 of laminate flooring to the impact categories global warming potential (GWP 100), ozone depletion potential (ODP), acidification potential (AP), eutrophication potential (EP), and photochemical oxidation formation potential (summer smog potential POCP). In addition the renewable primary energy (PE reg.) and the nonrenewable primary energy (PE ne) are listed again. When considering the manufacturing system boundary under consideration of the end of life in a waste incinerator using the wet method, the significance of the method of utilisation or disposal on the environmental impact over the entire life cycle becomes apparent.

Table 30 - Main information of the environmental assessment presented in the EPD for Printed Décor Laminate Floor Covering (PDL Floor Covering) produced by EPLF® (European Producers of Laminate Flooring e.V.)[126]

Item	*Observation*
title	Environmental Product Declaration (EPD) for Printed Décor Laminate Floor Covering (PDL Floor Covering)
authors	EPLF® (European Producers of Laminate Flooring e.V.)
reference and year	2009
type of study	Cradle to grave
scope	Calculate the environmental performance of Printed Décor laminate floor covering produced by EPLF®.
functional unit	1m^2 of laminate floor covering installed, for a reference service life of 15 years, with a minimum thickness of 6 mm and a maximum of 12 mm.
system boundaries	Cradle to factory gate including: - the production and transport of raw materials - production of the floor covering (manufacturing phase) - packaging and transport - installation, - use and cleaning - end-of-life stages

[126] EPD for Printed Décor Laminate Floor Covering (PDL Floor Covering) produced by EPLF®, available at: http://www.eplf.com/downloads/eplf.2009211.eng.pdf

	 **Figure 37 - Printed Décor Laminate Floor Covering production process**
assumptions (e.g. allocation)	It is calculated as thermal utilisation in a waste incinerator (wet method) with energy recovery. The reference service life is 15 years.
data sources and quality	The used background data are the International Reference Life Cycle Data System /ILCD/ integrated in the GABI software and the /GABI 4/ background database. For the electric and thermal energy average European background data are used.
1. Raw materials	The main material for the production of PDL floor coverings is the core board with a percentage of more than 96%. The core board is an HDF board composed of wood fibres and thermosetting resins, mainly MUF (melamine-urea-formaldehyde). Then there are: water based acrylic paints, acrylic based, UV curing layer and corundum.
2. Manufacturing	Processing steps: Application of base, décor layers, wear layer and UV curing; profiling.
3. Distribution/ transportation	In general the delivery of laminate floor coverings is carried out on the road by trucks (14-20t truck, 85% load). The average transport distance for the delivery of PDL floor coverings to the end consumer in Europe is approx. 500 km.
4. Use phase	Laminate floor coverings are generally installed floating. This means the floor covering is not fixed to the sub floor using glue, nails etc. The use stage includes the cleaning of the laminate floor covering for the 15 year reference service life.
5. Packaging	Laminate flooring is accordingly unit-packed and edge-protected using ribbed cardboard and shrink-wrapped in foil. These packaging materials shall be collected separately and be recycled.
6. End of Life	Post-consumer laminate floor covering waste can be recycled as wood based products. When appropriate recycling facilities do not exist, laminate floor covering shall be thermally recycled.

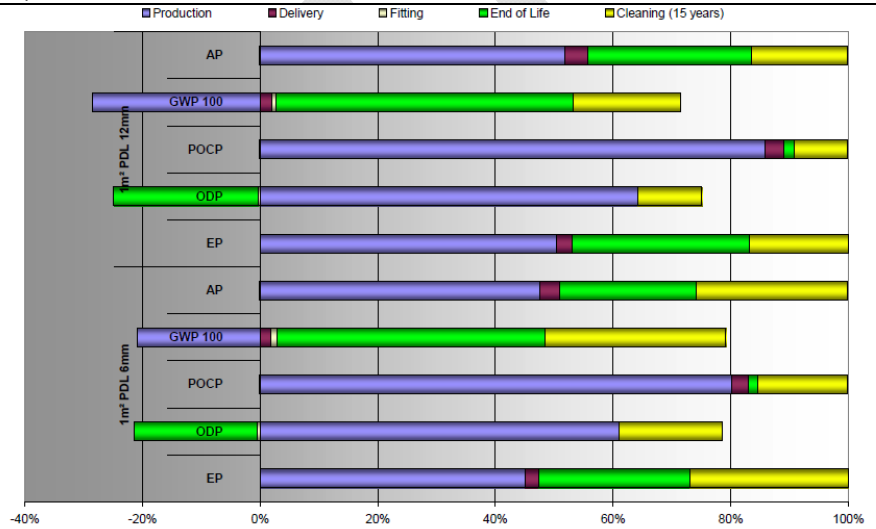
	A re-installation of laminate floor coverings is possible: the laminate floor coverings should be recycled or re-used after its service life.
Impact assessment categories/methods	Impact assessment method: CML 2002 Impact categories considered: - Global Warming Potential (GWP 100) Acidification Potential (AP) - Ozone depletion potential (ODP) Photochemical ozone creation potential (POCP) - Eutrophication Potential (EP)
Conclusions (e.g. most important LC phases; drivers to impacts, process or material; improvement options)	 **Figure 38 - Breakdown of LCA impact categories for all life cycle stages: the percentage of all life cycle stages of 1m² DPL floor covering related to the impact categories** The balance shows credits for GWP 100 and ODP. The greenhouse gas carbon dioxide is locked in from the air in the course of the tree growth via photosynthesis and stored during the use stage. The contribution of cleaning over a 15-year reference service life period is more relevant. The production of the core board shows the highest environmental impact percentage (>70%) in all impact categories. The energy consumption varies between 1-19%. Supply, corundum and packaging have only marginal influence on the overall environment impact. The recycling of production waste is in all categories negligible except for GWP (approx. 9%). The LCA results show a linear correlation between the thickness of a laminate floor covering and their environmental impact.

Table 31 - Main information of the environmental assessment presented in the EPD of Direct Print Laminate Flooring (DPR®) produced by Egger

Item	*Observation*
title	Environmental Product Declaration (EPD) for Direct Print Laminate Flooring (DPR®) produced by Egger
authors	Egger
reference and year	2013
type of study	Cradle to factory gate
scope	Calculate the environmental performance of laminate floor covering produced by Egger
functional unit	1 m^2 of average finished direct print laminate flooring. The average raw density of the direct print laminate flooring is 880 kg/m³ (+/- 20 kg, 5-7 % moisture).
system boundaries	Cradle to factory gate including: - the production and transport of raw materials production of the floor covering (manufacturing phase) - packaging and transport installation, - use and cleaning end-of-life stages
assumptions (e.g. allocation)	The laminate flooring manufacturing system in question and the associated energy supply do not require any allocations; waste materials are utilised as a source of energy. The combustion is accounted for using GaBi 2006 and, similar to end of life, energy credits are assigned. It is calculated as thermal utilisation in a waste incinerator (wet method) with energy recovery.
data sources and quality	To model the life cycle for the manufacturing and disposal of Egger Retail Products, the software system for comprehensive accounting "GaBi 4" was used (GaBi 2006). All background data sets relevant to the manufacturing and disposal were taken from the GaBi 4 software database. The upstream chain for the harvesting was accounted for according to Schweinle & Thoroe 2001.
1. Raw materials	HDF coreboard with thicknesses between 6 and 8 mm with an average density of 880kg/m³ consisting of (specified in mass % per 1 m³ of production): - Wood fibres, primarily spruce and pine wood, approx. 82% - Water approx. 5-7% - UMF glue (melamine urea resin) approx. 11% - Paraffin wax emulsion <1% Wood from indigenous, predominantly regional forest stands is used in the production of Egger Retail Products laminate flooring. The wood is sourced from forests within a radius of approx. 250 km from the production site.
2. Manufacturing	Production process: manufacturing of the rawboard, laminated master boards, finished planks.
3. Distribution/ tte	Transport of the raw materials and secondary materials used is included in principle.

4. Use phase	The usage condition as well as possible associated unusual effects were not researched in the life cycle assessment. For system comparisons, the lifespan must be accounted for under consideration of the stress and loading aspects and care/maintenance of the flooring.
5. Packaging	Wood pallets, paperboard, PET strapping and recyclable PE film are used.
6. End of Life	Laminate flooring laid without glue can easily be separated and used again for the same application. Egger Retail Products laminate flooring can be processed and used again in a wood-based material manufacturing process.
Impact assessment categories/methods	Impact categories considered: - Global Warming Potential (GWP 100) Acidification Potential (AP) - Ozone depletion potential (ODP) Photochemical ozone creation potential (POCP) - Eutrophication Potential (EP) Primary energy PE renewable - Primary energy PE non-renewable
Conclusions (e.g. most important LC phases; drivers to impacts, process or material; improvement options)	

	PE ne	PE reg.	Global warming potential GWP 100	Ozone depletion potential (ODP)
Unit	MJ	MJ	kg CO_2 eqv.	kg R11 eqv.
Raw materials	75.8	162.8	-9.8	1.73E-07
Production	23.5	-32.3	4.22	2.66E-07
Transportation	1.8	0.0	0.13	2.16E-10
Packaging	2.7	0.8	0.01	5.94E-09
Σ Manufactur-ing	**103.8**	**131.3**	**-5.40**	**4.45E-07**
End of Life	-57.8	-0.9	6.06	-1.98E-07
Total	**46.0**	**13 .4**	**0.67**	**2.47E-07**

	Acidification potential (AP)	Eutrophication potential (EP)	Photochemical oxidant formation potential (POFP)
Unit	kg SO_2 eqv.	kg phosphate eqv.	kg ethylene eqv.
Raw materials	1.11E-02	3.80E-03	2.18E-03
Production	8.78E-03	1.35E-03	5.85E-03
Transportation	1.33E-03	1.53E-04	9.01E-05
Packaging	3.29E-04	5.23E-05	3.72E-05
Σ Manufactur-ing	**2.16E-02**	**5.35E-03**	**8.15E-03**
End of Life	1.43E-02	3.04E-03	4.16E-04
Total	**3.59E-02**	**8.39E-03**	**8.57E-03**

Figure 39 - Absolute contributions of manufacturing and end of life per m^2 of finished Direct Print laminate flooring mix to PE ne, PE reg, GWP 100, ODP, AP, EP and POCP.

Considering the global warming potential, in manufacturing, it is dominated by carbon dioxide. Per m^2 of direct print laminate flooring, around 13.85 kg of CO_2 is bound in the input through re-growing raw materials. This binding of CO2 in the tree growth phase is offset by further CO_2 emissions during the provisioning of raw materials, production, transportation, and packaging. Around 91.5 % of the global warming effect is caused by carbon dioxide, about 4 % by nitrous oxide and around 4.5 % by VOC emissions (especially methane).

4.4.2 Environmental product declaration for cork flooring

The information provided in the EPDs for cork flooring made by the European Resilient Flooring Manufacturers' Institute (ERFMI), corresponds to resilient floor coverings that are an entire product family of flexible flooring solutions available in sheet, tiles and plank. This section is based on the information provided by EPD of cork tiles and cork floating.

Table 32 - Main information of the environmental assessment presented in the EPD for Cork floor tiles flooring by ERFMI[127]

Item	***Observation***
title	Environmental Product Declaration for Cork tiles flooring produced by ERFMI
authors	European Resilient Flooring Manufacturers' Institute (ERFMI)
reference and year	2013
type of study	Cradle to grave
scope	Calculate the environmental performance of cork tile flooring produced by ERFMI
functional unit	1m^2 of cork floor covering installed, with a thickness of 4mm. The reference service life is not indicated.
system boundaries	Cradle to gate including: - provision of all materials products and energy - transportation to factory gate waste processing up to the end-of-waste state.
assumptions (e.g. allocation)	25 years domestic use 15 years commercial use Electricity mix from Portugal as it is the main European producer Cork shreds are internally reused in a close loop process

[127] EPD-ERF-2013911-E, Cork floor tiles, installed in European Resilient Flooring manufactures institute (ERFMI), available at: http://construction-environment.com/download/Cffb648dX13dea6483bcX66ba/EPD_ERF_2013911_E.pdf

data sources , quality	Ecoinvent (updated 2010), industry data 2.2 databases (2007) and literature (2005)
1. Raw materials	Production and harvesting of cork, stripping the bark from cork oak trees every nine years.
2. Manufacturing	For the flooring production the cork granules are mixed with an adhesive. This mixture is cured under temperature and pressure. The cork flooring surface is finally decorated with colour and finished with a UV varnish in order to guarantee wear resistance of the surface. Cork tiles flooring is made of 85.7% of cork, 11.4% of additives and 2.9% of laquer.
3. Distribution/ transportation	Transport processes up to the factory gate and transport of the floor covering to the place of installation are considered. Also transportation of the post-consumer waste to waste processing is included.
4. Use phase	It includes provision of cleaning agent, energy and water consumption for the cleaning of the floor covering incl. waste water treatment. The LCA results in this EPD are declared for a one year usage.
5. Packaging	It is included (also its incineration, after the installation of cork tiles)
6. End of Life	Two end of life scenarios declared for: 100% incineration in a waste incineration plant (WIP) or 100% landfilling
Impact assessment categories/methods	Impact categories considered: - Global Warming Potential (GWP 100) Acidification Potential (AP) - Ozone depletion potential (ODP) Photochemical ozone creation potential (POCP) - Eutrophication Potential (EP) Abiotic depletion potential for non fossil resources (ADPE) - Abiotic depletion potential for fossil resources (ADPF)
Conclusions (e.g. most important LC phases; drivers to impacts, process or material; improvement options)	The results from the EPD of cork tiles show that the *production stage* (raw material supply, transport and manufacturing) *accounts for the highest energy and water consumption* and for most of the indicators considered in the PCR. However, the *production stage does not score the highest value for the GWP indicato*r since cork is considered as CO_2 storage. These data are also reflected in the *use of resources.* The modules A1-A3 present the *highest energy consumption both renewable and non-renewable* followed by the construction process. Only the *recovery of this product allows for credits on the total energy consum*ption what is accounted in the module D. Likely the *water consumption is important in the production stage*, being followed by the waste processing stage, construction and use stages.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARYS
Raw material supply	Transport	Manufacturing	Transport	Construction-installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X			X	X	MND	X	MND	MND	MND	MND	MND	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1m² installed

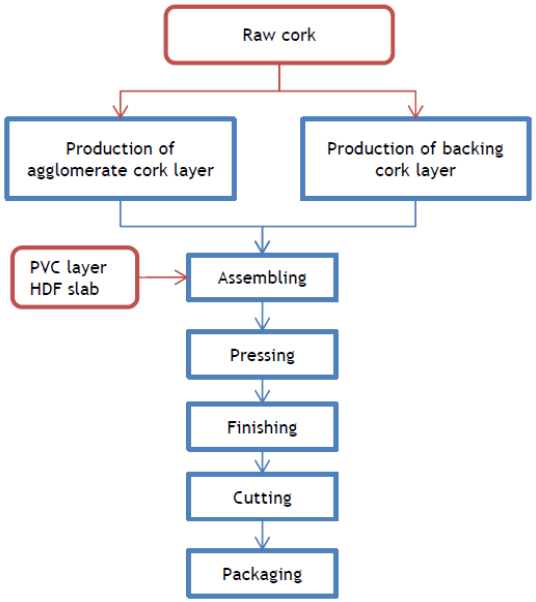
Parameter	Unit	A1 - A3	A4	A5	B2	C1	C2	C3/I[1]	C3/L[2]	C4/I	C4/L	D/I	D/L
GWP	[kg CO_2-Äq.]	-3,1E+00	2,3E-01	1,2E+00	4,3E-01	1,4E-02	1,9E-02	3,6E+00	0	0	1,5E-01	-1,4E+00	-3,8E-01
ODP	[kg CFC11-Äq.]	1,9E-08	4,1E-12	5,1E-10	2,6E-10	1,3E-11	3,3E-13	4,0E-11	0	0	7,5E-11	-5,4E-10	-1,43E-10
AP	[kg SO_2-Äq.]	1,5E-02	1,1E-03	1,0E-03	1,6E-03	6,8E-05	8,6E-05	1,2E-03	0	0	4,3E-04	-3,4E-03	-9,1E-04
EP	[kg PO_4^{3-}-Äq.]	2,9E-03	2,4E-04	1,7E-04	1,3E-04	3,6E-06	2,0E-05	3,0E-04	0	0	5,3E-04	-2,3E-04	-6,3E-05
POCP	[kg Ethen Äq.]	1,6E-03	-3,5E-04	1,5E-04	1,7E-04	4,0E-06	-2,8E-05	8,5E-05	0	0	6,7E-05	-2,8E-04	-7,61E-05
ADPE	[kg Sb Äq.]	4,5E-06	8,7E-09	1,2E-07	2,0E-07	2,0E-09	7,1E-10	3,1E-08	0	0	2,8E-08	-1,1E-07	-3,0E-08
ADPF	[MJ]	7,8E+01	3,2E+00	1,1E+01	8,3E+00	2,5E-01	2,6E-01	1,1E+00	0	0	2,2E+00	-2,4E+01	-6,5E+00
Caption	GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non fossil resources; ADPF = Abiotic depletion potential for fossil resources												

Another EPD is available from the IBU system and it is about cork floating coverings and made by Amorim Revestimentos S. A.

Table 33 – Main information of the environmental assessment for EPD for Cork floating coverings by Amorim Revestimentos[128]

Item	***Observation***
title	Environmentel Product Declaration (EPD) for Corkcomfort Floating HPS
authors	Amorim Revestimentos S. A.

[128] Amorim Revestimentos, EPD for Cork floating coverings, available at: http://construction-environment.com/download/C1e754ab8X1409bb78301X690e/EPD_AMO_2013131_E.pdf

reference and year	2013
type of study	Cradle to factory gate
scope	Calculate the environmental performance of cork flooring produced by ERFMI
functional unit	1m^2 of cork floor covering installed
system boundaries	Data are representative of the average European situation except for the energy mix that corresponds to Portugal as it is the main producer. The cork powder and cork shreds resulting from production is reused in the process to produce thermal energy and electricity. This Cradle to grave analysis includes: - raw material supply, transport and manufacturing - transport to the place of installation - production of the adhesive for the installation and incineration of the off-cuts and packing material  **Figure 40 – Cork flooring production process** The production process begins with the manufacturing of agglomerate cork and the cork backing layer. Following this process, HDF is assembled to both cork layers. After this, the product is assembled to a PVC layer. The top layer is coated with a protective varnish, creating a hard wearing surface. The next stage consists in pre-cutting and cutting, in order to shape the planks. The last stage is packaging.

assumptions (e.g. allocation)	CO_2 intake due to photosynthesis associated to cork and wood was considered. Information on components and average weight percentage of varnishes and adhesives was obtained from suppliers.
data sources and quality	Specific data was used based on average production of 2011. For processes which the producer has no influence or specific information, like the extraction of raw materials and electricity production, generic data from Ecoinvent and Industry data 2.2 databases, considering geographical significance, have been used.
1. Raw materials	Raw materials included: cork (24.9% w/w), HDF (wood (59.6% w/w), adhesives (7.6% w/w), varnishes (0.2% w/w) and PVC (7.7% w/w).
2. Manufacturing	Production process: agglomerating of cork in backing layers, HDF assembling and then glued to a PVC layer, coating with a protective varnish, cutting.
3. Distribution/ tte	Transport processes up to the factory gate are included as well as the transport of any waste arising from those processes.
4. Use phase	The expected service life is 25 years old for domestic use and 15 for commercial use.
5. Packaging	Product planks are laid in cardboard boxes, wrapped in packaging film and placed on wooden pallets, secured by plastic straps. These packaging materials can be collected separately and recycled.
6. End of Life	The product is mainly composed by cork, HDF (wood) and PVC. PVC layers can be shredded, granulated or powdered and then re-melted to make a secondary input material. Wood and cork can also be suitable for composting. Analysis of three end-of-life scenarios: - landfilling - incineration - reuse, recovery and recycling potential
Impact assessment categories/methods	Impact categories considered: - Global Warming Potential (GWP 100) Acidification Potential (AP) - Ozone depletion potential (ODP) Photochemical ozone creation potential (POCP) - Eutrophication Potential (EP) Abiotic depletion potential for non fossil resources (ADPE) - Abiotic depletion potential for fossil resources (ADPF)
Conclusions (e.g. most important LC phases; drivers to impacts, process or material; improvement options)	The main environmental impacts are causing during the *assembling and finishing stage* due to the *use of materials and electricity consumption*. This is the stage that contributes with a greatest environmental burden in all categories, except for the GWP category. The *HDF production* also is significant *due to its electricity consumption and the treatment of the effluents and pollutants* to the ground from this stage. The *PVC layer production* contributes to the environmental impact and the *cork agglomeration* due to its *large associated electricity consumption and the use of resins*. The GWP category is negative meaning that there is more sequestration of CO_2 during the process than emissions resulting from the process. The fixation of CO_2 is due to the use of cork and also due to the use of HDF introduced during the assembly. Cutting and packaging the final product is the only stage with a positive impact in GWP.

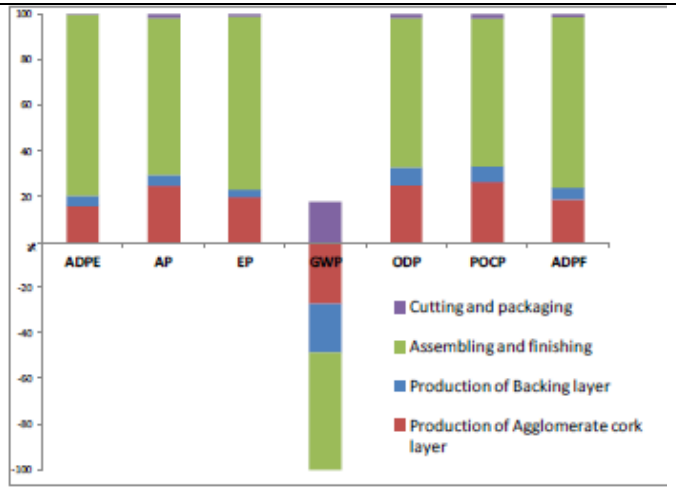


Figure 41 - Results from the LCA analysis from a cork floating covering

4.4.3 Environmental product declaration for bamboo flooring

No EPD are available about solid wood or bamboo flooring (neither within the German IBU one where EPDs on laminate and cork flooring were found).

4.5 Critical review and summary of selected LCA and EPDs

The LCA studies and EPD documents reviewed in this revision have provided a useful insight for the technical and environmental analysis of the wooden floor coverings. The studies provide useful outcomes regarding the key environmental impacts of different WFC production system, the relative contribution of different life stages (materials, manufacturing, packaging, distribution, use and end-of-use) to the impact categories, main sources of concern and possible improvement potential options (design, raw materials, production processes, distribution, life duration and end of life scenarios).

In terms of the **scope**, solid wood flooring and bamboo flooring are mainly covered by LCA analysis, laminate flooring by EPDs and cork flooring by both types of studies. All the studies scrutinized include the extraction of materials and manufacturing process while the use and end-of-life stages are only considered in some of them. Regarding the EPDs almost all EPDs are from "cradle to grave" or "cradle to gate". In the former case the end-of-life scenarios include incineration or landfill as the most common options.

In terms of **materials**, the main material analysed in the studies are wood, wood-based materials and in some cases also the resins and binders used for the production of the main core panels. EPDs of laminate floorings also include the printed paper in the bill of materials. Information about the materials and production steps comes from companies and databases (commercial) and usually gathered for upstream and core processes, downstream processes (end-of-life) usually refer to statistics and literature. When impacts of the use phase are included, maintenance and cleaning operations are considered.

In terms of **goals and outcomes** from the studies, most of studies identify hotspots along the product life cycle. Some studies also perform sensitive analysis on different design options or do comparative analyses, trying to better understand the differences between the different types of flooring.

The main outcomes from the LCA and EPD review can be summarised as it follows:

- ***Raw materials production:*** the extraction of materials (wood) is related to the damage to the ecosystem caused by land use and the loss in the biodiversity. These issues are in relation to the management of the forestry and the period of harvesting for the extraction of cork and bamboo. All of them seem to be of high relevance but the lack of data and particularities of each habitat make difficult to account for them. On the other hand, forest and plantation are ways of carbon sequestration reporting credits to the overall environmental assessment.

  The key environmental aspects of solid wood are mainly related to the legal and sustainable character of the originating forest management. The impacts related to uncontrolled wood logging are for example loss of biodiversity, erosion and soil degradation. As the majority of wood used in wooden floor covering is treated, attention must be paid to the surface treatment of wood. In addition to solid wood, wood-based products (such as panels) are also widely used, especially in laminate flooring.

  The three main categories of wooden panels are fibreboard, particleboard and plywood. They are essentially produced under heat and pressure with the addition of an adhesive to glue fibres, particles or sheets of wood respectively. The environmental and health impacts of these products are linked to forestry practices and the substances used as glues and finishing.

  Taking both wood and wood-based products into account, criteria should be defined to reduce their environmental impact in relation to:
    - Origin of timber – management of the originating forest;
    - Use of hazardous substances in the production process;
    - Formaldehyde emissions.

Finally, it is also important to highlight that wood, bamboo and cork timber is a renewable resource in comparison to other materials such as metal or plastic. As such, its use should be promoted.

- ***Manufacturing:*** Manufacturing seems to be the second most relevant stage of the lifecycle because of the energy consumption and use of resins in the laminate floorings. The energy consumption needed in process steps such as *felling*, *sawing***,** *drying*, or *pressing* account for the highest environmental impacts of this stage. Those impacts strongly depend on the type of technology used to get the electricity and heat required as well as the fuel fed. The use of cogeneration installations, energy efficiency techniques such as heat recovery or use of renewable sources can decrease these impacts.

  Other aspects that are relevant at this stage are the use of resins, PVC or other kind of chemical substances. The main reason of this importance is that the environmental impacts caused during the production of these chemical compounds are accounted at this stage and they can reach approximately 70% of the total environmental impacts.

- ***Packaging***: Packaging is assessed in terms of materials used and impacts related, in general its environmental load is negligible.

- ***Distribution:*** Transport of materials is less important than processing, but it could become more relevant when non-local materials are used. This is the case of international sea transportation of exotic wood (e.g. bamboo) and materials from Asia and Africa and to a lower extent by road inside Europe. Improvement potential options have been found like using local suppliers, or improvement the efficiency of vehicles.

- ***Use:*** When maintenance is included in the assessment it results to have low but not negligible impacts. The contribution of cleaning over a reference service life period is more relevant, considering it varies from 15-20 for wooden floor covering up to 50 years for cork coverings.

- ***End-of-Life:*** End-of-life impacts vary depending of the waste treatment scenarios. Landfilling and incineration are mostly considered although in different ratios depending on the geographical area and authors. Burdens to landfilling are relatively low compared to other lifecycle stages. Environmental impacts associated with incineration depend on the technology used as well as on the previous treatment of the floorings. In general, it is considered that wood and wood based materials absorb CO_2 during its growth and life until harvest and it will remain locked in the material until its release when the material is burnt. If burnt in electrical and heat power plants it is considered to substitute the use of carbon intensive fuels and thus be perceived as additional carbon credit. If the material is recycled or reused the CO_2 is not released and thus it is considered that it keeps as a CO_2 fixator accounting the corresponding carbon credits.

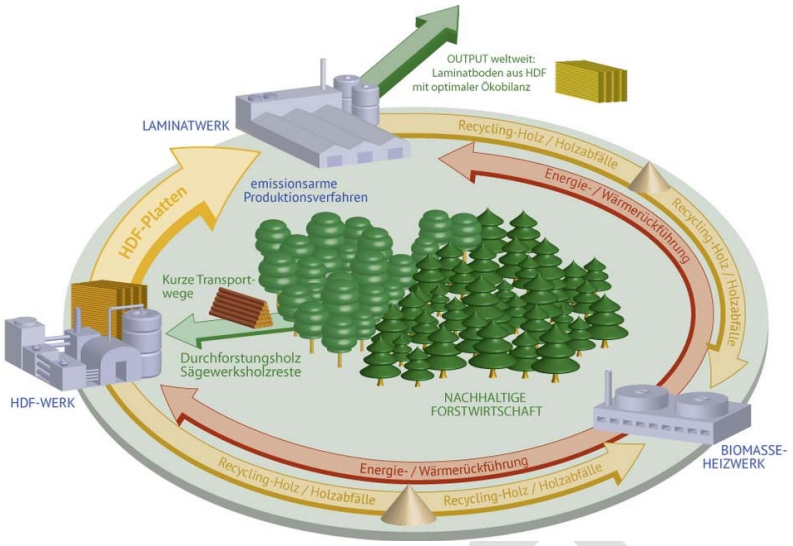


Figure 42 - Life Cycle Steps along laminate production process [129]

4.6 Identification of hot spots from the LCA screening

The review of the selected LCA studies and EPDs, allowed identifying environmental hot-spots along the lifecycle of WFC products. The distribution of the impacts can be aggregated from the information of the revised studies. Environmental impacts of WFC are mostly associated to the extraction of the raw materials and the manufacture stage.

Manufacturing of the WFC products mainly consisting in the boiling and pressing of the fibers is energy intensive causing large environmental impacts. Magnitude of the impacts is significantly higher than that of the materials and mainly due to the use of fossil fuels. The manufacturing steps that cause the largest environmental impacts are drying and board sawing. Positive effects can be achieved through reuse of waste production in place of virgin fibers or through energy recovery. The implementation of best available techniques (BAT) for the manufacturing of the panels can help in this way and it will be commented in the coming sections

The **extraction of the raw materials** especially of wood and wood-based materials is usually the second most important stage in terms of environmental impacts. The impacts are difficult to evaluate as they are due to the land use change and loss of biodiversity. The environmental impacts from the production or **binders, resins, paints and varnishes** is also remarkable as well as the use and emissions of substances in the finishing processes. For instance, significant levels of toxicity can be associated to the used of some resins as well as a significant contribution to POCP can also result from some finishing processes, use of solvent based on xylenes and emissions from paints and varnishes, fillers and diluents. In order to decrease these impacts, attention to possible feasible alternatives and techniques to reduce the emissions can be implemented.

Contribution from **product transport** and **disposal** is interesting in this type of products. According to the information of this section, the environmental impacts caused by the international sea transportation of raw materials and finished products is of importance due to the long distances

[129] Classen Flooring: http://www.classen.de/media/sites/images/zoom/oekosystem2.jpg

while the local transportation, depending on the mean distance, seems to be of less importance. Recovery of the product through valorisation seems to be a trade-off between the fossil fuel that can be saved and the burning of a product that is considered as a mean to CO_2 storage.

Use stage does not seem to contribute appreciably to the environmental impacts. In those studies where cleaning or maintenance operations are considered, impacts of this stage are not relevant. Durability of the WFC is an important parameter since it will determine the lifespan. However, in some cases, it is preferred not to increase the durability of the product if additional harmful chemicals should be used for this purpose.

In Table 34 it is shown an average rounded distribution of impacts among the different life cycle stages by each impact category. It can be seen that wood cultivation and harvesting, in absolute value, have the highest contribution in GWP_{100}, followed by manufacturing. For EP and AP manufacturing, transport and raw material have the highest impact, due to emissions in air and cultivation phase for wood.

Table 34 - Quantification of the environmental impact for each lifetime stage

	Materials extraction	Manufacturing	Transport	Installation & Use stage	End of life
GWP_{100}	-45%[130]	35%	2%	8%	10%
EP	20%	40%	15%	10%	15%
AP	20%	40%	15%	10%	15%
POCP	1%	2%	1%	90%	1%
ODP	2%	30%	10%	55%	3%

[130] Wood cultivation and harvesting: it is negative considering the CO_2 sequestration.

5 TECHNICAL ANALYSIS: GOING INTO THE ENVIRONMETAL ASPECTS

In this section a preliminary technical analysis is developed following the different life stages of the WFC products. A specific section has been developed for the assessment of hazardous substances, which includes the substances used in processing of raw materials, manufacturing and packaging

5.1 Raw materials

The LCA screening shows that the second more important lifecycle environmental impacts of WFC are mainly due to the materials. The most common materials used in the production of WFC are wood, plant-based materials, resins and other spreadable materials.

a) **Wood**: Solid wood and wood based products such as panels are widely used in WFC sector. Wood and wood panels can be produced or bought by the assemblers. The three main categories of wooden panels are:
   - **Particleboard**: Wooden panels produced under heat and pressure with the addition of an adhesive to particles.
   - **Fiberboard:** Wooden panels produced under heat and pressure with the addition of an adhesive to glue fibres. The types of fibreboard, in order of increasing density, include particle board, medium-density fibreboard and hardboard. Fiberboard, particularly medium-density fibreboard (MDF) is heavily used in the WFC industry.
   - **Plywood:** Wooden panels produced under heat and pressure with the addition of an adhesive to sheets of wood.

b) **Plant-based materials**: two main of plant based products are used in the production of WFC: cork bark and bamboo. Both materials are harvested from the forest without damaging the plants.

c) **Adhesives, resins and glues** Adhesives are used in the production of wooden panels as well as in the assembly and laying of wooden flooring. Different types of adhesives are on the market which can be natural or synthetic (petroleum based adhesives):

- **Natural adhesives (glues):** natural adhesives are made from organic sources such as vegetable matter, starch (dextrin), natural resins or from animals e.g. casein or animal glue. They are also called bioadhesives:
  - Animal glues: often called “hot blue” are made from hides, bones and other parts of cattle.
  - Starch (vegetable) glues: made from cassava starch in water. They can be applied hot or cold.
  - Casein: is formulated from protein (curds) obtained from milk.
  - Other naturals: soybean and blood. They are similar to vegetable and casein and are used primarily for veneer gluing.

- **Synthetic adhesives:** These are organized into reactive and non-reactive adhesives, which refers to if the adhesive chemically reacts to harden.
  - **Reactive adhesives**:
    - **Thermosetting adhesives**: which require heat to cure. They ften contain formaldehyde as a major ingredient. Examples: urea, urea-formaldehyde resins, phenol-formaldehyde resins, resorcinol and phenol-resorcinol, melamine resins and epoxy cyanoacrylate.

- **Thermoplastic adhesives**: which undergo irreversible chemical curing reactions to produce the glue joint. Examples thermoplastic hot melts (using polyethylene and polypropylene) and polyvinyl-acetate (PVA).
- **Elastomers**
- **Emulsions**

- **Non-reactive adhesives**: Those that do not chemically cure and, therefore, may soften with heat.

d) **Surface treatment:** Surface treatments consist in mostly liquid material such as biocides, paint and varnishes, etc. that are used during the finishing of the product and aim to protect or add particular properties to the final product. These materials are usually bought (not produced) by the WFC producers.

e) Plastics: they are scarcely used in the WFC industry. However, the use of PVC has been reported in little quantities in the cork and laminate flooring sectors to add protection to the final products.

5.2 Wood and plant-based materials

As listed before, the type of wood and plant based materials used in WFC sector are coming from different trees and plants. Today's wood floors come in more than 50 species, both domestic and exotic, that gives different aspects to the final product. Popular woods are white or red oak and cherry, other are beech, yellow birch, black walnut, maple, elm, alder, poplar or aspen and others are also becoming more and more popular such as bamboo, cork oak trees, etc.

The key environmental aspects of solid wood[92] are mainly related to the legal and sustainable character of the originating forest management. The impacts related to uncontrolled wood logging are for example loss of biodiversity, erosion and soil degradation. As wood used in WFC is largely treated, attention must be paid also to the surface treatment of wood. The environmental and health impacts of wooden products are linked mainly to the substances used such as glues and finishing. These substances usually contain formaldehyde resins, melamine, epoxy, polyurethane resins, ethylene vinyl acetate, etc., and will be discussed later in detail.

Energy used to transform wood materials, especially for boards, contributes significantly to environmental impacts like global warming potential and photochemical oxidant formation and therefore it will be also discussed in detail later on.

5.2.1 Origin and traceability of the wood and wood-based materials

According to the LCA analysis, one of the main environmental aspects of WFCs is due to the extraction of the raw materials, in particular wood and wood-based materials. According to COM(2013)659 on "A new EU Forest strategy: for forests and forest-based sector"[131], the forests and other wooden land cover over 40% of the EU's land area, with a great diversity of character across regions. Afforestation and natural succession have increased the EU's forest area by around 0.4% annually over recent decades. Globally, however, forest area continues to decrease.

[131] Communication from the Commission to the European parliament, the council, the European Economic and social committee and the committee of the Regions, A new EU Forest Strategy: for forests and the forest-based sector, {SWD(2013) 342 final}, {SWD(2013) 343 final}

Forests are serving economic, social and environmental purposes as they offer habitats for animals and plants and play a major role in mitigating climate change and other environmental services. Nearly a quarter of the EU's forest area is protected under Natura 2000, and much of the rest is home to species protected under EU nature legislation. Forests also offer wide societal benefits, including for human health, recreation and tourism. Finally, they contribute to rural development and proved around three millions jobs. Wood is still the main source of financial revenue from forests, but it is provided with other raw materials such as cork, resins, mushrooms, nuts, games and berries. So a European Forestry strategy also looks at the EU forest-based industries, subject to EU industrial policy. Wood is also considered and important source of raw material for emerging bio-based industries, e.g. biomass for energy generation.

Ensuring legality of the wood and wood-based product placed on the EU market is the first step to guarantee the future of the forest and forest-based sectors. The 1998 EU Forest Strategy Directive[132] established a framework for forest-related actions that supported sustainable forest management and were based on cooperative, beneficial links between EU and Member State policies and initiatives. The Forest Action Plan[133] 2007-2011 was an important instrument for implementing the strategy but ex-post evaluation of this plan underlined the need for a new forest strategy that develops and implements a common vision of multifunctional and sustainable forest management in Europe, defines action priorities and targets, links EU and Member State funding strategies and plans, strengths coherent cross-sectional activity planning, funding and implementation, establishes clear mechanisms for monitoring, evaluating and reporting and revises stakeholder involvement.

This policy was reinforced by the new EU Forest Regulation No 995/2010 of the European Parliament and of the Council of 20 October 2010 that started in 2003. This regulation, in line with the above mentioned framework, lays down the obligations of operations of operators who place timber products on the market. It covers a wide range of timber products, including plywood, veneer or particleboard. This regulation set three main obligations for wood traders:

a) it prohibits the placing of illegally harvested timber and products derived from such timber on the EU market, whether they are of domestic or imported origin,

b) timber accompanied by a FLEGT or CITES license will be accepted as legal. In all other cases, operators must exercise "due diligence"[134] when they sell imported and domestic timber or timber products.

c) traders (those after the operators in the supply chain) need to keep records on their suppliers (and customers). In this way the operators can always be traced.

However, and although the legally of the timber is already regulated, additional schemes are needed to guarantee that the wood has been grown respecting the sustainable principles.

[132] EU Forest Strategy Directive

[133] COM (2006) 302 Action Plant for EU forests

[134] **Due diligence** is that operators have to undertake a risk management exercise so as to minimise the risk of placing illegally harvested timber, or timber products containing illegally harvested timber, on the EU market. The three key elements of the "due diligence system" are: a) *Information:* The operator must have access to information describing the timber and timber products, country of harvest, quantity, details of the supplier and information on compliance with national legislation. b) *Risk assessment:* The operator should assess the risk of illegal timber in his supply chain, based on the information identified above and taking into account criteria set out in the regulation. c) *Risk mitigation*: When the assessment shows that there is a risk of illegal timber in the supply chain that risk can be mitigated by requiring additional information and verification from his supplier

5.2.2 Sustainability of the wood and wood-based materials: use of certified wood

Ensuring sustainable forest management, and consequently the placement on the market of sustainable wood and wood-based products, is essential if these benefits are to be delivered in a balanced way. The communication COM(2013)659 on "A new EU Forest Strategy: for forest and forest-based industries"[135] defines sustainable forest management as the way of using the forests and forest land in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystems[136.]

The COM(2013)659 supports and identifies those principles needed to strengthen sustainable forest management and improve competitiveness while ensuring forest protection and delivery of ecosystem services. These guiding principles are the FOREST EUROPE principles[137] applied by Member States' policies and supported by the EU. The six criteria are listed below and a brief explanation together with the indicators to be measured and monitored included in the ANNEX I: SUSTAINABLE FOREST CRITERIA

1 - Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles;

2 - Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems;

3 - Maintenance of forest ecosystems' health and vitality;

4 - Maintenance and encouragement of productive functions of forests (wood and non-wood);

5 - Maintenance, conservation and appropriate enhancement of protective functions in forest management (notably soil and water); and

6 - Maintenance of other socio-economic functions and conditions.

Forest management plans are an important tool for the implementation of the sustainable forest management at the operational level, and can be a proxy to sustainability. Forest management plants are information (in the form of text, maps, tables and graphs) collected during periodic forest inventories at operational forest unit level (stands, compartments) and operations planned for individual stands or compartments to reach the management goals. Equivalent instruments is information collected on forest area, at forest management or aggregated forest management unit level (forest blocks, farms, enterprises, watersheds, municipalities or wider units) and strategies/management activities planned to reach the management or development goals.

Forest certification has been one of the tools to document the sustainability of forest management. The main important certification schemes related to sustainable forest are listed in Table 35.

[135] Communication from the Commission to the European parliament, the council, the European Economic and social committee and the committee of the Regions, A new EU Forest Strategy: for forests and the forest-based sector, {SWD(2013) 342 final}, {SWD(2013) 343 final}

[136] Ministerial conference on the protection of Forest in Europe, Helsinki 1993

[137] http://www.foresteurope.org/sfm_criteria/criteria

Table 35 - Sustainable management forestry systems

Scheme	Main data
FSC Forest stewardship council	Total certificate area (2013): 180552millions ha (43% in Europe) No countries: 79 Total no certificates: 1211
PEFC Programme for the endorsement of Forest Certification schemes	Total certificate area (2012): 247millions ha (35% in Europe) No countries: 37 Total no certificates: 9520 certificates of supply chain custody PEFC
CSA Canada's National Sustainable Forest management	Canada endorsed by the programme of the endorsement of forest certification (PEFC)
FSI Sustainable forest initiative	USA and Canada. Endorsed by the Programme for the Endorsement of Forest Certification (PEFC)

Looking at the number of ha certified and products carrying a logo of certification, it is clear that certification has gained importance, year after year. In the EU around 50% of forest and other wooded land are certified by FSC or PEFC, certified by these two main voluntary forest management certification systems (PEFC and FSC) cover 412million ha of forest (165 and 247 million ha respectively), which represent around 10% of the forest world area.

Regarding the type of wood certified, in Europe the availability of softwood from certified forestry is generally high, whereas the availability of hardwood is significantly lower. Regarding the kind of forest, 64% of forest area certified by FSC was natural forest (around 11583Mha), 28% is semi-natural and mixed plantation and natural forest 950.91Mha) and 7.61% is plantation (13.74Mha).

Bamboo and cork are two raw materials that are included into the classification of *"products of biological origin other than wood derived from forests, other wooded land and trees outside forests"*[138]. This term includes all biological materials other than wood which are extracted from forests for human use. Demand for bamboo and cork flooring is growing - as reported in Section 3.6 and 3.7. However, the certification schemes for these raw materials are not so well spread.

At present bamboo is also available as FSC-certified material, although little bamboo from certified areas is available. Other Ecolabel Schemes as Nordic Ecolabelling have criteria regarding bamboo to ensure that raw materials do not derive from areas where biodiversity or social conservation values are under threat. This point is of especial relevance as bamboo is often perceived as being environmentally friendly.

In light of its importance of certified cork, in 2011 PEFC International started with PEFC Spain and other partners to promote cork certification. This initiative looks at both ends of the supply chain, creating demand and awareness about the benefits of using PEFC certified cork, and encouraging forest owners in Portugal, Spain, France and Italy to produce PEFC-certified cork.

5.2.3 Recycled wood

The use of recycled wood is widely spread nowadays in the WFC industry. Many types of chipboard contain recycled fibres. This brings several environmental benefits such as the reduction of raw

[138] FAO 2007, Towards a harmonized definition of non-wood forest products (http://www.fao.org/docrep/x2450e/x2450e0d.htm#fao forestry)

materials consumption and the related minimization of waste streams coming from forestry, timber production and wood products waste.

Comparisons between the production of panels made of virgin fibres and recycled fibres coming from other wooden products showed that there is a reduction in many environmental impacts with increase in recycled fibre content in panels. Compared to virgin panels production, the content of recycled fibres in boards shows a reduction in most impacts categories such as GWP, EP or ecotoxicity. When the recycled content is increased, these reductions are higher. There is a potential reduction of 0.52tons of CO_2eq per ton of panel produced with recycled fibres[139].

The use of recycled wood in the manufacture of panels requires deliveries of material to the processor to ensure that reclaimed raw materials and the finished panel product are strictly controlled in respect of contaminating chemical elements and compounds that might be present at unacceptable levels in recycled wood. Therefore, a problem associated with the use of recycled fibres is the risk of contamination by pollutants content in the recycled wood.

5.2.4 Genetically modified wood and plant-based material

Generally modified organism (GMO) and therefore wood are organisms that have been transformed by the insertion of one or more isolated genes. Scientists and the public have expressed worries with regard to the risks of potential gene flow. From the environmental point of view, the hazards of GMO trees include for example a reduction of the diversity as plantations using one or few transgenic clones will contain less landscape-level diversity, asexual transfer of genes from GMOs with antibiotic resistance to pathogenic microorganism, spread of herbicide resistance gene is sexual progeny to trees in environments where those trees are undesirable and where the target herbicide is used, increased resistance of target insect pests and/or deleterious effect on natural enemies of the target insects, changes to structural integrity, adaptation and pest resistance of trees, rate of decay of dead wood and soil structure and reduced adaptability to environmental stress, among others.

A study from the Food and Agriculture Organization of the United Nations (FAO)[140] suggested that as of 2002, less than 500 ha of genetically modified forest trees (poplar clones) were being grown commercially in China. *Populus* is the genus of forest tree in which genetic modification has been researched most widely, although some genetic modification research has been reported for about 19 genera of forest trees. In general, it seems that for the time being the area of genetically modified forest trees is not significant enough to distort the current wood and wood-based material markets. The FSC bans all forms of genetically engineered trees on certified lands.

5.3 Adhesives and resins

Usually resins are used in the manufacturing of panel boards, regarding the type of panel. Several consequences are associated to this type of adhesives such as use of non-renewable raw materials, formaldehyde emissions or limited recyclability of the final product.

The choice of the resin is determined by the quality wanted in the final product and balanced to the price of resin and the possibilities of the press to work under different conditions according to the

[139] Background of wooden furniture, September 2013: http://susproc.jrc.ec.europa.eu/furniture/docs/Background_report_Furniture_September_2013.pdf

[140] FAO. 2004. The State of Food and Agriculture 2003-04. Rome.

optimum press time and the temperature. Resin formulations are not standard and considered confidential information.

Resins applied in wood-based panel production can be divided into five main groups:

- *urea formaldehyde resin (UF):* the absolute majority of PB and MDF production is based on this resin as it represents 84% and 68% respectively. The main reason is that this resin is the cheapest and most versatile resin.

- *melamine urea formaldehyde resin (MUF):* it is an important contributor to PB production getting 11% of the market share and of MDF getting 30% of the market.

- *melamine urea phenol formaldehyde resin (MUPF)*

- *phenol and phenol urea formaldehyde resin (PF/PUF)*

- *methylene di-isocyanate (pMDI):* this resin is mainly used for the production of OSB

A few other resins have been registered as used but in minor quantities at dedicated productions, such as lignosulphonate[141] for wood-based panels production. Some of the resins are used as additions to the main resin in 5-10 % bends, while other resins are used for special productions. The consumption of resin varies between products, between product qualities and even between core and surface layers in particleboard. The resin quantity represent between 5-10% of the final wood-based panel product.

The main environmental impacts caused by the adhesives and resins are associated with the ingredients of these materials. There are three types of adhesives: solvent-borne, water-borne and formaldehyde free adhesives. Solvent-borne adhesives are those mostly used for the production of wooden flooring due to their lower costs but they are less environmental friendly that the other alternatives. Solvent-borne adhesives cause formaldehyde and VOCs emissions that are substances classified as environmental harmful.

Alternatives to solvent-based wood adhesives exist and efforts are being devoted to develop adhesives by using renewable-based substitutes. This section looks at the effect of substituting non-renewable resins or reducing the amount of resins in panelboards. Alternatives suggested in this section are all no-added formaldehyde (NAF) based resins. NAF base resins are resins formulated with no added formaldehyde as part of the resin across linking structure, and include resins made from soy, polyvinyl acetate or methylene diphenyl diisocyanate (MDI). The aim of NAF based resins is to avoid the main pollutant emitted from petroleum based resins: the formaldehyde and to some extent the VOCs. This section does not include ultra-low emitting formaldehyde (ULEF) resins because they are made with formaldehyde and still emit low amounts of it. The selection of the substitutes, in particular for the adhesives, in wood panels should consider many factors such as: strength, durability, wetting, consistency, pressure, temperature, moisture content, colour and finishing and costs.

5.3.1 Alternative non-added formaldehyde resins: overview

One group of alternative wood adhesives/resins contain isocyanates. Isocyanate-based adhesives have rinsed the interest of the industry because they have advantages compared to formaldehyde

[141] Lignosulphonate are water-soluble anionic polyelectrolyte polymers: they are byproducts from the production of wood pulp using sulfite pulping

based resins. They have a high internal bond strength, better elasticity and mode of rapture, they are more efficient and highly effective in lower doses, and cure at higher wood moisture contents and they do not emit formaldehyde (Table 36).

Methylenebis(4-phenyl isocyanate) (MDI) binders are for example used in over 20% of the high growth OSB industry worldwide and are in routine production in MDF mills in Europe. It should be noted that MDI is synthesized with formaldehyde.

Table 36 - Overview of some alternative non-added formaldehyde resins

Alternative	Product examples	Description
Methylenebis (4-phenyl isocyanate) MDI or PMDI	DHF/DFF panels from EGGER[142] (Germany)	DHF and DFF boards are board-shaped wood based materials made out of wood fibre according to EN 622-5 (DHF) and EN 13171 (DFF). They have a tongue and groove profile along the edges. The boards are manufactured using the so-called dry method in a hot press process and with addition of a PMD glue and paraffin wax emulsion for hydrophobising
PU binder	MDF, NAF e.g. Topan MDF standard FF from Glunz[143] (Germany)	A formaldehyde –free polyurethane (PUR) adhesives
	OSB panels e.g. Euroestrand OSB 4 TOP[144] from EGGER (Germany)	Uses PU binder = formaldehyde-free gluing (E1<0.03ppm). Classified as OSB/4 board according EN 300. The board complies with the strict requirements of the Federal association of German Prefabricate Construction (BDF/QDF) in terms of emissions and the requirements of the Japanese F****, standard with regard to the level of desiccation (a measurement of formaldehyde)
Bioresins (e.g. from soybean, linseed, rapeseed)	Purebond[145]	Soybased resins: say based plywood adhesives. It is a liquid cationinc amine polymer-epichlorohydrin amine called polyamide-epichlorohydrin (PAE)
Tannins	Glyoxalized lignin/ mimosa tannin/ Hexamine	The green adhesive can be considered to be produced industrial. All properties of the adhesives correspond to the needs for an industrial panel production

However, it should be paid attention to the possible hazardous characteristics of the substitutes. In this sense, the study SUBSPORT checked the alternatives proposed against databases of hazardous substances showing the following results.

Table 37 - Overview of hazardous characteristics of possible formaldehyde resins's substitutes

Chemical alternative	Comments	Database
MDI/PMDI Diphenylmethane diisocyanate /polymeric MDI Cas No: 4,4'MDI: 101-68-8	Contains isocynates: polymeric MDI (PMDI), the primary technical/commercial form of MDI is actually a mixture that contains 25-80% monomeric 4,4'-MDI as well as oliogomers containing 3-6 rings and other	Toxicological review by EPA: isocyanates have a strong irritant effect on the respiratory tract. Some people may become sensitised to isocyanates, even at

[142] http://www.pdistribution.pl/pdf_Egger/katalog%20plyt%20konstrukcyjnych%20jezyk%20angielski.pdf
[143] http://gluz.de/produkt_dekorativ/gruppe/221
[144] http://www.egger.com/downloads/bildarchiv/18000/1_18216_PP_Eurostrand-OSB-4-TOP_DE.pdf
[145] Purebond (2013). Available at: http://purebondplywood.com/

4,2'MDI: 2536-05-2 2,2'MDI: 5873-54-2 Mix of isomers 26447-40-5	minor isomers, such as 2,2'-isomer. The exact composition of PMDI varies with the manufacturer	very low levels.
PVA (polyvinyl-acrylates) Cas No: 9003-20-7 Vinylacetate Cas No: 108-05-04	Water based latex glue, polymere or vinylacetate. Acute (short-term) inhalation exposure of workers to vinyl acetate has resulted in eye irritation and upper respiratory tract irritation	
PU Cas No: 9009-54-5 Groupe: 61789-63-7	Polyurethanes contain isocyanate: they are formed between the reaction of a di-isocyanate and a polyol to form a urethane linkage	PU is included in the list of hazardous substances because it contains isocyanate with sensitising properties H317, H334
Protein based bioresins: soybean oil Cas No: 8001-22-7		Not included. Purebond, TURI contains in small amounts epichlorohydrin a carcinogen
Tannis Cas No: 1401-55-4		Not included

Considering Table 36 and Table 37, most of the identified synthetically alternatives resins (MDI and PU) do not emit formaldehyde and do not contribute to formaldehyde emission in the indoor air. But as they use isocynate - a sensitiser- to bond wood composites. PVA adhesives have a small application range because they are not water resistant and not heat resistant. The bioresins are still in the stage of development. Different research groups are developing bioresins for the wood and construction industry.

As a summary, from the technical point of view, currently the use spectrum of the presented alternatives is not as broad as for formaldehyde-based or isocyanate-based resins. It is necessary to improve the performance of alternative resins (e.g. bioresins) to push the substitution for formaldehyde based wood panels. Bioresins able to compete with formaldehyde- or isocyanate-based resins need additives that may be hazardous. In addition, those water-borne adhesives that are widely used for wood bonding (PVA) do not work well at high moisture levels.

Taking into account that the present alternatives are suitable for different uses it is difficult to compare the costs, but for example Purebond is currently available at a similar cost of formaldehyde-based plywood.

5.4 Surface treatment

Various agents can be used for the protection and preservation of wood. The ultimate goal is to extend the useful lifespan since for example the biocides protect from decomposition by the action of bacteria and microorganisms and varnishes protect from the action of external agents such as humidity.

5.4.1 Biocides

The **Biocidal Products Regulation** (BPR) (EU) 528/2012[146] concerns the placing on the market and use of biocidal products which are used to protect humans, animals, materials or articles against harmful

[146] More information available online at: http://echa.europa.eu/regulations/biocidal-products-regulation

organisms like pests or bacteria, by the action of the active substances contained in the biocidal product. This regulation on the use and placing on the market of biocidal products repeals and replaces the Biocides Directive 98/8/EC. 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. Wood preservatives are covered under Product type 8 in the Regulation and are defined as: products used for the preservation of wood, from and including the sawmill stage or wood products by the control of wood-destroying or wood-disfiguring organisms. This product type includes both preventive and curative products. The European Commission includes approved active substances in a list of approved active substances (formerly Annex I of Directive 98/8/EC) keeping the list updated and electronically available to the public[147]. Product type 18 of the biocide regulation is also relevant for wood materials. It includes, instead, insecticides, acaricides and products to control other arthropods. These types of products are used for the control of arthropods like insects, arachnids and crustaceans by means other than repulsion or attraction.

Only biocidal products containing approved and authorised biocidal active substances are allowed for use. Based on those both lists (types 8 and 18), the identification of substances of concern is based on its inherent hazardous properties to environment and human health according to the harmonised classification set up in Annex VI, table 3.1 of CLP regulation. An in-deeper analysis of this kind of products will be carried out in the coming sections.

The major environmental problem associated with the use of biocides is the contamination of soil and drained water from spills and timber after processing. If the wood protection product is accidentally leaked or washed out, it can reach the ground and the surrounding terrain, which may even reach the water underground, which would cause a major environmental problem, since they often are used as source of drinking water for people and animals, as well as for irrigation of farmlands. Similarly, at the product's end of life, the substances present in the timber may prevent the use of waste as material premium in other applications, or generate leachate that contaminates both soil and groundwater.

5.4.2 Paints and varnishes

Paints and varnishes are used in WFCs sector in the production stage protecting the wood and the given them the desired appearance. In general, two types of products can be identified:

- water based surface treatments including acrylic and latex products
- solvent based surface treatments including oil-based , enamel and alkyd products.

Solvent-based surface treatments contain a significantly higher level of organic solvents than water based ones. The main concern therefore is the use of organic solvents, which can evaporate emitting VOCs. Solved-based surface treatments can have various combinations of organic solvents including aliphatics, aromatics, alcohols, ketones and white spirit. These compounds (e.g. toluene, phenol, formaldehyde, xylene, ethylbenzene, methyl methacrylate, butyl methacrylate, heptane, ethyl acetate, etc) are mainly volatile and flammable and mostly often classified according to their effect on human health as harmful if inhaled, irritant to eyes, skin and by inhalation.

[147] Directive 98/8/EC of the European Parliament and the council of 16 February 1998 concerning the placing of biocidal products on the market (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1998L0008:20101130:EN:PDF)

The use of surface treatments without organic solvents can permit maintaining good indoor air quality heaping to improve comfort, welfare and health of building occupants or users of the product, since VOCs are considered as an important factor in the quality indoor air.

Another parameter to be considered is the presence of heavy metals, which can be bioaccumulative and dangerous for the human health. Nowadays, a wide number of surface treatments which are metal free are available in the shelves.

If the surface treatment aims at giving colour to the product, it can content inks. An ink can contain pigments or dyes classified as either natural or synthetic. Natural pigments include various clays, calcium carbonate, mica, silica and talcs. Synthetic would include engineered molecules, calcined clays, blanc fixe, precipitated calcium carbonate and synthetic pyrogenic silicas. Some of them are toxic, such as the lead pigments that are used in lead paints (toxic substances are lead chromate, lead chromate molybdate sulphate red, lead sulfochromate yellow). Pigments and additives based on heavy metals can accumulate in the environment and cause serious damages to ecosystems and human health. One of the largest problems associated with the persistence of heavy metals is the potential for bioaccumulation causing heavier exposure for some organisms than is present in the environment alone. High concentrations of one or more heavy metals in a soil may lead to toxic effects in plants and animals.

5.5 Manufacturing

The processing of WFCs is different depending on the type of WFC to be produced. However, as exposed in Section 4, almost in all types of WFC the main environmental impacts caused in this life cycle stage are due to the energy consumption in the manufacturing stage, especially drying process Generally speaking, there are a certain number of common steps in every production process such as drying and sawing that are considered high energy intensive processes and where most of the harmful emissions take place that are the main focus of this section.

Although there are four types of wooden floorings covered in this study, the energy consumption related to the manufacturing stage could be qualitatively comparable because of the similarities in one or several production steps. For this reason, this section is based on the information summarized in the BREF of wooden panel document. Wooden panels are the core layer of most of the wooden floorings. This document identifies the main environmental impacts during their production as well as the best available techniques (BATs). The implementation of BATs in the production of wooden panels would bring relevant benefits from the environmental point of view.

The main environmental impacts in the production of the laminate floorings are due to the energy consumption and emissions of VOCs. These environmental impacts are of significant importance in the production steps of panels used as core layers of the laminate floorings and in particular steps such as drying and sawing. If this is the case, the implementation of the best available techniques can bring relevant benefits

BREF document for the production of wood-based panels covers the production in industrial installation of one or more of the following wood-based panels: **oriented strand board (OSB)**, **particleboard (PB)** or **fibreboard** (FB) with a production exceeding 600m^3/day. The production process includes the storage of wood raw materials and preparation of wood particles, drying of wood particles and fibres, including refining of fibres, mat forming and pressing and cooling and finish.

The BREF document focuses on the aspects that cause large environmental impacts and the available primary and secondary techniques for the abatement of these identified key environmental issues. The environmental issues identify in the BREF of wood-based panels are: dust emissions, TOC and formaldehyde. If these environmental issues are classified depending on the product to be produced and the production stage where they are located, the production of particleboard, OSB and MDF

caused the emissions of total particulate matter/dust from dryers, consisting of wood dust and condensable organic compounds and emissions of non-condensable natural VOC, including formaldehyde. Emissions from the presses applying high temperature and pressure include VOC, including formaldehyde and low content of wood dust and finally emissions of NO_x from direct dryers. The NO_x is mainly created during the combustion of fuel in the combustion plant.

The production of MDF and all other fibreboard productions accounts for emission of process water with high concentration of COD and TSS and high water consumption and the production sites cause consumption of energy, surface run-off water from outdoor areas, emissions from combustion plants and noise.

The BATs to be applied to the production of wood-based panels are classified depending on the environmental impact addressed. Starting with the techniques to prevent or reduce emission to the air and the water to saving energy measures. Among the BATs considered for preventing or reducing the emissions of air pollutants the following ones should be considered:

a) *primary techniques to prevent dust emission* such as controlled dryer operation, dust abatement by electrostatic precipitator or bag filters on flue-gases, before they are used for direct drying or secondary dust abatement techniques applied to the dryer emissions, particularly wet scrubbing, biofilters, wet electrostatic and high efficiency cyclones;

b) *approaches for controlling TOC emissions from dryers* include appropriate dryer operation and the selection of wood raw materials with low VOC content as primary measures and as secondary abatement techniques applied to the dryer emissions, particularly wet scrubbers and bioscrubbers, which address VOC emissions, but also thermal oxidation or incineration of press waste gases in an on-site combustion plant;

c) for controlling formaldehyde emissions form dryers the four main approaches to be considered are the appropriate dryer operation, the selection of resins with low content of free formaldehyde, the use of formaldehyde scavengers in the resin mix and as secondary abatement techniques the use of biofilters or scrubbers which address formaldehyde and the use of chemical oxidation.

Other techniques that prevent the emissions to the air is the recirculation of waste gases back to the front of the dryer, where the gas is reheated by mixing with the hot gas generated from the combustion plant. This transferred heat from the dryer waste gas to the hot gas improves the overall energy efficiency of the processes, and also the TOC content in the dryer gas is incinerated, thus lowering the total TOC emissions from the dryer. The combined heat and dryer systems that recirculate dryer emissions to the combustion plant or a heat exchanger, treating drying emissions in a close loop and the use of low sulphur fuel or SNCR for NO_x reduction.

The *BATs to prevent or reduce emissions to water* are the minimization of contamination loads in collected waste water streams e.g. by paving the log yard surface and segregating the areas with the storage of wood raw materials from areas with outdoors wood-processing, recirculating of process waste water from wood fibre production and treating the surface run-off water by using sand filters, removal of larger solids, biological treatment and tertiary techniques that can include the removal of settable solids and nitrogen compounds from treated waste water before recycling or discharge. Filtration, biological nitrification and de-nitrification techniques or reverse osmosis that removes residual nitrogen compounds are also considered BATs.

But analysing the production of wood based panels, the *increasing energy efficiency and lowering the overall energy consumption* at the site level is part of the environmental management system. General measures to obtain high energy efficiency and therefore lower environmental impacts are proper design of the installations as well as proper maintenance of the plants within the installation, including processing equipment and related fans, motors and abatement systems.

In the sector, it is especially the energy demanding operations, including drying, pressing and refining, where development of energy efficient solutions have taken place. These measures include the recovery of energy in hot air emissions, combustion control to improve the combustion performance, dewatering of bark and sludge, use of combine heat and power plants and heat recovery from steam during refining.

Additionally, improvement in the flooring design can bring further environmental impact reductions. There are some panels that are assembled without using adhesive resins or chemical binders[148]. These are slabs that are provided by a click system that ensures the adhesion between them without needing any additional glue.

5.6 Packaging

Different materials are used for packaging of WFC products under study. Packaging is usually made of different kinds of plastic and paper or cardboard:

- *Plastic packaging*: Impacts come mainly from energy use in the manufacturing stage and the presence of hazardous substances. Plastic films are used to enveloped the boxes that contain the flooring slabs on wooden panels. The plastic films are usually HDPE films.
- *Paper/cardboard packaging*: Paper and cardboard packaging production involves mechanical, chemical - or a combination of both - pulping to convert raw materials into various paper products. These processes consume large amounts of energy and use natural resources, including trees and water. Certain processing techniques such as bleaching are also known to be environmentally harmful. The environmental impacts associated with the production of paper and cardboard packaging are those reported for the extraction of wood and wood-based materials, the energy consumption and the use of water. Additionally, when paper goes to landfill it produces dangerous greenhouse gases during decomposition.

  As commented, making paper and cardboard packaging from virgin materials requires not just more energy and resources but also chemical pretreatment. Recycling paper and cardboard packaging will contribute to sustainable resource usage and reduce the amount of waste to landfill.

5.7 Hazardous substances and other product related issues

5.7.1 REACH and the methodology for identification and risk assessment for Substances of Very High Concern (SVHC)

The Regulation (EC) 1907/2006, concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals, **REACH**, entered into force in 2007. REACH does not allow placing on the market substances on their own, in mixtures and in certain cases in articles in quantities equal or superior to 1 tonne per year if they have not been registered by every legal entity that manufactures

[148] http://www.matthew-corp.co.uk/default.cfm?l=Uk&IDSection=3&IdSubSection=3

or imports outside the European Union. REACH will be gradually implemented in the European Economic Area (EEA)[149] through a phased approach with a timeline that extends until June 2018.

The Regulation (EC) 1272/2009 on classification, labelling and packaging of substances and mixtures (CLP), is based on the United Nations' Globally Harmonised System (GHS). The CLP Regulation ensures that the hazards of chemicals are properly communicated to workers and consumers in the European Union through classification and labelling of chemicals by 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 of substances and mixtures, classifying them in line with the identified hazards.

The date from which substances classification and labelling must be consistent with CLP was December 2010 and for mixtures will be June 2015. The aim of REACH and CLP is to ensure a high level of protection of human health and the environment from the risks that can be posed by chemicals, as well as promote alternative methods for the assessment of the hazards of substances and ensure the free movement of registered substances along the EEA while enhancing the competitiveness of the EU chemicals industry.

Moreover, REACH and CLP place greater responsibility on industry to manage the risks that chemicals may pose to the health and the environment, as well as to provide sufficient information on the safety of the products that would be communicated through the supply chain. 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. To ensure that they actually meet these obligations, a registration process should require them to submit a dossier jointly containing this information to ECHA[150]. In addition, communication of technical advice to support risk management should be encouraged throughout the supply chain to other professionals such as downstream users or distributors to meet their responsibility in relation to the management of risks arising from the identified uses of substances. They have to demonstrate to ECHA how the substance can be safely used and they must communicate the risk management measures to the users.

Obligations under REACH are determined by the company's role: manufacturer, importer, downstream user or distributor. In the case of substances of very high concern, the authorisation process will ensure the good functioning of the internal market while assuring that their risks are properly controlled and these substances are progressively replaced by suitable alternative substances or technologies where these are economically and technically viable . To this end, all manufacturers and importers shall 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 would consequently be forced to stop their activity.

Certain substances of concern may be subject to controls under the Authorisation process of REACH. The following criteria will be used to identify substances of very high concern:

[149] EAA: European Economic Area
[150] ECHA: European Chemicals Agency based in Helsinki: http://echa.europa.eu/it/home

a) Substances that stay in the environment for a long time, build up in the tissue of animals and cause some form of harmful effect (persistent, bioaccumulative and toxic – PBT) , or those that stay in the environment for a very long time and build up in the tissue of animals very readily (very persistent, very bioaccumulative – vPvB).

b) Those substances which can cause cancer, genetic mutations or cause reproductive problems (these substances will have at least one of the following the following CLP Hazard statements H350, H350i, H340, H360F, H360D, H360FD, H360Df, H360Fd; risk phrases R45, R49, R46, R60, R61.

At this time, there are **155 substances** on the candidate list[151] of substances of very high concern for authorisation. ECHA prioritises the substances from the Candidate List to determine which ones should be included in the Authorisation List (Annex XIV of REACH) and therefore, subject to authorisation. This prioritisation is primarily based on intrinsic properties, volumes and dispersive uses of substances on the EU market. Currently there are a total of **22 substances** subjected to authorization included in Annex XIV[152].

According to EU Ecolabel Regulation EC/66/2010[153], the product or any part of it there of 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. Hazardous substances can be classified through the hazard statements provided in ANNEX II: HAZARDOUS SUBSTANCES STATEMENTS of this report.

The main objective of this section is to identify the areas with the highest environmental impact taking into account the potential minimization or substitution of hazardous substances according to REACH regulation as a basis and paying especial attention to SVHC (Annex XIV) and the candidate list for authorisation. The REACH analysis follows three main phases:

- *Phase 1: Identification of substances and mixtures used in the WFC production processes*

  Analysis of the most common chemical substances present in the products (mainly for surface treatments) and their function has been carried out. A detailed and specific knowledge of the exact function for a particular use will allow looking for other ways of performing that function. This may be done using another substance or technology or by changing the process or end product. This step has partially been completed in the previous section.

- *- Phase 2: Obtaining information on composition (Safety Data Sheets)*

  Information of the characteristics of different products existing on the market has been gathered in order to do a preliminary analysis of the most common substances used. For this analysis, information from literature, as well as a compilation of Safety Data Sheets and stakeholder and trade/sector organisations' knowledge, is collected. Representativeness has

[151] Candidate list of substances of very high concern, available online at: http://echa.europa.eu/web/guest/candidate-list-table – last access July, 2014

[152] Authorisation List, Annex XIV REACH Regulation: http://echa.europa.eu/addressing-chemicals-of-concern/authorisation/recommendation-for-inclusion-in-the-authorisation-list/authorisation-list last access, July 2014

[153] Regulation (EC) N º 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

been taken into account, so that different kinds of wooden flooring products included in the category have been studied.

- *Phase 3: Assessing the risk*

Based on the information provided by the list of harmonized classification according to Annex VI of CLP regulation, ESIS and ECHA[154], a priority list of hazardous substances present on the most common materials as well as used in the wooden floor covering production processes (mainly glues and adhesive), which are determined to pose the most significant potential threat to human health and environment has been prepared. It is important to remember that less dangerous chemicals are not necessarily harmless. Therefore, risk management measures are still needed in many cases.

5.7.2 Identification of substances and material of potential concern in the WFC sector

5.7.2.1 Formaldehyde

a. Functions and uses

Formaldehyde emissions are coming from several raw materials and in several production steps. Among the raw materials that contain formaldeydes are adhesives and resines, surface treatment substances such as paints and varnishes, wood preservatives or glues. Formaldehyde has been classified in different international databases based on its physical, human health and environmental hazards. A summary of this review is shown in Table 38.

Table 38 - Hazard characteristics of formaldehyde

	Properties	**Source of information**
Physical hazards		
Flammability	Conclusive but not sufficient for classification[155]	ECHA registred substances, data dossier formaldehyde (2012)
	Cat 1	GHS classification
Oxidizing	Conclusive but not sufficient for classification	ECHA registred substances, data dossier formaldehyde[156]
Human health hazards		
Highly toxic	Toxic if swallow H301 Toxic in contact with skin H311 Toxic if inhaled H331	SDSC- CLP[157]
Skin or eye corrosion / irritation	Skin Corr 1B	SDSC (2012)
Carcinogenicity	Carc 2	CLP
	Carc Cat 3	ESIS Annex I to Directive 67/548/EEC[158]

[154] Website of the European Chemical Agency regarding substances of concern: http://echa.europa.eu/web/guest/addressing-chemicals-of concern/

[155] "conclusive but not sufficient for classification" means that there is sufficient data to decide that the substance is not classified as hazardous for that particular end point

[156] ECHA ECHA – European Chemicals Agency, Registered substances data dossier(2013). Available at: http://echa.europa.eu/information-on-chemicals/registered-substances

[157] CLP (Classification, Labelling and Packaging of Substances and Mixtures) List of harmonised classification and labelling of hazardous substances, Entry on April, 19, 2011, available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2008R1272:20110419:EN:PDF

	Group 1, 2A or 2B carcinogenous	IARC (2006)[159]
Mutagenicity	Germ cell mutagenicity conclusive but not sufficient for classification	ECHA registred substances, data dossier formaldehyde (2013)
Reproductive toxicity (incl development toxicity)	Conclusive but not sufficient for classification	ECHA registred substances, data dossier formaldehyde (2013)
Resporitory or skin sensitazation	Skin Sens 1	SDSC[160]
Environmental hazards		
Acute/chronic aquatic toxicity	Cat 2	GHS classification[161]
	Toxic to aquatic organism	PAN pesticide Database (2013)[162]
Bioaccumulation	Experiments performed on a variety of fish and shrimp show no bioconcentration of formaldehyde	OECD ChemPortal 2012[163] TURI 2006[164]
Persistence	Not classified	
GHG formation potential	Formaldehyde in the air breaks down in sunlight during the day into CO_2 and formic acid, a component of acid rain	TURI 2006

A key first step in identifying the level of risk and appropriate alternatives is to determine the functions, uses and processes associated with formaldehyde, as potential feasible and safer alternatives are often differ particularly where a substance has numerous disparate applications. Table 39 provides an overview about formaldehyde uses related to the wooden floor coverings.

Table 39 - Overview about formaldehyde uses related to the wooden floor coverings

Life stage	Function

[158] ESIS - European chemical Substances Information System (2013). Available at: http://esis.jrc.ec.europa.eu/
[159] IARC – International Agency for Research on Cancer, Formaldehyde. Monograph, 2006, pp. 401-435. Available at: http://monographs.iarc.fr/ENG/Monographs/vol100F/mono100F-29.pdf
160 Substance Database according to SUBSPORT screening criteria SDSC. Available at: http://www.subsport.eu/listoflists?choice=lname&suchart=fragment&search=all+substances&lists=31&type=listoflists&nr=1
[161] GHS classification
[162] PAN - Pesticide Action Network. Pesticide Database (2013), Available at: http://www.pesticideinfo.org/
[163] OECD, ChemPortal -The Global Portal to Information on Chemical Substances (2012). Available at: http://www.echemportal.org/echemportal/index?pageID=0&request_locale=en
[164] Toxics Use Reduction Institute (TURI), Five chemicals alternative assessment study, Final report, Chapter 4, 2006. Available at: http://pharosproject.net/uploads/files/sources/1214/1348176658.pdf

Production	Binding agent for wood, plywood and chipwood
	Surfacing of panels: laminates and surface coating
Production / installation	Biocide: disinfectant as biocidal product
	Biocide: bactericide, fungicide, preservative as component of paints and varnishes

Formaldehyde is a high volatile gas and is soluble in water, ethanol and diethyleter. It is widely used in the industry (over 3million tonnes in Europe in 2007) and has four basic uses: as an intermediate in the production of formaldehyde based resins, as an intermediate in the production of industrial chemicals and plastics, as a bactericide or fungicide and as a component in the formulation of end-use consumer items such as cosmetics, shampoos and glues.

Among these end uses, the highest consumption of formaldehyde is due to the production of derivative products such as resins. A breakdown of the formaldehyde consumption in 2004 in EU25+Norwey is shown in Table 40.

Table 40 – Breakdown of formaldehyde consumption in 2004 in EU25 countries +Norwey

Derivative products of formaldehyde	EU25+ Norwegian consumption in 2004 (%)
Urea formaldehyde resins UF	55
Melamine formaldehyde resins MF	14
Phenol formaldehyde resins PF	7
Polyacetal resins POM	6
1.4 butanediol BDO	4
Pentaerythritol	3

Urea-, phenol- and melamine formaldehyde resins (UF, PF and MF resins) accounted for about 65% of the world demand in 2011[165]. The overall main use is for the production of urea-formaldehyde resins (UF). UF is widely used in the industry as binding material for particle boards and medium density fibreboard (MDF) and plywood and as components of melamine-phenolic resins for production of laminated flooring board. According to Glopbalinsight UF accounted for 55% (about 5.4 millions tons) of EU25 and Norwegian formaldehyde consumption in 2004[166]

Melamine formaldehyde (MF) has an excellent water and weather resistance, as well as chemical and heat resistance. It is used for the impregnation of paper for surfacing of wood-based panel products (laminate), as wood adhesives where improved water resistance is required and as moulding compound[167]. EU25 consumption and Norwegian accounted for about 1.3million tons in 2004. Phenolic formaldehyde is mainly used in the automotive industry but also in the construction sector as water resistant wood adhesive and binders in mineral wood insulation. Its consumption accounted for about 75000 tons in 2004.

In the WFC sector, formaldehyde emissions during production and end-use are a relevant consequence with negative environmental impacts. Therefore, special attention is focused on the reduction of this type of adhesives as well as on their replacement by more environmentally- friendly as commented previously. However, and althoguh certain types of “green” fibreboard consist of non-added formaldehyde binders have been achieved, there is still no an alternative that can be largely

[165] IHS Chemical Directory of Chemical Producers, Formaldehyde. Chemical Economics Handbook, report, 2012. Available at: http://www.ihs.com/products/chemical/planning/ceh/formaldehyde.aspx

[166] Global Insight, Socio-Economic Benefits of Formaldehyde to the European Union (EU 25) and Norway. Report prepared for FormaCare, 2007, pp. 1-107. Available at: http://www.docstoc.com/docs/37251245/Socio--Economic--Benefits--Study

[167] Pizzi, A., Melamine–Formaldehyde Adhesives, in Handbook of Adhesive Technology, Marcel Dekker, New York, chapter 32, 2006. available at: http://203.158.253.140/media/e-Book/Engineer/Material/Handbook%20of%20Adhesive%20Technology/DK2131_Ch32.pdf

applied. Although containing formaldehyde, phenol-formaldehyde (PF) resins are more durable and do not emit formaldehyde after cure. However, they have a much higher cost and slower curing rate than UF resins, parameters that currently have been solved by manipulating the fiber temperatures, molecular weight distribution of PF resins and pressing parameters. As a result, the press times for PF-bonded fibreboard can be comparable to those for UF-bonded fibreboard and as advantage the resin content required for PF (less than 5%) is considerably lower than that required for UF. This alternative can be considered when manufacturing the panels.

b. Exposure to formaldehyde

Humans may be exposed to formaldehyde in the environment and in the workplace. Formaldehyde concentrations in the environment generally are reported in ppb, but exposure levels are much higher in the workplace occurring in the range of ppm. Manufacture of resins and wood-based products are among the sectors with the highest exposure of workers to this chemical. For this reason substitution of formaldehyde for these applications can be beneficial.

c. Regulations and standards

As commented before the Agency for Research on Cancer (IARC) changed its classification of formaldehyde from a group 2A substance "probably carcinogenic to humans" to group 1 "carcinogenic to humans" in 2004. The main source of formaldehyde emission general population is from breathing indoor caused by different sources including off-gassing from numerous construction products such as flooring. Concerns relating to formaldehyde exposure have therefore advanced the research for alternative resins and wood binders that do not contain formaldehyde.

The European Union has developed a strategic policy for protection of workers against risks from dangerous substances, defining two different OELS: indicative OELs and binding OELs. For the time being, there are no OELs for formaldehyde but the European Union Scientific Committee on Occupational Exposure Limit Values (SCOEL) proposed in 2008 a mandated 8h limit of 0.2ppm and short term exposure limit (STEL) of 0.4 ppm. They regard formaldehyde as a genotoxic carcinogenic.

OELS in the EU Member States are set by competent national authorities or other relevant national institutions as limits for concentrations of hazardous compounds in workplace air. They differ between the Member States depending on the assessment methods and on the actual risks of the chemicals themselves. This makes impossible the direct comparison between the national limits.

c.1) Regulation and standards for formaldehyde for composite wood products

Acceptable levels for formaldehyde emission from composite wood products have been continuously reduced over the last years. In 2004, Europe established the emission classes E1 and E2 (EN 13986) regarding wood products used in construction, in 2006 emissions class E1 became obligatory for panel production.

There are two main methods to measure formaldehyde emissions from wooden panels: the chamber method standardized in EN 717-1 and the performator method standardized by EN 120. A direct comparison of the values is not possible due to the different units involved. Differences in the test variables are shown in Table 40.

Table 41 Comparison of different tests/limits for formaldehyde emission from wood-based panels.

Method (type)	Test sample	Test conditions		Limit values
	Loading factor	Temp / RH	Air exchange rate / hour	
EN 717-1 (chamber)	1 m^2/m^3	23°C / 45%	1	≤ 0.124mg/m^2h*

EN 120 (perforator)	25x25mm pieces adding up to 500g	Toluene extraction at 110°C	N/A	≤ 8mg/100g dry board*

*maximum limits for E1 class panels in the EU as per EN 13986.

As can be seen from the above table, there are many variables that will affect the formaldehyde release rates. Some common factors to take into account when attempting to compare values are:

- The aim of the test. Chamber tests are less aggressive and aim to mimic natural environments and last up to 28 days whereas shorter and more aggressive tests are generally used for factory production control. The values in the Table 42 for EN 717-1 and EN 120 have been generally accepted as being equivalent to the same standard (E1).
- Higher temperature means higher formaldehyde release rates.
- Higher humidity generally means higher formaldehyde release rates.
- Higher air exchange rates will mean higher total formaldehyde extraction but possibly lower final formaldehyde "steady state" concentrations at the end of the test.
- When edges are to be fully or partly sealed, this can greatly reduce the total quantity of formaldehyde released in a given sample.

Sample conditioning prior to the test will result in lower emission rates and results.

The previous Ecolabel criteria for wooden flooring required the ambitious limit of 50% of E1. Some industry stakeholders criticised this requirement as too ambitious. But, on the other hand, stakeholders in support of the 50% E1 limit point to the similarly ambitious F-star (Japanese label) and CARB(Californian label) requirements and also point out that 6 EU Member States (Austria, Czech Republic, Denmark, Germany, Italy and Sweden) have regulations that only allow the use of panels that are E1 or better.

Different limits are set for different types of wood-based panel, the highest limit being for MDF. This approach is followed in several schemes, e.g. Nordic Swan criteria where, according to EN 717-1 tests, all panels are required to meet 56% (0.07 mg m-3) of E1 except for MDF, which only needs to meet the E1 requirement (0.124 mg m-3). Alternatively, Nordic Swan compliance can be demonstrated by the EN 120 method, where all panels must meet 50% of the E1 requirement (4 mg/ 100g dry board) except for MDF where up to 62.5% of E1 the limit (5 mg/ 100g dry board) is permitted. This is based on difficulties expressed by the industry in producing certain wood-based panels such as particleboard and fibreboard that use urea-formaldehyde (UF) resin

5.7.2.2 VOCs

a. Functions and uses

Emission of VOCs is also one of the environmental impacts of WFC products. VOCs are organic chemicals that easily pass to the gas state. They include a wide variety of compounds, including aldehydes, ketones and other light hydrocarbons. Among others, the VOCs are released by paints, adhesives and solvents used in the manufacture of wooden flooring. Solvent-based paints can have various combinations of organic solvents including aliphatics, aromatics, alcohols, ketones and white spirit. Specific examples of organic solvents are petroleum distillates, esters and glycol ethers. These compounds (e.g toluene, phenol, xylene, ethylbenzene, methyl methacrylate, butyl methacrylate, heptane, ethyl acetate, etc.) are mainly volatile and flammable and mostly often classified according to their effect on human health as harmful if inhaled, irritant to eyes, skin and by inhalation.

VOCs are considered as an important factor in the quality of indoor air. Some of them, such as methane, are also greenhouse gases, and others may react to form ozone in the troposphere, which can cause breathing problems. In addition, many VOCs are hazardous for human health. Thus, the reduction of VOC emissions from wood can lead to significant benefits. The main hazards related to VOCs are summarized in Table 42.

Table 42 - Hazard characteristics of VOC

	Properties	Source of information
Physical hazards		
Flammability	Highly inflammable	EPA[168]
Human health hazards		
Effects on humans and animals	Eye, nose, and throat irritation; headaches, loss of coordination, nausea; damage to liver, kidney, and central nervous system. Some organics can cause cancer in animals; some are suspected or known to cause cancer in humans. Key signs or symptoms associated with exposure to VOCs include conjunctival irritation, nose and throat discomfort, headache, allergic skin reaction, dyspnea, declines in serum cholinesterase levels, nausea, emesis, epistaxis, fatigue, dizziness.	EPA[169]
Risk phrases associated	R45 (H350 May cause cancer)	Guidance on the Solvent Emissions Regulations[170]
	R46 (H341 Suspected of causing genetic defects)	
	R49 (H350i May cause cancer by inhalation)	
	R60 (H360F May damage fertility)	
	R61 (H360FD May damage fertility. May damage the unborn child)	
	R40 (H351 Suspected of causing cancer)	
Environmental hazards		
Acute/chronic aquatic toxicity	VOC have harmful environmental effects (crop, vegetation and materials damage) and being bioaccumulated.	
GHG formation potential	They chemically interact with oxides of nitrogen and sunlight to form ground-level ozone, contributing to the depletion of ozone layer.	

c. Regulations and standards

c.1) Regulation and standards for VOC in wood products

The method most commonly attributed to VOC emission testing is the ISO 16000 series of standards. Due to the lack of large chamber facilities in many areas of Europe, it is relevant to assess whether or not existing chambers that are set up for formaldehyde emission testing according to EN 717-1 may also be suitable for the ISO 16000 test. It has been commented that although EN 717-1 chambers can be constructed of plastics that have been shown to not absorb formaldehyde, if the same plastics were to be used in VOC emission tests, they may selectively absorb certain VOCs and invalidate test results. Also it must be commented that some technical aspects of the procedure defined in ISO 16000 lack certain details that result in a relatively poor level of reproducibility. Consequently, under the remit of the Construction Products Regulation (305/2011), and more specifically EC Mandate 366, a working group is defining a new technical standard (CEN/TS 16516) which modifies the ISO 16000 approach in such a manner as to improve reproducibility between tests and testing institutions.

[168] EPA: http://www.epa.gov/iaq/voc.html#Health_Effects
[169] EPA: http://www.epa.gov/iaq/voc.html#Health_Effects
[170] http://www.scotland.gov.uk/Publications/2004/06/19563/39634

Table 43 -Comparison of test parameters for different VOC emission methods

	Draft CEN/TS 16516	ISO 16000-9	EN 717-1
Material scope	Construction products	Various	Wood-based panels
Temp. °C (Range)	23 (± 1)	23 (± 2)	23 (± 0.5)
Rel. humidity % (Range)	50 (± 5)	50 (± 5)	45 (± 3)
Ventilation rate*	0.5	0.5	1.0
Range	0.25 – 1.5	Unlimited***	± 0.05
Loading factor m^2/m^3	See below	See below	1.0
Flooring	0.4	0.4	-
Walls	1.0	1.4	-
Small surfaces	0.05	-	-
V. small surfaces	0.007	0.011	-
Range	± 50%	Unlimited***	± 0.02
Air velocity**	0.1 – 0.3	0.1 – 0.3	0.1 – 0.3
Chamber size	>20 L	not specified	225 L, $1m^3$ or $12m^3$
Chamber material	SS or glass	SS or glass	SS, glass, Al, PVC, PMMA..

*ventilation rate (air change rate) the volumetric flow rate (m^3/h) divided by chamber volume (m^3).

**air velocity at the surface of test specimens (m/s)

***unlimited, so long as the ratio between the loading factor and ventilation rate is kept constant

The draft CEN/TS 16516 standard attempts to clarify a number of areas of uncertainty or compromise between different parameters used in EN 717-1 and ISO 16000. The proposed standard does not specify limits for VOCs, only the test procedure to be used so that the product groups can be labelled with the CE marking. It is unlikely that limits for VOCs would be made on the product group since this would represent a potential barrier to free-trade. Instead, Member States are likely to simply require that the data be made available, which could perhaps then be linked to a national labelling scheme. Individual Member State regulations exist already or are being considered in France[171], Germany[172] and Belgium[173]. The EU ecolabel in this respect is simply another labelling scheme.

The EU approach has been strongly influenced by the previous work carried out by the ANSES and AgBB institutions in France and Germany respectively. Report No. 29 of the European Collaborative Action on "Urban Air, indoor environment and human exposure"[174], published recently by the JRC in 2013, attempts to compile a list of substances whose emission in indoor air environments may cause adverse effects on humans and sets out a framework for agreeing on such substances and their acceptable limits. It describes the LCI[175] concept and how these values have been assigned to a number of priority substances.

[171] Decret no 2011-321 du 23 mars 2011 relatif a l'étiquetage des produits de construction ou de revetement de mur ou de sol et des peintures et vernis sur leurs émissions de polluants volatils (in French).

[172] Evaluation procedure for VOCs from building products. Ed. AgBB, Committee for Health-related Evaluation of Building Products. Berlin 2012.

[173] Draft Royal Decree establishing threshold levels for the emissions to the indoor environment from construction products for certain intended uses. Notified to the European Commission: 2012/568/b.

[174] Titled "Harmonisation framework for health based evaluation of indoor emissions from construction products in the EU using the EU-LCI concept".

[175] LCI = Lowest Concentration of Interest (of individual VOCs). The LCI concept was first developed by the European Collaborative Action on 'Indoor Air Quality and its Impact on Man' when considering the best way to evaluate emissions

The report states that a total of 177 VOCs of interest have been identified, 82 of which already have interim EU-LCI values assigned and 95 of which have yet to be assigned a value. The list of 82 substances can be found in Annex IV of this document. So far the integrated EU approach has yet to tackle VVOCs and SVOCs.

Comparing the list of 35 VOCs with defined CRELs in the US and the EU-LCI list of 82 VOCs, it is surprising that there is very little overlap in the compounds of interest. In total, only 6 compounds have defined limits in both databases. These are given in the table below.

Table 44 VOCs with emission limits defined under different systems

No.	Compound Name	CAS No.	CREL	EU-LCI	ANSES	AgBB
			($\mu g/m^3$)			
1	Acetaldehyde	75-07-0	140	1200	200	--
7	Dichlorobenzene (1,4-)	106-46-7	800	150	60	--
12	Ethylbenzene	100-41-4	2000	850	750	880
28	Styrene	100-42-5	900	250	250	860
30	Toluene	108-88-3	300	2900	300	1900
33	Xylenes, (m-, o-, p-xylene combined)	108-38-3, 95-47-6, 106-42-3	700	500	200	2200

Another factor to consider is the contribution of emissions from one particular product towards reaching the CREL or LCI values. In reality, any product will contain multiple potential sources of VOC emissions.

5.7.2.3 Pesticides

a. Functions and uses

Solid wood, after logging, shall not be treated with substances or preparations containing substances that are included in any of the following lists:

- WHO recommended classification of pesticides by hazard classified as class 1a (extremely hazardous)[176]
- WHO recommended classification of pesticides by hazard classified as class 1b (highly hazardous)

from solid flooring materials. It was defined (see ECA Report No.18, 1997) as "the lowest concentration above which, according to best professional judgement, the pollutant may have some effect on people in the indoor environment".

[176] The WHO recommended classification of pesticides by hazard and guidelines to classification, available at http://www.inchem.org/documents/pds/pdsother/class_2009.pdf

Annex 11 includes the list of ingredients in pesticides classified as 1a or 1b by WHO. In addition to the above mentioned lists. The following list (Table 45) of compounds is proposed to be banned as pesticides. Most of them fall into the any or several of the R-phases and thus they are excluded to be used as ingredients of the impregnation wood preservatives.

Table 45 - Hazardous properties of mostly compounds in pesticides

Compound	CAS no	Classification
Aldrin	309-00-2	R24/25-48/24/25 Carc. Cat. 3; R40 R50-53
Chlordane	57-74-9	Carc. Cat. 3; R40 Xn; R21/22 N; R50-53
DDT (dichlorodiphenyltrichloroethane)	50-29-3	T; R25-48/25 Carc. Cat. 3; R40 N; R50-53
endrin[177]	72-20-8	T+; R28 T; R24 N; R50-53
alpha-HCH (hexachlorocyclohexane)	319-84-6	
beta-HCH (hexachlorocyclohexane)	319-85-7	
delta-HCH (hexachlorocyclohexane)	319-86-8	
heptachlor	76-44-8	T; R24/25 Carc. Cat. 3; R40 R33 N; R50-53
hexachlorobenzene	118-74-1	Carc. Cat. 2; R45 T; R48/25 N; R50-53
cyfluthrin	68359-37-5	T+; R26/28 N; R50-53

c. Regulations and standards

Only pentachlorophenol is included in the list of highly hazardous ingredients of pesticides, but this chemical compound was formerly banned in 1987 due to its human carcinogenus properties.

On the other hand, the second part of the criteria includes two lists of substances banned by the Directive 79/117/EEC on prohibiting the placing on the market and use of plant protection products containing certain active substances and Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations. These lists of criteria ban the use of mercury compounds, organo-chlorine compounds and other hazardous listed compounds that have been for long phased out of the European market.

5.8 Conclusions from the technical analysis going into the environmental aspects

This section was developed following the different life stages of the wooden floor coverings: raw materials, manufacturing, use phase and disposal. In addition especial attention was paid to the use of substances of concerns that can be used in the products or release from it and represent a harm for the health of the end users or the environment

The environmental impacts due to the use of raw materials are mainly caused by harvesting of wood and plant based materials, the production of resins, adhesives and other chemicals. These impacts include the loss of biodiversity and land uses and the emissions of pollutants from the chemicals.

Regarding the harvesting of wood and plant-based materials, impacts can be reduced is the legality of the materials is ensured but even more important is to ensure that those materials are coming

[177] 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalene

from sustainable managed forests. Sustainable management forests are those that are run in agreement with the sustainable criteria defined in EU Forestry and that are summarized in Annex III.

The impacts caused by the use of natural resources can also be decreased if they are replaced by recycled materials. Reuse, recycling and revalorization of wooden floorings have several environmental benefits regarding the non-depletion of natural resources, the storage of CO_2 in those materials or the minimization of waste streams coming from forestry, timber production and wood product waste. However, in order to ensure the quality of the products, several quality standards should be regarded. These standards limit the amount of contaminants in the recycled wood as well as other dangerous substances such as impregnation substances or preservatives.

A large research was carried out concerning the use and possible alternatives of adhesives and resins as well as chemicals used in the surface treatment. Due to the changes in the wooden flooring sector, wooden flooring with higher amount of adhesives became more important. Mostly used adhesives in the wooden flooring sector are solvent-borne based on formaldehyde. This means that they are potential emitters of formaldehydes and VOCs. Similarly, chemicals and chemical products used for the surface treatment are also mostly solvent-borne becoming potential pollutant emitters during the manufacturing and use phases of the products.

Alternatives are currently available on the market although their technical performance and/or their environmental performance do not completely fulfil the requirements. For this reason, other techniques such as mixtures of solvents, efficient application techniques or alternative technologies have been investigated too.

Manufacturing of the wooden flooring involves large energy consumption. Although the production process of the wooden flooring are different some similarities arisen. Keeping this in mind, it was possible to identify several best available technologies to be used that can significantly reduce the energy consumption during this stage. The development of energy efficient solutions such as recovery of energy in hot air emissions, combustion control to improve the combustion performance, dewatering of bark and sludge, use of a combine heat and power plants and heat recovery from steam during refinery will remarkably reduce the total energy bill. Other techniques are the implementation of an energy management plan, a proper design of the installations as well as a proper maintenance of the processing equipment (fans, motors, kiln, etc).

Finally, attention was paid to the release of dangerous substances during the use phase. Two related air pollutants were investigated in detail: formaldehyde and volatile organic compounds. The function and uses, classification as risk or hazardous substances, exposure patterns and regulations and standards were investigated in detail.

In brief differences were found in the multiple standards used at national and international level to measure the release of these pollutants. These differences make difficult a direct comparison among the schemes and regulations. However, two main methods EN 717-1 and EN 120 were identified for measuring formaldehyde and the standard ISO 16000 series for measuring VOCs. Comparing the ambition level of the schemes for formaldehyde emissions, the strictest ones proposed 50% of the E1 level for all kind of panels with the except of MDF panels. This exemption is based on production requirements. The strictness levels for VOCs emissions set a limit of 0.169 mg/m^3 after 28 days.

This information together with the information collected and analysed in previous sections has been used to draft the new EU Ecolabel criteria for Wooden Floor Covering in this revision. Further information about how this transition has been performed can be found in Appendix I – Towards the European Ecolabel criteria for Wooden Floor Coverings.

6 IMPROVEMENT POTENTIAL

6.1 Background – Key environmental issues of wooden floor coverings

Based on the environmental hot spots identified in the previous tasks, in this task the environmental potential of the product group is analysed and prioritised. This includes best available standards or technologies (BATs) already available on the market, a comparison of requirements on certain issues as specified in other Ecolabels, as well as challenges linked to some the o the criteria revisions.

A series of issues of relevance for the criteria development and revision were identified, based on stakeholder consultation, on market and legislation analyses and on the LCA information gathered along the project and described above. Issues have been grouped by thematic area.

The technical analysis of LCA studies on WFCs revealed that the production phase has the highest environmental impacts, being due to the energy consumption and the harvest of the wood and plant-based materials.

The following Figure provides an overview how the key environmental issues of wooden floor coverings are covered by the EU Ecolabel criteria representing potential areas for improvement which will be further revised in the accompanying documents (Technical Report for the revision of the EU Ecolabel criteria for Wooden Floor Covering).

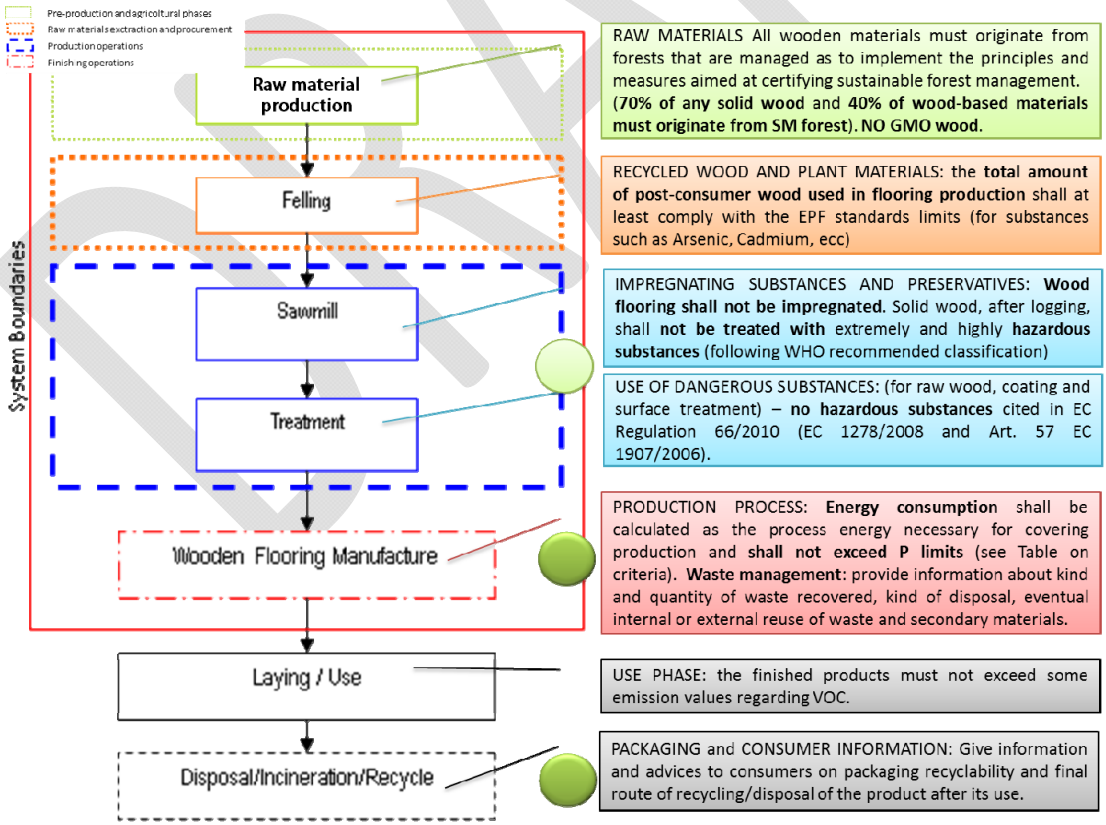


Figure xx

6.2 Manufacture process

Manufacture of the product to the customers is source of environmental concern. Three points are identified as potential improvement areas and further addressed within this discussion:

1. Improving the energy performance of manufacture
2. Promoting best industrial practices
3. Requiring EMS and CSR for the production site

6.2.1 Improving the energy performance of manufacture

In section 4, it was shown that energy used for manufacture contributes to shape the environmental profile of all kinds of wooden floor coverings included in this study. Based on data published in the literature, it was considered that energy consumption can range significantly as well as the associated emissions. But in general, wooden floor coverings (based on wooden based panels) is an intensive energy sector where the best available technologies (BATs) have been identified at EU level to reduce the energy consumption and the environmental damages associated with. Drying the wood is the most energy consuming process step being followed by the sawing and milling. Both demands can be reduced, for example, by using air-drying or waste materials for on-site energy production.

The last revision of Nordic Swam criteria provides background information on the energy consumption for the manufacture of floor coverings on the current market, being focused on the Nordic countries. Even if this sample of data cannot be considered statistically representative for the market, it however highlights the potential importance of this issue. This study also shows the improvements on the energy performance of the sector in the recent past and points out the need of updating the calculation method.

Additionally, the revision of the Nordic Swam criterion recognizes the important contribution of the use of renewable energy sources in the manufacturing process to contribute to the reduction of the overall environmental impact of this stage. In this sense, in the new proposed calculation method, equally weights the contributions of the energy consumption and the use of renewable energy sources. In this sense, the less energy is used during the manufacture or the higher the proportion of renewable fuels is introduced, the easier is to comply with the revised criterion.

6.2.2 Promoting best industrial practices

Introducing criteria for promoting best practices for manufacturing and transport of wooden floor covering would have the potential to produce direct benefits, as pointed out from the LCA information collected in section 4.

The BREF on wooden-based panels' document identified this industrial sector as an energy intensive sector where the implementation of best available technologies that can reduce the energy consumption as well as associated emissions will bring environmental benefits. A list of the kind of measures described in this document and of relevance for this study can be found in section 4.

One potential measure to be taken in order to promote the best industrial practices is the development of a clear and sound environmental policy for the production site. This report shall include the scores of the indicators chosen to monitor the improvement achieved by the company with its optimization measures. However, and according to the stakeholders' feedback in other similar projects, they generally doubt that it would be realistic and possible to introduce such a criterion. For instance, it was reported that:

- Such a prescription would impose additional burdens to manufacturers;
- Logistics practices are very complex and different;

- This issue was never introduced before and it would be difficult to be handled and verified;
- Ambitious levels should be defined quantitatively.

6.2.3 Requiring environmental management systems (EMS) for the production site

Based on the information and on feedback collected, demonstrating the responsibility of the wooden floor covering producers on environmental issues requires the development and implementation of environmental management systems for the production facility. Environmental management systems (e.g. EMAS or ISO 14001) will set up the goals and measures to be taken at present and in the future to improve the environmental performance of the manufacturing site.

Therefore a new criterion is proposed for developing and implementing at least an energy management program that helps reducing both the overall energy demand of the production site as well as the emissions. However, it is not overall agree that this program shall fulfil specific requirements e.g. being certified. This is apparently due to the number of SMEs involved, which do not have time or resources to be certified.

6.3 Extraction of raw materials

The review of the selected LCA studies and EPDs allowed identifying the sources of the impacts. Environmental impacts of WFC are secondly mostly associated to the extraction of the raw materials.

The **extraction of the raw materials** causes impacts that are difficult to evaluate as they are due to the land use change and loss of biodiversity. The environmental impacts from the production of **binders, resins, paints and varnishes** is also remarkable as well as the use and emissions of substances in the finishing processes. For instance, significant levels of toxicity can be associated to the used of some resins as well as a significant contribution to POCP can also result from some finishing processes, use of solvent based on xylenes and emissions from paints and varnishes, fillers and diluents. In order to decrease these impacts, attention to possible feasible alternatives and techniques to reduce the emissions can be implemented.

6.3.1 Wood and plant-based raw materials

The extraction of raw materials, especially those considered as forest based materials is source of concern due to the difficulties to assess and evaluate the environmental impacts caused. Two points are identified as potential improvement areas and further addressed within this discussion:

1. Ensuring the legality and sustainably sourced wood and plant-based materials use
2. Promoting recyclability of the wood and plant-based materials

Ensuring legal and sustainably sourced wood and plant-based materials use

The recent entering into force of the EU Forestry Regulation ensures that all the wood and plant-based materials put into place in the European market are coming from legal sources. This measure is the first step to promote a sustainable use of the natural resources.

Although there is a general agreement on the aim of this criterion, the wording and especially the verification are considered a key issue. Tracking the wood and plant-based materials use for the production of the wooden floorings could be an arduous process, particularly if materials are mixed coming from different sources (forest) and would either require large autocracy if the complete tracing of supply chains is required. In addition, it is not easy to decide the most appropriate way of

verifying conformity with this criteria, as this could either be achieved through a third party verification and/or to a self-declaration.

With this respect, reference to well-know and recognized systems is generally provided by the stakeholders. FSC and PEFC systems are those with the largest certification areas in Europe and world-wide. However, they are not exactly equivalent and the compliance with the requirements of one system does not allow awarding the other system. In addition, both schemes hold different labels that confirm the compliance with different requirements.

Promoting recyclability of the wood and plant-based materials

The recyclability of floorings can be prevented depending on the chemicals used and in particular the wood preservatives the wood can be impregnated with. Moreover, chemicals are difficult to remove during the end-of-life of flooring restricting the recyclability of those materials into new products. Industry pointed out that recycled wood should comply with certain quality standards to ensure the quality of the final product.

European industry developed serie of standards to ensure the quality of the recycled wood and prevent possible issues during the production of new wooden floorings. These standards are still updated.

6.4 Restrictions to use hazardous substances

Recent changes to the EU Ecolabel legislation (EC/66/2010) have placed further restrictions on the use of hazardous materials and substances. Hazardous materials and substances can be classified through hazard statements/risk phrases (provided in Appendix II). These substances, if present above a certain concentration threshold, must not be contained in the final product. Derogations of specific substances are allowable in exceptional circumstances where inclusion would prevent take up of the EU Ecolabel or shift the environmental burden to other life cycle phases or impacts (Article 6(7) of the EU Ecolabel regulation).

The restrictions on hazardous substances and materials in the new EU Ecolabel regulation will require the addition of a horizontal ban of substances based on risk phrases/hazard statements, with derogations made under exception circumstances to specifically handle these requirements. Five main areas of discussion are presented below:

i. Appropriateness and robustness of a horizontal approach to limit the content of hazardous substances based on Hazard Statements/Risk Phrases.
ii. Setting thresholds for substances.
iii. How to identify substances which need to be derogated and what information is require
iv. Amalgamation of existing/other criteria with this new criterion.

Appropriateness and robustness of a horizontal approach to limit the content of hazardous substances based on Hazard Statements/Risk Phrases.

In general, in other project stakeholders accepted that this general approach was required, most agreeing that a ban of specific properties was a sensible approach. However, not-homogeneous feedback is generally received on the way in which the existing criteria should be incorporated into this general ban.

Verification is generally perceived as a key issue. For instance, ensuring all substances in floorings do not carry any of the hazard statements associated with them could be difficult. This could be an arduous process, particularly as the list of phrases is long, and would either require large amounts of testing procedures or complete tracing of supply chains. In addition, there was uncertainty over the most appropriate way of verifying conformity with this criteria, as this could either be achieved through a third party verification and/or to a self-declaration listing all substances and their hazard

statements. With this respect, reference should be made to the list of registered substances under the REACH regulation scheme, available at:

http://echa.europa.eu/information-on-chemicals/registered-substances

Setting thresholds for substances.

The current EU Ecolabel approach to substances classified as hazardous according to the CLP regulation is to refer to the specific and generic concentrations reported in this piece of regulation. For SVHC as defined in the REACH regulation, the reference concentration is 0.1 % wt. It was noted that trace quantities of substances which meet the requirements for classification with the H statements/R phrases in Annex II are likely to be present in floorings. For example, biocides used in wood preservation may not be completely removed by processing, so may be present in very low concentrations.

The 0.1 % wt of the final product could allow the presence of significant amounts of substances. Therefore, it may be appropriate to refer to homogeneous parts of the final product, where the particular hazardous substance is found. In other relevant projects for this study, industry reported that lower concentration limits would be impossible to be respected because the 0.1% concentration threshold of REACH is already a challenging burden. However, risk assessments are already provided in REACH Dossiers which ensure that the use of certain substances is safe.

Further points of discussion with stakeholders included:

- Concentration thresholds should be based on the evaluation of actual human health and environmental impacts for each substance.
- Impurities may be contained in the final materials used which may require separate specifications for some substances.
- Classification of hazardous substances depends on data available from manufacturers, which may not be complete. Reference to REACH Dossiers was suggested.

Derogation of substances

Whilst substances are banned based on their hazard statements / risk phrases, derogations may be made for some substances (provided they are not listed as SVCH). Stakeholders will be asked to provide an indication of substances and materials for which derogations may be taken into consideration within the wooden floor covering group.

A request for derogation could be examined properly only if supporting robust information is given to demonstrate that:

i. The use of the substance/material is significantly widespread within the product group

ii. Inherently safer and more environmentally friendly options are not technically possible at the moment.

With respect to substances that cannot be derogated, it was agreed in other relevant projects, that the SVHC list is the most appropriate reference, though a longer but less stable list of substances could be identified which comply with article 57 of the REACH regulation. Moreover, it was indicated that introducing too strict criteria could have a detrimental impact on the number of applications for the EU Ecolabel

Impact on existing criteria

This horizontal criterion could be used to replace some of the existing criteria on hazardous substances, bringing biocides, plasticizers and other substances under a single criterion. This would have the benefit of simplifying the criteria document, although it may make it more difficult to distinguish between different uses and properties of substances. Stakeholders feedback on the possibility of absorbed existing criteria within this horizontal criterion for hazardous substances and for which specific uses/properties should be rather be handled separately will be collected.

6.5 Fitness for use

6.5.1 Ensuring an appropriate duration and maintenance

The environmental profile of wooden floorings is determined by a balance between the materials and resources used to produce it and its lifespan. The impacts of the manufacturing phase (including the extraction of the materials) can be directly reduced by ensuring the sustainable sourced of the raw materials and increase energy efficiency and/or wider use of renewable energy sources or indirectly by extending the lifetime. Therefore, at least theoretically, an extension of the lifespan of flooring would reduce the impacts of the product. Nevertheless, this would require increasing the amount and the quality of materials, which could offset the benefits due to an extended lifespan.

This aspect became of higher relevance due to the transformation of the market conditions in the last years. The market analysis of this study indicated that the replacement cycle for wooden floorings depends on the type of floors. Laminates are estimated to have an average lifetime shorter than 20 years while solid wood floorings are over 20 years. Due to the fact that EU market is shifting towards laminate flooring compared to the previous market conditions where solid wood floorings were dominating the market, the current trend generates and increasing overall environmental impacts, larger depletion of the resources and an increasing amount of waste as well.

Based on the information gathered along the project this action could be addressed in the present revision by informing consumers on the correct use and maintenance of the product.

6.5.2 Ensuring an appropriate quality

The quality of floorings is perceived as one important factor to improve the overall environmental performance of wooden flooring and the attractiveness of the EU Ecolabel. A good quality product should indeed ensure that product is not replaced prematurely in maintenance is correctly performed. Therefore, this aspect is closely related to the previous one.

The current EU Ecolabel criteria require products to be tested for quality against international standards. However, benchmarks are not set up depending on the intended use of the flooring. this issue is proposed to be amended in the revised EU Ecolabel criteria.

6.6 Packaging

As apparent from Section 4, the contribution to the packaging to the environmental impacts of the product is marginal. Based on this outcome it is proposed to remove the prescription on the use of recycled plastics and other materials for primary and secondary packaging.

6.7 End-of-life

The technical analysis of LCA studies also reveals as a possible improvement potential that the environmental impacts of the manufacturing phase of wooden floor coverings can be reduced, if the end-of-life treatment is performed in accordance with a sound management, since the secondary resources from recycling can avoid primary production and especially reduced the amount of wood and plant-based materials that should be harvested.

The most common disposal route for end-of-life for wooden flooring appears to be landfill or incineration. Construction materials in general account for a large proportion of the total waste sent

to landfill and this represents a large quantity of material which is not recovered. This aspect is recognized by the European legislation and for example, the EU Waste Framework Directive highlights the need to alter disposal routes, favouring prevention of waste, reuse, recycling and energy recovery over sending to landfill. More specifically, the EU Landfill Directive targets the reduction volume of waste sent to landfill and increasing recycling rates.

Various recycling schemes have been identified, although this practice does not appear to be widespread. The recycling process for wooden flooring is not generally sophisticated, but the content of wood preservatives and other hazardous substances can prevent it. Therefore, processing end-of-life wooden flooring can be complicated by the different chemicals that could have been used. This also provides uncertainty over the value and quality of the recycled materials available in the flooring. On the other hand, achieving high rates of recycled wood in floorings ensure that the CO_2 storage in these materials is not released and contributes to the prevention of the climate change.

It is clear that flooring disposal is an issue of significant concern; however, this is generally an end-of-life issue and therefore outside the direct control of the flooring producers. This makes influencing these practices through the EU Ecolabel scheme difficult unless producers incorporate some form of extended producer responsibility. Other ways of encouraging alternative disposal could be explored, such as:

- Providing information on best practices of final disposal to consumers,
- Listing the chemicals and chemical products used for the benefit of recyclers,
- Implementing eco-design principles for more efficient use of resources and recycling after use,
- Limiting the quantity of materials used,
- Using recycled materials,
- Assigning a bonus if old wooden floorings are given back to the producer. But this approach requires a waste management system in place in the production site.

Moreover, durability and quality of floorings are other factors which have an indirect effect on the end of life impact of mattresses. Stricter requirements for these parameters could be another option to be explored.

Stakeholders are kindly invited to provide their feedback on the actions they consider more feasible within this scheme.

Another action which could produce potential benefits for the environment could be focusing on the design of the wooden flooring in order to improve:

- The possibility and ease of repair;
- The ease of disassembly to facilitate sorting and allow the best treatment of the material.

These factors are taken into account during the design of the product. It could be asked to applicants to provide a report in which they demonstrate that a preliminary design study was performed in order to improve the maintenance and disassembling of the flooring. However, this aspect does not seem relevant due to the simplicity of the product.

6.8 Conclusions

	Environmental impact	Potential env gain	Good environmental practices/restrictions	Improvement potential
Extraction/production of raw materials	Wood production and extraction cause secondly ranked environmental impacts. The production of binders, resins, paints and varnishes is also remarkable. The impact of this phase is about |45%| of the overall environmental burden.	High	Use of exclusively wood/wood products coming from legal sources. Reduce the use of materials that have high environment impacts by substituting them. Restrictions/substitution of hazardous substances.	Ensuring legality and sustainability of sourced wood and plant-based materials. Promoting recyclability of the wood and plant-based materials. Concentration thresholds of the hazardous substances could be based on the evaluation of actual human health and environmental impact risks.
Manufacture process	Energy used for manufacture is around 35% of the overall environmental impact for each kind of wooden floor coverings. Wood drying is the most energy consuming process step being followed by sawing and milling	High	Improving the energy performance of manufacture by: - Promoting best industrial practices. - Requiring environmental management systems. - Increasing renewable energy sources.	Reducing both the overall energy demand of the production site as well as the emissions.
Fitness for use	The environmental profile is determined by a balance between the use of materials and resources during production and product's lifespan.	Medium	Ensuring an appropriate duration and maintenance to reduce the environmental burden. Optimize the lifespan. Optimize the quality of the flooring to the expected functions.	Informing consumers on the correct use and maintenance of the product. Ensuring suitable quality for the expected use
Packaging and consumer info	Marginal contribution of packaging to the overall env impacts (lower than 10%).	Low	Use of recycled and recycling materials for primary and secondary packaging.	Reduction of packaging (wt of packaging per wt of product) Reduction of non- recycled or non-recyclable packaging.
End of life	The environmental impact related to this phase is about 10%.	Medium	Limiting the quantity of materials used. Assigning a bonus if old wooden floorings are given back to the producer. Providing information on best practices of maintenance final disposal to consumers. Using recycled materials.	Increase the possibility and ease to repair old wood flooring. Easy disassembling to facilitate sorting and allow the best treatment of the material.

7 APPENDIX 1 – TOWARDS THE EUROPEAN ECOLABEL CRITERIA FOR WOODEN FLOOR COVERINGS

JRC/IPTS is currently developing proposals for a revision of the EU Ecolabel criteria for wooden floor covering. The objective of this revision is to update the current EU Ecolabel criteria (including removal or addition of new criteria) so that they can reflect the current market conditions and be able to label the top environmental performing wooden floor coverings on the European market.

The current criteria are aggregated under several categories: raw materials, use of dangerous substances, production stage, use stage, packaging, fitness for use and consumer information. These categories are proposed to remain unchanged and make the main sections of this appendix.

A.1 RAW MATERIALS

The importance of sustainable raw materials for floor covering has been highlighted in section 5.1 of this report. The large amount of wood and wood-based materials needed for the production of wooden floor coverings and the large number of direct and indirect environmental impacts associated with these materials make these criteria 1.1 to 1.4 of relevance.

The scope of this section includes the revision of the position regarding the benchmarks of criteria related to the raw materials (in particular wood and wood-based materials) used for wooden floor covering production. This section therefore, provides the justification and the recommendations for the proposed criteria changes based on the most updated technical data, current legislation and stakeholder's feedback.

Proposed revision scope

In this revision, we have considered several factors that may have an impact on the current criteria for raw materials. These factors are:

- how **wood and wood-based materials can be tracked to their origin** to ensure that it has been legally forested
- how wood and wood-based materials can be **tracked and verified to ensure that they have been forest under in a sustainable way**
- what benchmarks and declaration should be required regarding the **current market conditions and availability of sustainable certified wood**
- what declarations or certificates and benchmarks should be required regarding the current market conditions and availability of recycled wood
- which **wood treatments should or should not be allowed**
- should or should not **genetically modified wood (GMO)** be allowed as raw material

A1.1 Traceability of the wood to its origin

The Timber Trade Regulation (No 994/2010) that came into force in 2013 bans that illegal wood enters in Europe. However, the attributed devastating environmental impacts and the knowledge that it is still a common practice in some countries is the justification for having a clear and separate criterion requesting for legal wood. Although no reliable statistics are available, a 2012 joint study by the UNEP and Interpol[178] stated that illegal logging accounts for up to 30% of the global logging trade and contributes to more than 50% of tropical deforestation in Central Africa, the Amazon Basin and South East Africa. This illegal wood can enter to Europe if, as it is the case, floorings or raw materials are imported from these countries.

Complying with this EU Timber Regulation (No 994/2010) ensures that an effective ban to the entry and commercialization of illegally harvested timber in the EU is set since it should be applied to all the combined nomenclature in which the wooden floor covering can fall into. A list of those product groups of relevance for this product group is showed in Table 47.

Table 46 – Product categories related to wooden floor coverings and covered by the EU Timber Regulation (EC) No 994/2010

Code	Description
4407	Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed of a thickness exceeding 6mm
4408	Sheets for veneering (including those obtained by slicing laminated wood). For plywood or for the other similar laminated wood and other wood, sawn lengthwise, sliced or peeled, whether or not planed, sanded, spliced or end-jointed of a thickness not exceeding 6mm
4409	Wood (including strips and friezes for parquet flooring not assembled) continuously shape (tongued, grooved, rebated, chamfered, V-jointed, beaded, moulded, rounded or the like) along any of its edged, ends or faces, whether or not planed, sanded or end-jointed.
4410	Particle board, oriented strand board (OSB) and similar board (for example, waferboard) of wood or other ligneous materials, whether or not agglomerated with resins or other organic binding substances
4411	Fibreboard of wood or other ligneous materials, whether or not bonded with resins or other organic substances
4412	Plywood, veneered panels and similar laminated wood

The **EU Timber Regulation (EC) No 994/2010** obliges the operators (the first person that puts the timber on the EU market) to comply and shown that the timber has been legally harvested. Legally harvested means harvested in accordance with the applicable legislation in the country of harvest. That is

- rights to harvest timber within legally gazette boundaries,
- payments for harvest rights and timber including duties related to timber harvesting,
- timber harvesting including environmental and forest legislation including forest management and biodiversity conservation, where directly related to timber harvesting,
- third parties 'legal rights concerning use and tenure that are affected by timber harvesting, and
- trade and customs, in so far as the forest sector is concerned.

[178] Illegal logging trade documents forest, Africa: allafrica.com 2012, retrieved 18 October 2012

The regulation takes a flexible approach by listing a number of legislative areas without specifying particular laws, which are differ from country to country and may be subject to amendments. In order to obtain documents or other information indicating compliance with the applicable legislation in the country of harvest operators must in the first place be aware of what legislation exists in a particular country of harvest. In this effort they may be supported by the member states competent authorities in collaboration with the European Commission. They may also make use of the services of monitoring organizations (MO). Documents that prove the legality of the harvest can be found in the guidance document for the EU timber regulation[179]

The Regulation clearly states that it applies to either harvested inside the territory or imported and cleared by customs for free circulations. The regulation applies to each individual product placed on the market after its date of entry into application and not to the launch of a new product or product line. Moreover the concept of placing on the market refers to each individual product, not to a type of product, irrespective of whether it was manufactured as an individual unit or a series.

The "due of diligence" requires an operator to gather information about timber and timber products and their suppliers in order to conduct a full risk assessment. The information required to be assessed under Article 6 can be divided into two categories:

- *specific information related to the timber or timber product itself:* a description, its country of harvest (and, where applicable the sub-national region and concession), the supplier and trader, and documentation indicating compliance with applicable legislation
- *general information providing the context for assessing the product- specific information*, about the prevalence of illegal harvesting of specific tree specific tree species and prevalence of illegal harvesting practices in the place of harvest, and on the complexity of the supply chain.

While the general information provides operators with the context in which to evaluate the level of risk, the product specific information is necessary to determine the risk linked to the timber product itself. It means that if the general information points to potential risks, special attention needs to be given to the gathering of the product specific-information. If the product is derived from several timber sources it will be necessary to assess the risk for each component or species.

The level of risk can only be assessed on a case-by-case basis as it depends upon a number of factors. Although there is not a single accepted system for risk assessment, as a general rule however, the operator will have to address among other the following points: where the timber was harvested, the level of governance of concern, the availability and verification of the documents provided by the supplier, the involvement of the company in the supply chain in practices related to illegal logging and the complexity of the supply chain.

Although the regulation forces the operators to collect the information, it does not oblige final manufactures to maintain chain of custody certificates. Thus it is possible that although the wood was legally harvested, the end producer may not be aware of the origin of the wood*.* By setting this requirement into the EU Ecolabel criteria to the manufactures, operators will be forced to shown their due of diligence and consumers will get a better understanding of where the timber is coming from.

[179] http://ec.europa.eu/environment/forests/pdf/Final%20Guidance%20document.pdf

A1.2 Sustainability of the wood

The above commented EU Timber Regulation (EC) No 994/2010 requires the compliance with legally harvested timber, but it does not require to be sustainably harvested. Market requirements may be for either "legal" or "sustainable" timber.

- Legal timber refers to timber which originates from forests where there was a legal right to harvest and where management ensured that all domestic laws relevant to forest management were being met.
- ***Sustainable timber means that the timber comes from a forest where, in addition to legality, account is also taken of other aspects of management including social, environmental and economic issues.***

In this sense, the concept of sustainable wood, for the virgin wood at least, is basically considered as wood sourced from "sustainably managed forests". Although the definition of sustainable wood is generally agreed, from a legal perspective, it is often very difficult to define the boundaries between precisely when a forest is sustainably managed or not.

Whether the requirement is for *legality or sustainability it is the forest of origin of the timber which is being discussed and not the legality or sustainability of the manufacturing process*. This means that manufacturers and exporters are being asked to provide information about the forest the timber came from, and not about their own practices. Therefore, apart from information on the forest management, **reliable supply chain control** is also required.

There are many ways to demonstrate compliance with policies and regulations. It is essential for suppliers to understand what policies and regulations on legality and/or sustainability their customers face and the types of evidence they can use to meet these demands. ***Evidence should cover forest management and supply chain control. This means that suppliers have to provide proof that the timber has been harvested legally and/or sustainably, and also provide evidence that the timber used in the products was not mixed or substituted.***

The most common method is forest certification. All public and private procurement policies accept forest certification schemes as evidence of sustainability. This is usually ***demonstrated by supplying certified timber of acceptable schemes with full Chain of Custody (CoC).*** Many public procurement policies accept FLEGT licensed timber when it is available as evidence of compliance. Moreover, there is a range of legality verification schemes available on the market to provide proof of legality.

In addition to independent verification, other types of evidence can sometimes be used to demonstrate compliance and may be acceptable by the private sector including trade federations and individual companies. For example, copies of relevant documents such as harvesting licences, concession permits and forest management plans.

The availability of certified sustainable wood and wood-based materials is increasing around the world and also in Europe. In 2005 there were about 200 million hectares of PEFC-certified forests producing millions of tons of certified timber. This certification is the largest in the world (approx. 68%) and covers the majority of the European forests, but there are other certifications that also are present and with important market shares such as FSC[180]. The share markets of both certifications

[180] https://www.internationalpaper.com/documents/EN/Sustainability/EN_IP_PEFC_Q%26A.pdf

together ensure the availability of certified wood and wood-based materials on the European market.

A brief summary of the best know ones is included in this section. A deep understanding of the requirements and the labelling that they offer is important regarding the benchmarks and verification processes of the EU Ecolabel criteria[181].

Description of different sustainable wood certification schemes

a) Forest Stewardship Council (FSC)

The FSC is an international association that includes forest owners, timber industries, social groups and environmental organisations amongst its members and provides a global forest certification system by which forests can be audited and certified. The system also extends to auditing of intermediate traders and end-product producers where the final product is labelled with the FSC logo and all intermediates must be able to demonstrate valid chain of custody (COC) certification. The FSC was formed in 1993, in part due to the failure to reach an adequate international and legally binding agreement to protect high biodiversity forests from logging. As of June 2014, over 183 million ha of forest are covered by FSC under more than 1200 forest management certificates.

To obtain certification, the organisation that applies for the certificate must meet the FSC principles to a sufficient degree to the auditor's satisfaction. Audits are typically carried out once per year. The latest version (5.0) of the FSC system defines 10 governing principles for sustainable forest management and a total of 70 sub-criteria that will be applied in their audits from December 2015 onwards. The 10 principles are:

1. Compliance with laws
2. Workers' rights and employment conditions
3. Indigenous peoples' rights
4. Community relations
5. Benefits from the forest
6. Environmental values and impacts
7. Management planning
8. Monitoring and assessment
9. High conservation values
10. Implementation of management activities.

It is difficult to apply standard forest management principles across different countries with different forest types, climates, cultures and laws. As a result, the FSC is currently working on publishing a series of "International Generic Indicators" for use in forest characterisation.

When a forestry organisation has been awarded the FSC certificate, the wood they produce may carry the FSC label, which also includes the certificate number that any client can check against a database[182] to ensure that it is still valid. If the wood material is sold to a client who then wishes to sell the wood directly again or as new product, then they must obtain a chain of custody (COC) certificate if they want to display the FSC label on their products.

[181] Intern Report by Shane Donatello, August 2014
[182] http://welcome.fsc.org/certificate-holder-database.17.htm

The only situations when an organisation can handle FSC certified wood but is not required to hold a COC certificate are for retailers who sell to end users, end users themselves and other entities such as auctioneers and logistics companies who handle FSC certified products without taking legal ownership of them.

In 2014, over 28,000 COC certificates are currently valid. To obtain a COC certificate, the company must pass an audit by an FSC approved certification body. The COC certification system is defined by the latest version of FSC-STD-40-004 and involves auditing of certificate holders by independent third parties that have been approved by the FSC. The audit process analyses the following aspects:

- Quality management: responsibilities, procedures and records.
- Product scope: definition of product group(s) and outsourcing arrangements.
- Material sourcing: material specifications.
- Material receipt and storage: identification and segregation
- Production control: control of quantities, identify FSC claims
- Sales and delivery: invoicing and transport documentation
- Labelling: application of FSC labels on-product and labelling thresholds

With regards to material sourcing, it is very important to understand how FSC distinguishes between certified wood, controlled wood and reclaimed materials.

1. *Certified wood* is basically virgin wood sourced from certified FSC forest areas that complies with the 10 principles and sub-criteria mentioned above and handled only by any producers and intermediaries that possess valid COC certificates.

2. *Controlled wood*, according to the FSC definition, is wood that is supplied by organisations that comply with FSC-STD-40-005 or FSC-STD-30-010 or has been satisfactorily risk-assessed by the FSC certified buying organisation. FSC-controlled wood must comply with the following requisites:

   - Illegally harvested wood.
   - Wood harvested in violation of traditional and civil rights
   - Wood harvested in forests where high conservation values are threatened by management activities.
   - Wood harvested in forests being converted to plantations or non-forest use.
   - Wood from forests in which genetically modified trees are planted.

3. *Reclaimed material* is a global term defined by the FSC in the FSC-STD-40-007 standard as basically material that would otherwise have been disposed of as waste or used for energy recovery but has instead been used in-lieu of virgin materials in a manufacturing process. The term includes both post-consumer reclaimed material and pre-consumer reclaimed material.

   - *Post-consumer reclaimed material* is considered as: "*Material that is reclaimed from a consumer or commercial product that has been used for its intended purpose by individuals, households or by commercial, industrial and institutional facilities in their role as end-users of the product*."

   - *Pre-consumer reclaimed material* is considered as: "*Material that is reclaimed from a process of secondary manufacture or further downstream industry, in which the material has not been intentionally produced, is unfit for end use and not capable of being re-used on-site in the same manufacturing process that generated it*."

The term "secondary manufacture" is underlined in the above paragraph because it means that sawdust and other residues or co-products from saw-mills are not considered as pre-consumer recycled materials. Instead, they will be considered as FSC-certified materials (if the wood processed was FSC certified) or as controlled materials (if the wood processed was controlled wood).

The final aspect to consider is **labelling.** The FSC define strict conditions under which a label may be used (see FSC-STD-50-001). In final products, one of three labels may be used:

1. "**FSC 100%**" where 100% of the wood based materials used must come from FSC certified forests.
2. "**FSC Mix**" where ≥70% of all wood based materials are FSC certified virgin materials and/or post-consumer reclaimed materials and the remainder consists of pre-consumer reclaimed materials and/or controlled wood.
3. "**FSC Recycled**" where 100% of the wood based materials are reclaimed, with at least 85% being post-consumer and the remainder being pre-consumer recycled materials.

b) PEFC (Programme for the Endorsement of Forest Certification)

The PEFC is an independent, non-profit organisation that was founded in 1999. As of January 2014, over 258 million hectares of forest was covered by PEFC certificates, the majority in the North America (Canada 119 million ha and the US 34 million ha). The members of PEFC widely represent various wood-based product industries.

For a forest area to be PEFC certified, it first must belong to a country for which a national forest certification system has been published and found to be in compliance with PEFC's Sustainability Benchmark by independent assessors and subsequently endorsed internationally by the PEFC. It is actively required that the relevant forestry industries participate in the development of the national forest certification system to be assessed by PEFC. In the GL/2/2011 document published in 2011, the PEFC list 7 sustainability criteria, along with some 76 sub-criteria. The main criteria are described in the PEFC ST 1003 2010 document as follows:

- Maintenance and appropriate enhancement of forest resources and their contribution to the global carbon cycle.
- Maintenance of forest ecosystem health and vitality
- Maintenance and encouragement of productive functions of forests (wood and non-wood)
- Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems
- Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water).
- Maintenance of other socio-economic functions and conditions
- Compliance with legal requirements.

Wood produced from PEFC certified forests can carry the PEFC claim, but if intermediaries and traders wish to also use the claim, they must obtain **chain of custody** (COC) certification, which follows a similar philosophy to the FSC system and is described in the PEFC ST 2002:2013 standard. The COC requirements align very well with the due diligence requirements of the European Timber Regulation (EUTR – No.995/2010) which bans illegally harvested wood from being placed on the EU market. Any organisation wishing to obtain a PEFC COC certificate must be successfully audited by a PEFC approved third party independent auditing body. The audit scheme covers the following aspects:

- Identification of the material category of material/products at delivery and supplier levels.

- The implementation of a Due Diligence System that specifically excludes conflict timber[183], controversial sources[184] and genetically modified forest based organisms.
- A risk assessment procedure to apply to suppliers and steps required if a "significant risk" is identified.
- Physical separation, record keeping, management system and method for transferring PEFC certified claims to products (as well as the correct usage of logos and labels).
- Social and health and safety requirements within the chain of custody.

Also in a similar manner to the FSC system, the PEFC system makes a distinction between "certified wood", "recycled material" and "controlled wood". Certified wood or material is simply defined as material whose origin is covered by the chain of custody claims. The definition of recycled material is based on the text in ISO 14021:1999 and thus is slightly different to the definition of FSC reclaimed material. The PEFC definition for recycled material mentioned in PEFC ST 2002:2010 is:

> "*Forest based material that is:*
>
> *a) diverted from the waste stream during a manufacturing process. Excluded is reutilisation of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it and*
>
> *b) generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain*."

By-products such as sawmilling by-products (sawdust, chips, bark, etc.) or forestry residues (bark, chips from branches, roots, etc.) are excluded from the definition of PEFC recycled material since they do not represent waste streams. Residue generated by a press line in panel board production would not be considered as recycled material since it can be reused within the same process that generated it.

PEFC Controlled wood can only be supplied by organisations that possess a valid PEFC COC certificate and this certificate, or a document confirming this must accompany any deliveries of such material. PEFC controlled wood must not meet any of the following conditions:

- Be harvested in a way that does not comply with local, national or international legislation.
- Violate any legislation regarding indigenous peoples traditional and civil rights.
- Violate any legislation regarding harvesting and management in areas with a designated high environmental and/or cultural value.
- Does not involve the conversion of primary forests to forest plantations.
- Does not include material from genetically modified organisms.

It should be noted that there is a considerable amount of debate about the precise wording and implications of the FSC and PEFC criteria, particularly in the areas of controversial sources and controlled wood.

[183] Defined as "Timber that has been traded at some point in the chain of custody by armed groups, be they rebel fractions or regular soldiers, or by a civilian administration involved in armed conflict or its representatives, either to perpetuate conflict or take advantage of conflict situations for personal gain… conflict timber is not necessarily illegal" or the exploitation of timber may itself be a direct cause of conflict.

[184] Includes forest activities that do not comply with local, national or international legislation relating to forestry harvesting practices, areas of designated high environmental/cultural value, CITES protected and endangered species, health and labour issues for forest workers, indigenous peoples and third parties property, tenure and use rights, that involve the conversion of primary forests to forest plantations.

Labelling is an area where FSC and PEFC clearly differentiate, although certain common aspects can be found. The main differences are that PEFC does not have a specific 100% logo and that no distinction is made between pre-consumer and post-consumer recycled material by PEFC, unlike FSC.

The two types of PEFC logo, described in PEFC ST 2001:2008, that can be used are:

- **PEFC certified**: includes minimum of 70 % of "PEFC certified" material from forest which has been certified against a PEFC endorsed forest certification scheme as sustainably managed or from recycled material. The content of recycled material is lower than 85 %.
- **PEFC recycled**: The product includes a minimum of 70 % of "PEFC certified" material from recycled sources. The content of recycled material is calculated based on ISO / IEC 14021.

In both cases, any remainder of wood-based material that is not PEFC certified or PEFC recycled must be made up by PEFC controlled wood, as is implied on the labels, shown below.

b) Other schemes

FSC and PEFC are by far the two dominant international forest certification schemes. Other notable schemes include the SFI (Sustainable Forestry Initiative), the AFTS (American Tree Farm System) and CSA (CAN/CSA-Z809-02 Sustainable Forest Management standard). Since around 2005, these North American based schemes became incorporated under the PEFC certification scheme and are largely responsible for making PEFC the largest international forest certification scheme (accounting for approximately 60% of all area covered worldwide by PEFC).

The EU Ecolabel criteria aim at ensuring the use of environmental friendly materials that caused lower environmental impact without creating market restrictions. Therefore, the promotion of sustainable sourced virgin wood and plant-based materials as well as recycled wood seems to be recommendable. The issue of how to demonstrate and verify the sustainable origin of the wood and plant-based materials as well as the percentage of this type of wood to be requested is discussed in the coming sections. Both issues although referring to different aspects should be jointly considered in order to draft a valid and feasible EU Ecolabel criterion.

Widely accepted are the above both described schemes in Europe to recognize the sustainably managed forestry. Both schemes certify "forest based products" what goes beyond timber, e.g. cork, fruits, bamboo, rubber, etc. as long as they originate from FSC/PEFC certified forests. An FSC/PEFC certified forest means that the forest management unit concerned is certified against indicators for performance that are derived from an FSC/PEFC forest management standard and that the management unit has received the certificate from a certification body which audited the company for this purpose and repeats such an audit at least once a year. Both schemes have procedures in place to complain against misbehavior of certificate holders and /or certification bodies. However, both schemes are not equivalent and they don't recognize each other as equivalent, which can cause some barriers during the verification process of the EU Ecolabel criteria. In detail, PEFC allows mixing with FSC materials, but only as "controlled sources" and FSC does not allow mixing with PEFC material, at least they pass the FSC controlled test.

Other important differences among the schemes are;

a) *the number of requirements that the controlled wood should comply with.* FSC controlled wood is material that has been checked on compliance with five criteria, low risk that it is coming from:
    1. illegally harvested wood
    2. wood harvested in violations of traditional and civil rights
    3. wood harvested in forests where high conservation values are threatened by management activities

4. wood harvested in forests being converted to plantations or non-forest use
5. wood from forests in which genetically modifies trees or plants are planted

PEFC controlled sourced wood follows the same principle, but tested only against three principles, equivalent to the above categories 1., 4., and 5.

b) *The value given to the types of recycled or reclaimed wood*. FSC regards "post-consumer reclaimed materials" as equivalent in value with certified virgin materials, and "pre-consumer reclaimed materials" as of lesser value in environmental terms, so equivalent to controlled wood. On the other hand, PFEC also allows working with recycled materials but does not make the distinction between post and pre-consumer. PEFC refers to ISO rules to define recycled materials.

c) *The claims and the logos used for end products* although the principle is the same: any claim can only be composed of certified materials, recycled/reclaimed materials and controlled wood/sources. Unidentified materials cannot be included, unless they are considered "neutral". Neutral however non-forest is based materials such as plastics, metals, paints, etc.

d) *The number and types of labeling that hold each schemes* is an important reference regarding the feasibility and easiness of the verification of the EU Ecolabel criterion. The recognition of these labels as compliance with EU Ecolabel criteria and benchmarks would make the verification process easier, cost-effective and reliable. As defined before, the FSC schemes hold three labels while PEFC hold only two. In all the cases, the labels ensure that either 100% or 70% of the materials from the total certified wood comply with the requirements of that label and that in all the cases, all the materials are at least controlled wood.

Considering these differences among the schemes, and the purpose of this criterion, it seems to be feasible to require that all the materials use for the production comply with the requirements of controlled sources and that the benchmark for sustainable or recycled wood reaches 70% wt. Requiring that all the wooden materials comply with "controlled sourced" materials, it is ensured, at least, that they are legally harvested, not coming from forests that have been converted to plantations or non-forest use and that are not genetically modified. Requiring a percentage of 70% virgin certified sustainable wood or recycled, it is ensured that the re-use of the materials is encouraged whenever feasible and that where virgin materials are used, they are sustainably sourced. In addition, this benchmark makes the verification easier if the product already holds any of the described labelled.

The thresholds for cork and bamboo floorings regarding the share of sustainable certified or recycled plant materials should be slightly lower, according to the information collected in the last revision of some national schemes. Nowadays there is an increasing pressure on bamboo and a risk that felling and the use of pesticides and fertilizers may lead to destruction of functioning ecosystems. In order to ensure that the raw material does not come from areas where there is threat to biodiversity or social values all materials should at least fulfill the requirements of controlled wood.

Bamboo is able to be certified under sustainable forestry standards, organically grown raw materials or raw materials originating from growers in transition towards organic production. The cork can also be certified. It is common for the relatively small forest owners in the Mediterranean basin to group together to run their forest in line with the FSC standard. FSC has certified Mediterranean cork since

2005. In 2012, 72000 ha of the cork stock in the Mediterranean area and North Africa was FSC certified and a further 1.5 million ha in Spain was PEFC certified[185]. The inclusion of bamboo and cork under certified raw materials has been based on increasing availability over the last years and the consideration that it is possible to purchase this proportion of certified wood. We are aware that it is a major increase in the requirement and therefore a merge with the recycled plant-based materials is proposed. However, stakeholders feedback is particularly welcome on this issue.

A1.3 Recycled wood and wood-based materials

Regarding the type of wood sources for the production for particleboards, annually the European industry used 24% virgin solid wood, 14% recycled wood and 61% sawmill by products[186]. Wood plays an important role in combating climate change as they are CO_2 reservoirs. Greater use of wood products will stimulate the abundant of forests and longer used of wood products would ensure that the CO_2 is not released to the atmosphere. Therefore, it is important that wood products are recovered following the functionally cascade: primary products, reuse and/or recycle and eventually use wood as an energy source (only after it has been fully used). This sound use of wood and the value chain of the wood resource are at present not respected in all Member States, where the material suitable for the production of wood-based products is used directly for energy generation. Only do Italy, Germany, Portugal, UK and Belgium show relevant percentages of reused or recycled wood.

Therefore it is important to enhance the use of wood products by encouraging recycling of wood by-products and residues, supporting research on sorting and cleaning technologies and improving the waste regulations that allow that wood residues complying with the quality standards are not classified as waste.

The use of *recycled wood* in the manufacture of particleboards or fibreboards requires deliveries of material to the processor to ensure that reclaimed raw materials and the finished panel product are strictly controlled in respect of contaminating chemical elements and compounds that might be present at unacceptable levels in recycled wood.

In this sense, a clear definition of what is recycled wood is needed. The term "recycled wood" includes those wood materials that are sourced either pre-consumer or post-consumer and that are, either before or after the consume use, reclaimed and recycled as raw material for a manufacturing process (e.g. from the manufacture of panelboards, assembled products or building structures).

The recycled wood is coming from "waste wood" that can be divided into three categories depending on its origin: untreated wood, non-hazardous treated wood and hazardous waste wood. The proportion of each of these waste streams has been estimated for untreated wood to be 15-10% of the total waste wood, 75-80% of the non-hazardous treated wood and 15-5% for the hazardous waste wood[187]. Untreated wood is that that has no received any chemical treatment.

For the EU Ecolabel criteria the above mentioned definition for recycled wood is proposed. This concept includes any kind of wooden materials diverted from the waste stream during a manufacturing process or generated by households or by commercial, industrial and institutional

[185] Background to ecolabelling for consultation. About Nordic Ecolabelled 029 Floor covering version 6.0. 15 May 2014

[186] http://www.unece.org/fileadmin/DAM/timber/docs/tc-sessions/tc-61/presentations/14-janssens.pdf

[187] The quantitative distribution of these waste streams has been indicated for Germany in Goerisch 2002, http://www.europanels.org/upload/EPF-Standard-for-recycled-wood-use.pdf

facilities in their roles as end-users of the product, which can no longer be used for their intended purpose.

Treated wood[188] can be divided into non-hazardous or hazardous treated wood depending on the treatment the wood has received to be sold. Wood preservatives[189] in particular can be identified as hazardous components according to 91/689/EEC, ANNEX II[190]. Further contaminants are heavy metals from coatings/staining, hardeners such as ammonium chloride, formaldehydes and also flame retardants. In addition substances such as copper chromium arsenic (CCA), copper organics, creosote, light organic solvent preservatives (LOSP), micro-emulsion, paint / stain or varnish can also be present.

Even though many of the above listed substances are not allowed to be used or are restricted in use today, they are still present within the waste wood arising. For example, both wood treated with the preservatives CCA and creosote, are restricted in use under the Marketing and Use Directives. Creosote treated timber may be supplied for second hand use but not for a range of identified applications where frequent skin contact is likely, or in containers intended for growing purposes or in packaging which may come into contact with products destined for human and animal consumption. CCA treated timber is also eligible for second time use, but only for professional and industrial applications, where skin contact by general public or livestock is unlikely. Despite these restrictions however, there is significant re-use of materials, such as creosote treated railway sleepers, in industrial applications. Further information about these preservatives is included into the next section.

Possible treatment with any of a number of hazardous preservatives and fungicides may have occurred during the previous manufacture and use of the wood to be recycled. There are a range of novel remediation techniques that have emerged which attempt to remove chemical treatment from wood. Pre-treatment to remove the preservative might allow the material to be recycled, re-used or recovered through conventional routes. It may prove necessary to apply a combination of these processes in order to achieve the requisite level of remediation. In general however, these techniques often result in a deterioration of the wood fibre quality and are yet to prove themselves at a commercial scale of operation. In addition, even after careful pre-treatment, traces of these substances may still remain in the recycled wood fibers and it is necessary to test these materials prior to their re-use in any new products.

Currently the greatest user of recycled wood fibre is the panelboard sector principally in the manufacture of particleboard. The panelboard industry has adopted a voluntary standard that imposes very strict limits on contamination for such materials as creosote and heavy metals. It is unlikely that board produced from 100% CCA treated wood waste would pass this industry standard, even after remediation. In addition the reduction in fibre quality from using remediated wood waste may undermine the board quality limiting the range of applications for which it is suitable. Other types of panelboard for which wood waste may be used include OSB and MDF production. For OSB,

[188] Treated wood is wood that contains halogenated organic compounds or heavy metals as a result of treatment with wood preservatives

[189] Wood preservatives: products intended to prevent wood-destroying or wood-disfiguring organisms (fungi, insects and marine borers) from attacking wood and wood-based products

[190] Council Directive 91/689/EC of 12 December 1991 on hazardous waste
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0689:EN:HTML

strength characteristics can be undermined if CCA treated feedstock is used, although resistance to degradation may be improved. There is also the potential to use wood waste in the production of non-panelboard products such as wood cement composites for which the use of CCA wood waste as a feedstock would allow some performance characteristics to improve.

Apart from the voluntary scheme developed by the European industry, a number of national quality control schemes exist. The most prominent in Europa is the German criteria defined for purposes of the RAL- Gütezeichen label "Recyclingprodukte aus Gebrauchtholz". In the United Kingdom the wood-based panels sector supports the European Panel Federation´s (EPF) "Industry Standard for delivery conditions of recycled wood", which is based on a responsible care approach. EFP[191] standards have been developed for delivery conditions of recycled wood that defines limit values of certain elements and substances that are at particular risk of being present in recycled wood due to treatment with fungicides, paints and/or vanishes.

In order to assess if the recycling of treated wood poses an acceptable risk, risk assessments were undertaken by TRADA Technology & Enviros Consulting Ltd. This involves the identification of hazards, an assessment of the likelihood of the occurrence of the hazard and comparison of the outcome to an accepted standard. For this assessment, the hazards associated with treated wood waste were identified. The likelihood of the hazard being present does not require evaluating because it was assumed that the wood waste is in the waste stream. The outcome of the assessment was compared to available standards.

The risk assessment was based on a three-tier approach. All treatments were assessed at Tier 1. If a hazard that could not be mitigated was identified it was assessed at Tier 2, where the risk was compared against all pertinent legislation. Any hazards that may not be controlled adequately at Tier 2 were required to undergo a Tier 3 assessment. This involved a quantitative risk assessment, whereby the amount of treatment in the wood is estimated and a comparison is made between the concentration of active ingredients and LD_{50}. Treatment loadings were based on EPF Standard loading levels, however, for certain service situations lower levels than those prescribed by the EPF Standard are often used in practice, and some of these were also assessed.

The results show that for the more hazardous preservative treated wood wastes, CCA and creosote, the management options are more limited (as they don't include mulch, animal bedding or compost) while these are options for wood waste recovery treated with paint or varnishes, LOSP, micro-emulsions or copper organics. However, re-use is a feasible option, which in the waste management hierarchy, is the most favorable option apart from waste prevention at source[192].

Based on the positive results of this study and the outcomes of the research carried out for the revision of other EU Ecolabel schemes, it is proposed to keep this criterion without any modification.

[191] EPF Industry standard, as reported in paragraph 6 of document 'EPF Standard for delivery conditions of recycled wood' of 24 October 2002, more information available online at: http://www.europanels.org/upload/EPF-Standard-for-recycled-wood-use.pdf

[192] http://www2.wrap.org.uk/downloads/Options_and_Risk_Assessment_for_Treated_Wood_Waste.f3ffb99e.2237.pdf

A1.4 Wood treatments: wood preservatives and impregnating substances

Wood has been traditionally treated with pesticides to prevent the undesired damages caused by inserts and mould over time. In this sense, the use of wood pesticides and in general the use of wood preservatives can extend the life of the wood and reduce the need for forest resources, but proper use is important. Some preservatives can slowly leach into the surrounding soil or water and even, sometimes touching the wood can leave residue on exposed skin.

The classification of pesticides in the WHO distinguishes between the more and the less hazardous forms of each pesticide in that it is based on the toxicity of the technical compound and on its formulation. The classification is based primarily on the accurate oral and dermal toxicity to the rat since these determinations are standard procedures in toxicology. According to the WHO classification the pesticides are ranked in four groups: 1a (extremely hazardous), 1b (highly hazardous), 2 (moderately hazardous) and 3 (slightly hazardous). The criterion proposed the ban on the two first groups classified as extremely and highly hazardous substances. The use of these pesticides is not widely applied in Europe and therefore this ban does not create market restrictions.

Wood preservatives that are used during the impregnation process can contain substances like chromium, arsenic, copper or creosote that are substances mostly banned or classified as hazardous substances in several official classifications. Some of mostly used preservatives are listed below along with their risky properties, when classified, in Table 47.

Table 47 - Some of mostly used preservatives and their hazardous properties.

Name	Use	R-phrase	Hazard
Acid Copper Chromate (ACC)	for industrial and commercial uses	R-26, R-27 R-43	ACC treated wood contains chromium (VI) that is a chemical highly toxic for oral, dermal contact, and inhalation and is also a strong skin sensitizer.
Alkaline copper Quaternary (ACQ)	widely used residential wood preservatives	R20/21/ R22 R34	Types A, B, C, and D are composed of copper oxide and a quaternary ammonia compound. There is no chemicals like arsenic or chromium
Bis-(N-cyclohexyldiazeniumdioxy)-copper (Cu-HDO):	outdoor wood preservative	R-50	Cu-HDO is used for pressure-treatment of lumber, poles, millwork, and piles. Cu-HDO is highly toxic to aquatic organisms, so it is not allowed in aquatic areas
Borates	protect wood from fungus, termites, and other wood-decomposing organisms	R60 R61	Comprised of disodium octoborate tetrahydrate being classified as low-toxicity treatments used primarily on indoor wood that is protected from weather (e.g. joists, sheathing or sill plates)
Chromated Copper Arsenate (CCA):	no longer used in most residential settings		Contents Cr, Cu and As. The chemicals leach into the surrounding environment and can transfer to the skin when people touch the wood.
Copper Azole (CA)	Copper azole is registered for uses above and below ground, as well as in freshwater and marine decking applications	R20/22 R34/36 R37/38 R43 R51/53	Type A (also known as CA-A) contains copper, boric acid, and tebuconazole. Type B (also known as CA-B) contains higher concentrations of copper and tebuconazole but no boric acid.
Creosote	containing more than 50 mg/Kg benzo(a)pyrene were banned in Europe	R34 R20/21/22 R23/24/25 R48 R36/37/38 R40, R45	Leach chemicals that may dissolve in water, move through soil and contaminate groundwater. Creosote can also be taken up by plants and animals and is considered a probable human carcinogen consist of polycyclic aromatic hydrocarbons (PAH´s) which some of these substances, especially benzo(a)pyrene was classified as carcinogenic.

		R68 R50/51/53	
Cyproconazole	Water-based fungicide for pressure treatment of above-ground wood (but not from insects) such as siding, plywood, millwork, shingles, lumber and other uses	R-51	It is harmful if swallowed and toxic to aquatic organisms
Micronized Copper		R36/37/38 R51/53	Use of very small particles of solid copper ($CuCO_3$) being injected into the wood. The small size of the copper particles in these products allows them to stay suspended in the solution being injected into the wood. However, their small size may also affect their potential to leach from the wood. The potential health and environmental risks of these formulations may be affected by the size of the copper particles being used in the product.
Pentachlorophenol	Restricted pesticide until 1987, used industrially as a wood preservative for utility poles, railroad ties, and wharf pilings	R24/25/26 R36/37/38 R40 R50/53	A probable human carcinogen and exposure to high levels can also have other health risks.
Propiconazole	Preventive of wood from decaying from fungus (but not from insect damage) and used as a fungicide on turf and ornamental plants, numerous food and feed crops, and as an antimicrobial preservative for other materials	R22 R43 R50/53	Its breakdown products can persist in the environment and be taken up by plants. It has been approved for surface application or pressure treatment of siding, plywood, millwork, shingles and shakes and above-ground structural lumber and timbers.

Among the wood preservatives mostly used and summarized in Table 47, only the **pentachlorophenol (Cas No 87-86-5)** is an ingredient of the pesticides included into the list of highly hazardous list (class 1B). However, the use of this chemical compound as an ingredient of the pesticides was banned in 1987.

The restriction of both lists of ingredients of pesticides is proposed to remain unchanged in the EU Ecolabel criteria due to the low relevance for the European market (where most of the ingredients are not listed into those WHO lists) and to prevent possible imports of wood products been treated with one or more banned hazardous preservatives.

The substances and mixtures banned in both Directive 79/117/EEC on prohibiting the placing on the market and use of plant protection products containing certain active substances and Directive

76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations include mercury compounds[193], persistent organo-chlorine compounds[194], polychlorinated biphenyls (PCB)[195], polychlorinated terphenyls (PCT) and preparations with a PCB or PCT content > 0.1%w/w and chloro-1-ethylene. None of the most common wood preservatives include this kind of ingredients. Therefore, this part of the criterion is proposed to remain unchanged to prevent possible wood preservatives imports of wood products been treated with one or more banned hazardous preservatives.

Creosotes are the portion of chemical products obtained by the distillation of a tar that remains heavier than water, notably useful for its anti-septic and preservative properties[196]. It is produced in some quantities from the burning of wood and coal in blast furnaces and fireplaces; commonly found inside chimney flues when the wood or coal burns incompletely. The two main types in industrial production are wood-tar creosote and coal-tar creosote. Coal tar creosote contains polycyclical aromatic hydrocarbons (PAH´s) which are genetically harmful for humans, affect the immune system and reproductive ability and are carcinogenic. This coal-tar variety has chiefly been used as a preservative for wood, while the wood-tar variety has been used for meat preservation, wood treatment, and for medicinal purposes as an expectorant, anti-septic, astringent, anaesthetic and laxative, though these have mostly been replaced by newer medicines.

Creosote and its compounds from coal tar contain substances classified as toxic and carcinogenic depending on the PAH content. According to table 3.1 of Annex VI of CLP Regulation, creosote (distillate of coal tar with EC number: 232-287-5 and CAS number: 8001-58-9) is classified as: Carc. 1B (H350). Wood tar creosote contains substances such as cresol, phenols and guaiacol. According to table 3.1 of Annex VI of CLP Regulation, cresol is classified as: Acute Tox 3 and Skin Corr. 1B (H311, H301, H314), phenol is classified as: Muta. 2, Acute Tox. 3, STOT RE 2 and Skin Corr. 1B (H341, H331, H311, H301, H373 and H314). Finally, guaiacol is classified as Acute Tox. 4, Eye Irrit. 2 and Skin Irrit. 2 (H302, H319 and H315). Legislative authorities have issued restrictions for the use of creosote. Tar oils containing more than 50 mg/Kg benzo(a)pyrene were banned in Europe. Creosote is included in the REACH Restriction list[27] according to its Annex XVII. For these reasons the use of creosote has been banned from the potential preservatives accepted in wooden-based panels complying with EU Ecolabel criteria in other schemes.

The international standards on durability of wood and wood-based products: "EN 351 on preservative treated solid wood" and "EN 335 divided in three parts, Part 1 on definitions of use classes in different service situations, Part 2 on their application to solid wood and Part 3 on their application to wood-based panels" classify the preservatives used for solid-wood depending on their hazardous properties. This classification is similar to that of the Nordic Wood Preservation Council (NTR) whose purpose is principally to make it easier for purchasers of pressure-impregnated wood to select the right impregnated wood, depending on how severely exposed to attack by rot the construction will be. European standards for wood that has been treated for protection are available,

[193] Mercury compounds such as mercury oxides, mercurous chloride (calomel), other inorganic mercury compounds, alkyl mercury compounds, alkoxyalkyl and aryl mercury compounds

[194] Persintent organo-chlorine compounds such as aldrin, chlordane, dieldrin, DDT, endrin, HCH (containing <99% of the gamma isomer), heptachlor, hexachlorobenzene

[195] Except mono- and dichlorinated biphenyls

[196] Price, Kelogg & Cox 1909, p. 7

but the industry has decided to retain the familiar Nordic wood protection classes). There are four main classifications for the preservatives:

- *Class M* which is the highest protective class, is intended for use in wooden constructions that are at risk of attack from aquatic pests such as shipworm, and in constructions that are exposed to extreme conditions, or on which particularly stringent safety requirements are placed. This corresponds to Protective Class 5 as specified in the European standard EN 335.
- *Wood impregnated according to Class A* is intended to be used for timber in contact with soil and in freshwater, and - in special cases - above ground, where there is a significant risk of attack by rot. This corresponds to Protective Class 4 as specified in EN 335.
- *Wood impregnated according to Class AB* is intended for use in exposed constructions above ground, such as fences and gable boards. This corresponds to Protective Class 3 as specified by EN 335.
- *Wood impregnated according to Class B* is intended solely for outdoor woodwork such as windows and doors.

Regarding the product group under scope, the use of this classification, and therefore the preservatives it allows, exceeds the needs of the wooden floor coverings. According to the proposed definition, wooden floor coverings should be only used indoors while even the wood impregnated according to Class B will be ready to be used outdoor. Therefore, it is considered this classification is not appropriated to set up any limitation regarding the use of wood preservatives and impregnation.

A1.2.5 Genetically modified wood

Genetically modified organisms (GMOs) are organisms that have been transformed by the insertion of one or more isolated genes. Often, but not always, the transferred genes have been derived from a species different from the recipient. The issue of genetic modification has been intensively debated and scientists and the public have expressed worries with regard to the risks of potential gene flow and environmental impacts (including the displacement of local species). Other concerns include consumer health and potential inequality of costs and benefits to developing countries and poor farmers.

Although in the agriculture, genetically modified organisms (GMOs) are already a reality, the forestry sector is far behind agricultural crops in this respect. Current availability of GMO wood is very low. In addition, the issue of GMO plants and trees remains a controversial issue for environmentalists and there is no obvious benefit to the wooden flooring industry permitting the use of wood from such species.

A study from the Food and Agriculture Organization of the United Nations (FAO)197 suggested that as of 2002, less than 500 ha of genetically modified forest trees (poplar clones) were being grown commercially in China. Populus is the genus of forest tree in which genetic modification has been researched most widely, although some genetic modification research has been reported for about 19 genera of forest trees. This same criterion can be found in other EU Ecolabel schemes e.g EU Ecolabel for wooden furniture, other type I Ecolabels (Nordic Ecolabel) and FSC certification.

[197] FAO. 2004. *The State of Food and Agriculture 2003-04*. Rome.

A.2 HAZARDOUS SUBTANCES

The Ecolabel regulation EC No 66/2010 aims to prevent the use of all chemicals classified as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction and substances that are restricted under REACH regulations. The regulation stipulates:

> *6. The EU Ecolabel may not be awarded to goods 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, nor to goods containing 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.*
>
> *7. For specific categories of goods containing substances referred to in paragraph 6, and only in the event that it is not technically feasible to substitute them as such, or via the use of alternative materials or designs, or in the case of products which have a significantly higher overall environment performance compared with other goods of the same category, the Commission may adopt measures to grant derogations from paragraph 6. No derogation shall be given concerning substances that meet the criteria of Article 57 of Regulation (EC) No 1907/2006 and that 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). Those measures, designed to amend non-essential elements of this Regulation, shall be adopted in accordance with the regulatory procedure with scrutiny referred to in Article 16(2).*

The use of the chemical requirements to avoid or restrict the use of dangerous substances cover all chemical and chemical products used in the manufacture of the flooring and any treatment conducted by the manufacturer or by its suppliers of raw materials or constituent products. Therefore, the chemical requirements apply to substances such as adhesives, paints, impregnating substances, sealants, pigments, binders and so on as well as to the constituent parts of the flooring such as the manufactured wooden board.

Proposed revision scope

In this revision, several factors are considered for revising and justifications for the proposals are included in this section. These factors are:

- *What are the substances that would be limited*

According to the Ecolabel Regulation (EC) No 66/2010 substances of concern are those classified as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction and substances that are restricted under REACH regulation whenever they are used in the production process.

The identification of substances of concern is not easy due to the large number of chemicals and chemical products that can be involved in the production process as well as the large number of steps. Substances of concern can be classified and aggregated based on their functionality or their inherent properties.

Regarding their functionality, substances that act as adhesives, resins, binders, paints, preservatives, varnishes, glues, impregnating substances, pigments, etc have been traditionally classified as such. Additionally, there are ingredients used in these substances that have also been restricted due to their possible adverse effects such as phthalates, halogenated organic binding agents, azidirin and

polyzirindins, VOCs, and pigments, plasticizers and additives based on lead, cadmium, chrome VI, mercury and their compounds, arsenic, boron, copper and organic tin compounds.

On the other hand, regarding their inherent properties there are several lists of substances and candidates that have been recognized or are going to be recognized as SVHC (article 59 and 57 of REACH, respectively).

- *Whether limits are applied to constituents and/or final products*

The current EU Ecolabel criteria apply the limits mainly at final product level. Limits are mostly set up in w/w ratios, specifying the total mass content of the substance of concern in relation to the total mass content.

Feedback from the stakeholders suggested that limits should be kept at final product level, even when the restrictions applied to single ingredients

- *What limits for the substances of concern should be applied*

The specific limits for the substances of concern should be applied in accordance with risk assessments. In this sense, those substances of very high concern should not be intentionally added while substances of concern should be restricted to the feasible and technical minimum. As it is difficult to draft a general rule, limitations are expected to be set up case-by-case.

- *What test method should be applied*

There are several international standards and recognized methodologies that can be applied to measure the content and/or release of substances of concern. If there are several standards developed to measure the same substances, those more appropriate should be chosen.

- *What reporting/declarations should be required*

The performance of the measurements should be conducted and reported by independent certified third parties. In addition, information about the content of substances of concern of boards and chemical products should be provided by the producers.

Due to the large number of hazardous substances involved in the manufacture process as well as in the surface treatment process, detailed information is provided in the coming pages.

A.2.1 Substances falling into the hazard classification and risk phrases in Regulation EC No 1272/2008

The Regulation CLP (EC) No 1272/2008 provides risk phrases that cover those inherent properties of the substances that are classified as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for the reproduction. An extensive list is included in Table 47.

Table A48. List of substances classified as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for the reproduction

Acute toxicity	
H300 Fatal if swallowed (R28)	H301 Toxic if swallowed (R25)
H310 Fatal in contact with skin (R27)	H311 Toxic in contact with skin (R24)
H330 Fatal if inhaled (R23/26)	H331 Toxic if inhaled (R23)
H304 May be fatal if swallowed and enters airways (R65)	EUH070 Toxic by eye contact (R39/41)
H370 Causes damage to organs (R39/23/24/25/26/27/28)	H371 May cause damage to organs (R68/20/21/22)
H372 Causes damage to organs (R48/25/24/23)	H373 May cause damage to organs (R48/20/21/22)
Sensitisers	
H317 (1A): May cause allergic skin reaction (R43)	H317 (1B): May cause allergic skin reaction (R43)
H334 (1A): May cause allergy or asthma symptoms or breathing difficulties if inhaled (R42)	H334 (1B): May cause allergy or asthma symptoms or breathing difficulties if inhaled (R42)

CMR	
H340 May cause genetic defects (R46)	H341 Suspected of causing genetic defects (R68)
H350 May cause cancer (R45)	H351 Suspected of causing cancer (R49)
H350i May cause cancer by inhalation (R49)	
H360F May damage fertility (R60)	H361f Suspected of damaging fertility (R62)
H360D May damage the unborn child (R61)	H361d Suspected of damaging the unborn child (R63)
H360FD May damage fertility. May damage the unborn child (R60/61/60-61)	H361fd Suspected of damaging fertility. Suspected of damaging the unborn child (R62/63)
H360Fd May damage fertility. Suspected of damaging the unborn child (R60/63)	H362 May cause harm to breast fed children (R64)
H360Df May damage the unborn child. Suspected of damaging fertility (R61/62)	
Environmental hazards	
H400 Very toxic to aquatic life (R50)	H411 Toxic to aquatic life with long-lasting effects (R51/53)
H410 Very toxic to aquatic life with long-lasting effects (R50/53)	H412 Harmful to aquatic life with long-lasting effects (R52/53)
H413 May cause long-lasting effects to aquatic life (R53)	H059 Hazardous to the ozone layer (R59)

The future changes in the classifications may cause that essential substances not classified at present change their status in the future. In order to mitigate these effects the most recent classification rules adopted by the European Union shall take precedence over the listed hazard classifications and risk phrases.

Regarding the assessment and verification, it was pointed out that manufacturers only have access to the information about ingoing substances equal to or higher than the 0.1% threshold for Safety Data sheet (SDS) preparation. Ingoing substances that have the potential to trigger classification of the final product as hazardous to the environment, acute toxicity, CMR or as an allergen may be present at less than 0.1% and may have specific concentration limits listed in Regulation (EC) No 1272/2008.

A.2.2 Substances listed on the candidate list for SVHC or as SVHC

In accordance with article 6.7 of the Regulation (EC) No 66/2010 the list requires that the final product and any ingoing ingredient shall not contain substances that:

- meet the criteria in article 57 of Regulation (EC) No 1907/2006 and of the Council of 18th December 2006 concerning the registration, evaluation, authorization and restriction of chemicals (REACH)
- have been identified according to the procedure described in article 59(1) which establishes the candidate list for SVHC

No derogation shall be given concerning substances that meet either one or both of these conditions and which are present in the products at levels higher than 0.1% (w/w). Specific concentration limits determined in accordance with Article 10 of Regulation (EC) No 1272/2008 shall apply in cases where the concentration is lower than 0.1%

Compliance shall be based on a screening of the ingoing substances against the restricted substances and mixtures list, the current ECHA candidate list for SVHC and the criteria in Article 57 of Regulation (EC) No 1907/2006. Concentration limits shall be specified in the SDS in accordance with Article 31 of Regulation (EC) No 1907/2006 for substances and mixtures.

SHVC are those substances that are classified as:

- CMR (category 1 and 2) under the Dangerous Substances directive 67/548/EEC
- category 1A and 1B under the CLP Regulation
- PBT substances and vPvB substances and
- Substances that have endocrine disruptive properties
- Environmentally harmful without meeting the criteria for PBT or vPvB.

SVHCs may be included on the Candidate List with a view to them being inscribed on the Authorization List, which means that the substance becomes regulated (ban, phasing out or other form of restriction). Since these substance face being phased out or banned, it is only logical not to permit this type of substances in the ecolabelled product that are considered front-runners from an environmental performance point of view.

PBT and vPvB substances are defined in Annex 13 of REACH. These materials are listed at: http:/csis.jrc.ec.europa.eu. Those substances "deferred" or substances "under evaluation" are assumed not to have PBT or vPvB properties.

Potential endocrine disruptor is another inherent property included in those of the SVHC. These substances may affect the hormone balance in the human and animals and have unwanted effects in the sexual development and reproduction. Emissions to the aquatic environment are one of the most significant routes for the spread of endocrine disruptors. Especial ban is set for the use of substances that are considered into the category 1 (there is evidence of a change in endocrine activity in at least one animal spices) or category 2 of biological activity related to changes in hormone balance

A.2.3 Substances listed in the restricted substances and mixture list for EU Ecolabelled wooden floor coverings

The products shall not contain the hazardous substances listed in the restricted substances and mixture list at or above the specified concentration limits. The list is shown in Table 47.

Table A49. Restricted substances and mixtures list

Substance group	Scope of restriction	Limit values	Verification and testing methods
Substances of Very High Concern (SVHC's)			
Substances onto the ECHA Candidate List. *Applicability:* All products	SVHC's that appear on the Candidate List that is current at the time of application and which may appear in the final product shall not be present at concentrations of more than 0.1% w/w The current Candidate List can be consulted at: http://echa.europa.eu/web/guest/candidate-list-table	0.1% w/w	*Verification:* Documentation of Candidate List screening. *Test method:* To be specified according to each substance.
Pigments, plasticiders and additives			
Metals and their compounds *Applicability:* All products.	The following metals shall not be used as an ingredient of the pigment, plasticiser or additive whether as a substance or part of a mixture itself: - lead, cadmium, chrome IV, mercury and their compounds - arsenic, boron and copper - organic tin compounds **Derogation** Pigment chromophore that is bonded within a crystal lattice and is insoluble	0.1% w/w	*Verification:* Documented testing demonstrating that the pigment chromophore is bonded within a crystal lattice and is insoluble. *Test method:* To be determined
Phthalates			
Adhesives and plasticiders *Applicability:* All products	*The following phthalates shall not be intentionally added as plasticisers:* DEHP (Bis-(2-ethylhexyl)-phthalate) BBP (Butylbenzylphthalate) DBP (Dibutylphthalate) DMEP (Bis2-methoxyethyl) phthalate DIBP (Diisobutylphthalat) DIHP (Di-C6-8-branched alkyphthalates) DHNUP (Di-C7-11-branched alkylphthalates) DHP (Di-n-hexylphthalate)	Sum total 0.1% w/w	*Verification:* SDS shall be provided for plasticisers used *Test method:* To be determined

Azidirin			
Adhesives, binders, etc *Applicability:* All products	Azidirin and polyaziridin shall not be used as an ingredient of the additive whether as a substance or part of a mixture itself	0.1% w/w	*Verification:* SDS *Test method:* To be determined
Halogenated organic binding agents			
Substances in general *Applicability:* All products	Halogenated organic binding agents shall not be used as an ingredient of the additive whether as a substance or part of a mixture itself	0.1% w/w	*Verification:* SDS *Test method:* To be determined

The following rationale describes the environmental aspects of the substances that are proposed to the banned in the revised criteria and also sets out the relevance of the substances to the wooden floor covering sector. These chemical products are:

- *Halogenated organic binding agents*

Halogenated organic bindings are organic compounds that contain the halogens: chlorine, bromine, fluorine or iodine, including chlorinated polymers. Halogenated organic compounds encompass a large number of substances that are harmful to health and environment, are highly toxic to aquatic organisms, carcinogenic or harmful to human health. Moreover, they do not degrade readily in the environment, a fact that increases the harmful effects. Halogenated organic compounds include for example methylene chloride (EC number 200-838-9) that is an organic compound widely used as a solvent and blowing agent for polyurethane foams (classified as (H351) Carc.2 in Annex VI of CLP regulation), chlorinated paraffins, perfluoralkyl compounds (PFOA and PFOS) and certain plasticisers.

- *Phthalates*

Phthalanes are classified as toxic for reproduction (Article 57c of REACH), some are endocrine disruptors and others are being more deeply investigated. Some examples of phthalates that have been already classified are:

- dibutyl phthalate (DBP), bis (2-ethylhexyl)phthalane (DEHP), benzyl butylphthalate (BBP) and diisobutylphthlate (DIBP) are included in Annex XIV of REACH regulation according to susbtances subjected to authorization
- dyclohexyl phthalate (DCHP), dihexexyl phthalate (DHP) and diethyl phthalate (DEP) are found on the EU's priority list of endocrine disruptors.
- dipentylphthlate (DPP), N-pentyl-isopentylphthlate, diisopentylphthlate (DIPP) and bis(2-methoxyethyl)phthalate are included in the candidate list of SVHC. Other phthalanes included in this list are diisobutyl phthalate (DIBP), diisoheptyl phthalane (DIHP) or bis(2-methoxyethyl) phthalate
- diisononylphthlate (DIN), diisodecylphthlate (DIDP) and di-n-octyl phthalate (DOP or DnOP) are included in annex XVII of the REACH regulation according to substances subjected to restriction.

Phthalates are typically used as plasticizers in PVC, a plastic that is scarcely used for manufacturing wooden floor covering. PVC is, according to the information publicly available, just present in the manufacturing of cork-vinyl products. This flooring has a polyvinyl chloride (PVC) backing, a cork (or PVC) inner layer and a cork underlayment, being the total content of PVC lower than 30% v/v. Considering that the cork flooring market share is not dominate, the overall present of PVC in the European wooden floor covering market is residual.

Due to the high toxicity of certain phthalates as well as the scarce used in the sector under study; three specific phthalates were proposed to be completely banned: DnOP, DINP and DIDP in the current EU Ecolabel criteria. The new revised criterion proposes to reinforce the current ban and also extend it to other phthalates such as DBP, DEHP, DIPP, BPP and DnPP due to the same reasons. This measure does not expect to bring any market restriction due to the above mentioned reasons.

The proposal is supported by the recent revisions of national schemes that include bans on phthalates acting as plasticizers. For example, Nordic Swam 6.0 excludes the use of phthalates in labelled products and NZ label requires the submission of appropriate information about the phthalanes used as plasticizers and ecplicitly bans the use of DBP, DEHP, DIPP, BPP, DnPP, DnOP, DINP and DIDP as they are considered phthalanes of concern.

- *Aziridine and polyaziridine*

Aziridine is classified as: Flam. Liq. 2, Carc. 1B, Muta. 1B, Acute Tox. 2, Acute Tox. 1, Skin Corr. 1B and Aquatic Chronic 2 (H225, H350, H340, H330, H310, H300, H314 and H411) according to harmonized classification of table 3.1 of Annex VI of CLP regulation. Aziridine is mainly used in polymerization products as a monomer for polyethylenemine (polyaziridines), in, for example, adhesives, binders, coating resins and varnishes

- *Pigments, plasticisers and additives based on:*
  - *lead, cadmium, chrome (VI), mercury and their compounds,*
  - *arsenic, boron and copper and*
  - *organic tin compounds*

Some pigments and adhesives that can be used in the flooring manufacturing are based on heavy metals that can accumulate in the environment and cause serious damage to ecosystems and human health, having the potential of bioaccumulation and leading to toxic effects in plants and animals if they are subjects of heavier exposure. For this reason, this sub-criterion focuses on excluding pigments, plasticisers and additives that are based on particular elements of concern (lead, mercury, etc.) rather than simply the actual hazard classification of the functional substance itself.

Heavy metals and compounds thereof such as those listed in point (i) and (ii) are banned from being present in chemical products or in the ingoing chemical substances used in the production of flooring.

Among these metals the following ones are of main concern and therefore they are proposed to remain as banned substances: chrome (VI) (as $HCrO_4^-$, CrO_4^{-2} and $Cr_2O_7^{-2}$) that causes severe allergic contact dermatitis in humans and is able to elicit dermatitis at very low concentrations. A range of chrome (VI) compounds are on the SVHC candidate list and Annex XV dossiers have been prepared for more than 15 chrome (VI) compounds[198], components used in surface treatments are like the lead chromate, lead sulfochromate yellow and lead chromate molybdate sulphate red that are included in the authorization list[199] under REACH regulation meeting the criteria of carcinogenic and toxic for reproduction pursuant to Article 57 (a) and (c) of REACH or arsenic that was used as wood preservative and associated with impacts on organisms living in aquatic environments in certain seawater areas.

However, there are some **pigments containing metals have been derogated in other EU Ecolabel schemes e.g. EU Ecolabel for paints and varnishes**[200]. They are pigments that even containing metals

[198] Annex XV dossiers of Directive 67/548/EEC (OJ 196, 16/08/1967, p. 1–98). EU Directive available online at: http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:31967L0548

[199] Authorization list of SVHC included in Annex XIV of REACH regulation. More information available online at: http://echa.europa.eu/addressing-chemicals-of-concern/authorisation/recommendation-for-inclusion-in-the-authorisation-list/authorisation-list

[200] EU Ecolabel paints and varnishes:

can be used where laboratory testing shows that the metal chromophore is bonded within a crystal lattice and is insoluble. The following metal containing pigments are derogated for use: barium sulphate, antimony nickel within an insoluble TiO_2 lattice, cobalt aluminate blue spinel and cobalt chromite blue-green spinel. As assessment and verification of this derogation test results are required demonstrating that the pigment chromophore is bonded within a crystal lattice and is insoluble in accordance with DIN 53770-1 or equivalent

Organic tin compounds such as tributyltin (TBT), dibutyltin (DBT), dioctyltin (DOT) and tryphenyltin (TPT) are all substances of concern that are used in pigments and additives. TBT is the organic tin compound that has been investigated most thoroughly showing to cause endocrine disruption in marine organisms.

A.2.4 Specific restrictions in substances used during the manufacturing process

The intensive use of adhesives and additives contenting formaldehyde and VOCs is the major concern of this criterion. This criterion has become more relevant in the last years due to the greater share of laminate floorings on the European market and their relative higher adhesive content with respect to other types of wooden flooring. Adhesives used for the manufacturing of wooden floor coverings can be classified as: VOC free, water-based or solvent-based. These three types of adhesives or their combination can be used in the same facilities being the major formaldehyde and VOC emissions arisen during the application and drying process of solvent-based coatings and subsequently those in the manufacturing of the boards. Minor formaldehyde and VOC emissions occur from mixing processes, cleaning of tools and equipment, storage of paints, wastes and other formaldehyde and VOC containing products used in the coating process but they can be minimized by good housekeeping practices.

Regarding the adhesives used in the board manufacturing, solvent-based adhesives are mostly used. In this type of adhesives the formaldehyde and VOCs content is significantly higher than in water borne products or VOC-free products. The potential substitutes for VOC (using low-VOC and VOC-free systems) should be evaluated considering possible alternatives or mixtures from the technical, economic and environmental points of view. If the complete substitution of organic solvents is impractical then changing to systems with a reduced VOC content (such as water-borne paints with 5-15% VOC, high solids with 25-40% VOC or UV curing paints with 2-5% VOC, in the case of surface treatments) can decrease content and emissions.

OJ L 181, 14/07/2009, p. 27–38 (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009D0543) and
OJ L 181, 14/07/2009, p. 39–48 (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009D0544)

Concerning the adhesives for lamination, there are four main types of adhesives. Two of these are based on formaldehyde (urea-formaldehyde resins and melamine-user-formaldehyde resins) and mainly used for manufacturing MDF, plywood and fibrewood, one is based on polyvinyl acetate (PVAs adhesive) and one is based on isocyanates (EPI adhesives).

If feasible from a technical point of view, it could be interesting, the possibility to substitute some substances with others, more environmental friendly**.** From the literature, it rises that for example it could be interesting the replacement of conventional urea-formaldehyde and melamine-formaldehyde resins with natural resins that have the same specifications in the final product. With this, and depending on the quantity of resin used in each product, the equivalent emissions of CO_2 would be further reduced. On average, this reduction is estimated at 16% for laminated wood and 46% for fibreboard[201]. However, this should also be feasible from a technical point of view, what according to the information provided in Section 5.31 is currently not possible. The limit sets in this criterion aims at encouraging the substitution of chemicals and increasing the use of water-based adhesive varieties, VOC-free adhesives or mixtures that keep the solvent adhesive proportion to the minimum feasible.

The key factor in determining the appropriate ambition level of formaldehyde emission criteria is to understand what resin formulations are commercially available and which their relative costs are. Table 47 summarizes the main resins used in wood-based panel manufacture and their costs in 2010.

Table A50. Comparison of wood-based panel resin costs and technical applications

Resin name	Cost (US$/kg)	Comments
Urea-formaldehyde (UF)	0.7-.08	Mainly used with PB and MDF in indoor and non-structural boards, poor moisture resistance. Risk of hydrolysis reactions releasing formaldehyde from final board.
Melamine formaldehyde (MF)	1.5-1.7	Mainly used with PB and MDF in indoor and non-structural boards, better moisture resistance and lower degree of potential long-term formaldehyde release than UF.
Phenol formaldehyde (PF)	0.7-1.1	Used in OSB, LVL and MDF. Good water resistance, virtually no reversible hydrolysis that leads to formaldehyde emissions. Can be used in structural and outdoor products. Requires higher press temperature than UF
Methylene-diphenol Diisocyanate (pMDD)	2.1-2.3	Mainly used in OSB and MDF. Does not contain formaldehyde, imparts good moisture resistance and can be used in outdoor and structural products. Does not require such high press temperatures as PF but MDI exposure is harmful to workers. RAL-UZ 76 actually requires a chamber test for MDI

An intermediate resin product also exists known as melamine-urea formaldehyde (MUF) where urea can be partially replaced by melamine and will have properties between those of UF and MF

[201] Zabalza Bribián, et al, 2011. *Life cycle assessment of building materials: Comparative analysis of energy and environmental impacts and evaluation of the eco-efficiency improvement potential*. Building and Environment 46, 1133-1140.

As shown in the table, existing alternatives that are VOC-free are already on the market. Most of these alternatives are based upon isocynates (e.g. polyurethane or polyuria). However, the use of these alternatives is not free of risks as isocyanate is classified as R40 and its use is also restricted in some national labels. For example, Nature plus restricts the use of isocyanate-adhesives to 2% w/w of the absolute dry weight of the wood/wood-based material. On the other hand, other national schemes such as Nordic Swam 6.0 allows its use thanks to derogation and the EU Ecolabel criteria for wooden furniture proposed a **default derogation to use isocyanate-adhesive classified as R40**. The main reason for this derogation is that current formulations on the market cure completely and leave no residue free isocyanate being adhesives that are effectively VOC-free. This proposal emerged as a request of stakeholders as they considered the original proposed criteria regarding harmful substances unclear and confusing on the limits for VOCs in coatings and adhesives.

The limitation of VOC in adhesives is required by other national schemes. For example, Nature Plus requires a content level lower than 5% w/w of the absolute dry weight of the wood/wood based material, Nordic Swam 6.0 only permits adhesives that contain no more than 3% w/w and the Belgian GPP scheme requires a maximum aromatics content of the solvents upto 5% w/w.

These benchmarks suggest that a limit of 3% w/w VOC in adhesives can be achieved and this is the value proposed of the revised EU Ecolabel criterion.

Formaldehyde is a particular kind of VOC that is very used to make clothes permanent-pressed, as a preservative, and as part of the makeup of adhesive products. It is also dangerous and exposure can damage health in high concentration. A great deal of wood flooring is manufactured of layers of wood particles or veneers pressed together and sealed with adhesives containing urea formaldehyde resin.

Formaldehyde as such is classed by the International Agency for Research on Cancer as a carcinogen, basing this classification on the possible effects of large doses of formaldehyde to which workers in some chemical and manufacturing plants were formerly exposed. There is no evidence that small dosages (much lower than the guideline limit, 0.1 mg/m^3, with reference to the domestic environment) have any carcinogenic effect. For this reason, formaldehyde has been traditionally checked on top of the VOC testing of several products.

Under test conditions, concentrations of formaldehyde vapour in the air are expressed in parts per million (ppm) or milligrams formaldehyde per cubic meter of air (mg/m^3). For formaldehyde $1mg/m^3$ = 0.81ppm. At levels of 1 to 3ppm it can be mildly to moderately irritating to the eyes and nose, depending on the sensitivity of the individual. At levels above 10 ppm it causes immediate strong discomfort, and long term continuous exposure at these extreme concentrations would result in serious health effects. There are extreme cases known where highly allergic individuals could be affected by exposure over a wide range of chemicals even at very low concentrations.

Not all wood-based panels contain added formaldehyde as a component of the binding system, and in those panel types where a formaldehyde based synthetic resin binder is used the amount of free formaldehyde given off by an individual panel is relatively low in respect to overall indoor air concentrations. Release of free formaldehyde from wood-based panels is influenced by a number of factors including: binder type, temperature, humidity, panel thickness and percentage concentration. Experiments have demonstrated that in a stable environment (temperature and humidity) formaldehyde release does decrease over time and the low initial values of typical particleboards and MDF will decrease by at least 50% within a few weeks of manufacture.

Although formaldehyde is recognized by the WHO as a suspect carcinogen, the use of formaldehyde-based resin formulations remains the most common method of producing wood-based panels. That is due to the lack of economically and technically available substitutes that without presenting physical or human health risks can be used for these applications. For this reason, a total ban of formaldehyde based resin is, for the time being, not feasible.

There are two possibility of regulating the free-formaldehydes: by setting up a limit on the free-formaldehyde content of the chemicals and chemical products used in the manufacturing process (content route) or by setting a limit on the formaldehyde emissions coming from a component of the product, the finished product or both. Due to the lack of free formaldehyde alternative adhesives, the current EU current criterion aimed at restricting the formaldehyde content in the raw materials. However, additional testing is also required to demonstrate the absence of formaldehyde emissions during the use phase. From our point of view, both criteria restrict the use of ingredients that are potential emitters of formaldehyde. The restriction on the formaldehyde content is however much more restrictive and limits the options of the producers.

The current Ecolabel criteria for wooden floor coverings regulate both the content of free-formaldehyde in chemicals and release of formaldehyde during the use phase. The current EU Ecolabel criterion requires two limits depending on the product that contents the free-formaldehyde. The first limit applies to products and preparations used in the panels and shall not exceed 0.3% w/w. The second limit applies to binding agents, adhesives and glues for plywood panels or laminated wood panels and shall not exceed 0.5% w/w.

Other EU Ecolabel related schemes (for example those for wooden furniture) have also required a revision of the wording used for formulating the criteria dealing with formaldehyde emissions and content. Stakeholders pointed out that a restriction in the content of free formaldehyde in the binding agents, adhesives and glues for plywood panels or laminated wood panels not exceeding 0.2% w/w could effectively prohibit all aminoplastic based resins from being EU Ecolabel products. Moreover, it was suggested that the limit should apply to the "resin formulation" (resin plus hardener), rather than individual components of the formulation. Additionally, the industry argued that concerns over risks from higher free formaldehyde ingredients are controlled automated handling processes. It was also communicated that for verification purposes, reference should be made to ISO 11402 tests for free-formaldehyde contents.

The revision of other national schemes points out the possibility of withdrawing this sub-criterion as a limit on formaldehyde emissions will be required in other criterion. In this sense, other national schemes such as the Nordic Swan version 6.0, Blue angel RAL-UL176, Nature Plus or even third party schemes such as the Korean label or the NZ Environmental choice proposed a limit on the formaldehyde emissions rather than the free formaldehyde content, which will be revised in the coming pages.

The revision of the **EU Ecolabel criteria wants to reduce the number of testing and the costs associated, therefore it is proposed to withdraw the criterion related to the free formaldehyde content in the adhesives and additive during the manufacture process** while proposing strict limits to the formaldehyde emissions from the finished products. If this alternative is not considered appropriated a lower limit upto 0.2% w/w for those non-MDF panels should be regarded.

EU Ecolabel team is aware that this is a major change and particularly welcomes comments on this during the consultation period.

A.2.4 Specific restrictions in substances used for surface treatments

The various types of flooring covering are often surface treated to ensure a durable, easy to clean surface and above all hard wearing surface that allows a long service life for the floor. The surface treatment largely takes the form of lacquers (different types) and oils along with primers, sealants, undercoats and top coats that are used alone or together in systems and often involves more than one lacquering product and several coats being applied in different quantities.

Considering that most of the surface treatments are not VOC-free, especial limitations are proposed for the chemicals and chemical products to be used in this manufacture step.

VOCs

The most important sources of solvent related VOC emissions occurs during the coating treatment and although depending on the process and products used, generally surface treatment and the subsequent drying process of the work piece are the most relevant ones. Techniques to reduce the environmental damages associated to this process are: use of low VOC substances, improved application efficiency in the coating process or use of abatement technologies (especially oxidation).

To optimize the coating process (and minimize the emissions) all involved process-steps and the properties of wood have to fit together. Changes in the coating process (e.g. usage of water-borne coatings) leads usually to changes in the application technology, grinding technology, different air filters, etc that should also be considered. This potential substitution should therefore be evaluated considering application technologies and any especial conditions needed for their use and for example at an industrial scale it is limited to coating of MDF, being the investment in the new application technology the main barrier[202].

UV-curing coatings employ "reactive solvents" that are chemically incorporated into the paint layer during the curing process. UV cured base coatings and sealants are applied by roller or spray and then cured in a special kiln using UV light. The major advantage of these treatments is the particular rapid curing after application, which allows handling and packaging after less than 10 seconds. UV treatments applied at around 70-100g/m3 wood flooring contain no or almost no VOC. UV treatments may contain substances classified as environmentally harmful such as benzophenone and various acrylates. The concentration of environmentally harmful substances may range from around 10 up to 50% in different UV treatments for flooring. These substances cure and then remain stable.

UV oil combines the benefits of an oiled floor and a UV lacquered floor. UV oil is based on natural oil that are UV stabilized through chemical modification. This gives better chemical properties and improved scratch resistance compared with natural oils. UV oiled floors do, however, require more maintenance than lacquered floors. UV oils can also contain high concentrations of environmentally harmful substances such as acrylates and polymers based on polyether polyols and acrylic acid esters. This may include as much as 60% substances that are classified as toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment (R51/53).

If the complete substitution of organic solvent is impractical then changing to systems with a reduced VOC content (such as water-borne paints with 5-15% VOC, high solids with 25-40% VOC or UV curing paints with 2-5% VOC) can decrease emissions. Completely VOC-free coatings are rarely used for wood coating. The main barriers to use these coating types are: the investments needed to update the technology and the additional changes in the exhaust and drying technologies as well as the potential adverse impacts on substrate properties and the corrosion of the equipment due to the use of water borne solvents.

Whenever the surface quality is an important issue and water-borne solvents are not recommended to use, the limits set for VOC content can be achieved by increasing the efficiency of the application technologies and consequently decreasing the total amount of organic solvent to be needed. The examination of the European best available technology report (BREF) on surface treatment using

[202] Guidance 10 on VOC Substitution and Reduction for Activities Covered by the VOC Solvents Emissions Directive (Directive 1999/13/EC) https://www.enviroportal.sk/uploads/files/ovzdusie/organicke%20rozpustadla/235pdfsamVOC-doc-210509.pdf

organic solvents[203] shows that it is appropriate to calculate the environmental impact of the use of organic solvents using the application method (g/m^2). The method involves calculating of environmentally harmful substances based on the application method and the percentage of content of any harmful substance in the solvents used. This method considers the efficiency of the mostly used techniques and applies efficacy rates that remain as shown in the previous tables. In addition, the emission level is calculated based on the:

- content of VOCs in products for surface treatment
- number of coats on the surface treatment and quantity applied per coat per m^2
- method of application, in accordance with the previously shown degrees of efficiency used for calculating the quantity applied.

The calculation is

$$VOC\ emission\left(\frac{g}{m^2}\right) = \frac{weight\ of\ coat\ layer\left(\frac{g}{m^2}\right) x\ weight\ (\%VOC)}{degree\ of\ efficiency\ (\%)}$$

The current EU Ecolabel criteria sets a restriction in the applied quantity of wet paint/varnish of environmentally harmful substances in accordance with the Directive 1999/45/EC that shall not exceed $14g/m^2$ surface area and applied quantity (wet paint/varnish) of VOC shall not exceed $35g/m^2$. In addition, it requires that chemical products for the surface treatment may content up to 5% w/w of organic volatile content. Both restrictions are proposed to be stricter in the revised EU Ecolabel criteria set since the technology and current market conditions allow for that. The permitted level of VOC is a low level but achievable level, and that it is possible to fulfil the requirement concerning the quality and durability of the flooring surface at this level.

Formaldehydes

Formaldehydes are also present in the chemicals used for surface treatment. The emissions of formaldehyde can be limited either restricting their content in the chemicals and chemical products to be used in the surface treatments as well as restricting their emissions from the finished product.

The second option is the preferred one in most of the national schemes. This option gives freedom to the producers to choose the most convenient combination of chemicals to obtain a high quality product while achieving the emission limits requested by the ecological criteria.

The revision of the EU Ecolabel criteria for the wooden floor coverings also proposed to be in line with these national schemes limiting the emissions of formaldehydes from the finished product instead of restricting their content in the chemical and chemicals products used in the surface treatments.

[203] European best available technology report on surface treatment using organic solvents, august 2007 available at: http://eippcb.jrc.ec.europa.eu/reference/BREF/sts_bref_0807.pdf

Eventually, **some stakeholders specifically stated during the revision of the EU Ecolabel criteria for wooden furniture[204] that derogation for R43 preservatives (biocides) would be required if water-borne coatings were to be used in EU Ecolabelled products**. The use of water-borne coatings is desirable due to the substantially lower VOC contents of such products compared to organic-solvent based equivalents. Although specific EU Ecolabel criteria have been developed for paints and varnishes, it should be highlighted that the scope for those criteria do not extend to coating compounds used in factory processes involving wood-based panel manufacture.

Biocides

In accordance with the set of EU Ecolabel criteria for other indoor wooden products biocides should not be permitted or applied to the surface of any finished material for the purposes of adding a final disinfected effect. These substances should only be permitted in the impregnation of wood logging activities that is stored prior and after the saw mill stage. The actives substance(s) used shall comply with the requirements on hazardous substances in accordance with general criterion 2a and contain only active substances approved under the biocidal Products Regulation (EC) No 528/2012 (for product group 8 or 18).

Applicants should consult the listing of authorized biocides approved by the European Commission by product type: http://ec.europa.eu/environment/chemicals/biocides/active-substances/approved-substances_en.htm

Preservatives for which a dossier has been submitted for evaluation pending a decision on authorization or non-inclusion may be used in the interim period up until the adoption of the Decision.

There are several biocides that are specifically excluded in other EU Ecolabel schemes for biocidal purposes and that are also proposed to be excluded in this set of Ecolabel criteria for wooden floor coverings. These substances are included in Table 47:

Table 51. List of substances used as biocides in wood materials and proposed to be excluded in ecolabelled products

Substance	Rationale and discussion
Chlorophenols (their salts and esters) (EC 201-778-6, CAS 87-86-5)	It is included in the Annex XVII of REACH Regulation according to restricted substances. It was banned in the EU in 1987 for this use. It is explicitly mentioned as a banned substance for the purpose of informing non-EU suppliers
Dimethylfumarate (DMFu)	It is a mould inhibitor which is used to protect items in transit from attack by micro-organisms. DMFu as a biocide is not allowed in the EU according to Decision 2009/251/EC (incorporated to REACH Annex XVII under entry 61)
Organic tin compounds including TBT, TBTO, TPhT, DBT and DOT	Restrictions to these compounds have already been introduced at the EU level by means of amendments to the Directive 76/769/EEC on Marketing and Use and Directive 2009/48/EC on toy safety. According to ECHA, organotin compounds covered by entry 20 of Annex XVII of REACH consist in organostanic compounds that must contain a carbon-tin bond. Substances like tin salts or organotin compounds for which tin is bound to an atom other than carbon are not covered by this entry. In conclusion, it is legal

[204] Page 27 of Revision of EU Ecolabel Criteria for Furniture, 2nd Ad-Hoc Working Group meeting Technical report: EU Ecolabel criteria draft 2.0, Prepared by S. Donatello, H.Moons, O. Wolf, C. Hidalgo, N. Fuentes, 16th April 2014 available at: http://susproc.jrc.ec.europa.eu/furniture/stakeholders.html

	requirement that organostannic compounds are not used as biocides in free association paint and this exclusion is proposed to be extended to biocides used in any materials involved with EU Ecolabel WFC.
Tributyltin (TBT)[205]	TBT compounds are included in the Rotterdam Convention and are considered toxic chemicals which have negative effects on human and environment. In addition, TBT compounds elicit effects in the endocrine systems of aquatic organisms and are moderately to highly persistent organic pollutants causing irreversible damage to the aquatic life.
Bis(tributyltin) oxide (TBTO)	It was identified as a SVHC meeting the criteria of a PBT substance pursuant to Article 57(d) and was therefore included in the candidate list for authorization. TBTO is currently only used in the EU as an intermediate for manufacture of other chemicals. The declining use of the TBT has been reflected in reduced levels of TBT found in sediments
Triphenyltin (TPhT)	It shall not be used after 01 July 2010 (except for articles that are already in used before that date) in articles in concentrations higher than 0.1% w/w of tin
Dibutyltin (DBT)	It shall not be used after 01 January 2012 (except for articles that are already in used before that date) although the exceptions include floor coverings. Even in these cases, the concentration in these articles must not exceed 0.1% w/w of tin

Another biocide that has restrictions to be used in some national schemes as well as in other EU Ecolabel schemes is **triclosan**. Examples of those schemes are Nature plus and current EU Ecolabel for Shampoos and soaps. According to some the information provided in the Technical Background[5], high doses of triclosan can be responsible for long-term liver damage, curbing the activity of the central nervous system and having allergic potential. In addition, triclosan can be degraded in wastewater to methyltriclosan, which persists in the environmental and accumulates in organisms (bioaccumulation). There are also considerable evidence that under the influence of chlorine, triclosan is degrade to become carcinogenic or hormone-disruptive substance (chloroform or 2,4 dichlorophenol). Triclosan falls into the R-phase groups R50/53 and H-phase H410 and H315 and has already existing alternatives on the market and therefore it is excluded to be used in any Ecolabel product.

Indoor wooden floor coverings correspond with use class 1 of the international standard EN 335:2013- Durability of wood and wood-based products – Use classes: definitions, applications to solid wood and wood-based products, where no exposure to the weather and wetting occurs. Attack by disfiguring or wood-destroying fungi is considered insignificant and always accidental and attack by wood-boring insects, including termites, is possible although the frequency and importance of the insect occurred depends on the geographical region. In the revision of the EU Ecolabel criteria of those related product groups it was decided that for geographical areas at high risk of attack by wood boring insects, it is preferred that the end user should decide whether or not if additional biocidal products are to be used on indoor wooden floor covering materials post-purchase rather than all consumers potentially being deprived of the opportunity to have biocide-free indoor wooden floor covering. Overall, indoor wooden floor coverings shall not be impregnated due to fact that the adverse environmental impact caused by chemical treatment outweighs by far the positive effect of inherent resistance to attacks by fungi or insects on indoor wooden floor coverings that perhaps may never occur during the use phase.

[205] http://www.toxipedia.org/display/toxipedia/Tributyltin

A.3 MANUFACTURING PROCESS

A.3.1 Energy consumption

The energy consumption during the manufacturing was identified in the Technical Background report[5] as the environmental aspect that causes the highest environmental damage, regardless the type of flooring. In general, wooden floor coverings (based on wooden based panels) is an intensive energy sector where the best available technologies (BATs)[206] have been identified at EU level to reduce the energy consumption and the environmental damages associated with. Drying the wood is the most energy consuming process step being followed by the sawing and milling. Both demands can be reduced, for example, by using air-drying or waste materials for on-site energy production, among other techniques.

The current criterion proposes a calculation formula and respective benchmarks depending on the type of wooden flooring. The calculation formula takes into account the proportion of raw material coming from certificated forests or equivalent, and eventually from recycled material, and the sources of energy to cover the energy demand of the process.

The current calculation formula is based on the estimations carried out by the Nordic Swam labelling 2006[207]. The requirements are organized in two parts: the calculation of a point score and the application of limits to the total score of wood, laminate and other floorings as indicated in the user manual[208]. In brief, the energy consumption is calculated as an annual average of the energy consumed during the production process (excluding premises heating) from the raw materials in bulk to the finished floor covering. This means, for example, that the energy calculation for wood and plant based products shall be measured from the input of raw material into the factory until the finishing operations, packaging included. The calculation does not include the embodied energy of the raw materials or that required for manufacturing adhesives and varnish or coatings.

This formula has been revised in the last proposal of Nordic Swam criteria for Floor covering in 2014 and proposes new stricter limits to award the licence in accordance to the following equation to calculate the energy consumption

$$E = \frac{A}{20} + \left(5 - \frac{B}{3}\right) + \left(5 - \frac{C}{7}\right)$$

Where A is the proportion of renewable fuel (%), B is the electricity consumption (kWh/m^2) with a maximum requirement of 15kWh/m^2 and C is the fuel consumption (kWh/m^2) within a maximum 35kWh/m^2. The minimum values to be achieved to award the label are:

- E>11.0 for solid wood and laminate flooring and
- E>8.0 for parquet flooring, bamboo flooring and cork flooring

[206] Best available techniques (BAT) reference document for the Production of Wood-based panels, available at: http://eippcb.jrc.ec.europa.eu/reference/BREF/WBP30072013D1.pdf

[207] Nordic Ecolabelling for Floor covering, Version 4, December, 7, 2006 available at: http://www.ecolabel.dk/kriteriedokumenter/029e_background.pdf

[208] User manual for the EU Ecolabel award scheme for Wooden Floor coverings, January 2010 available at: http://ec.europa.eu/environment/ecolabel/documents/User_manual_wooden_covering.pdf

The energy consumption is calculated as electricity and fuel consumption in drying and sawing and included in the calculation for parquet, bamboo and solid wood flooring. For flooring that includes wood-based board in the structure, the energy consumed in the manufacture of the board is to be included and for other flooring, the only thing included is the energy used in the final manufacturing of the flooring in the flooring factory. At least 95% w/w of the raw materials in the flooring must be included in the calculation of the energy consumption. Energy consumption in the manufacture of adhesives and lacquers used in the manufacture of the flooring are however not included.

This formulation has the advantages of being purely based on energy-related requirements, removing the parameters in the calculation relating to the proportion of wood raw material from certified forestry and the proportion of recycled wood raw material. The reason for this is that these points are dealt with in other criteria as for example criteria 1.1-1.4.

The energy requirement comprises two parts. One part contains requirements/limit values for the use of electricity and fuel. The other sets out a certain sum total that must be achieved in the energy formula. The energy requirement promotes low energy consumption in terms of electricity and fuel, plus a high proportion of renewable fuels. Each term of the equation may be a maximum of 5, contributing equally to the total E and making all of them significant. The less energy used during the manufacture, the higher the figure achieved within each set of brackets. In the same way, a high proportion of renewable fuel contributes a term that is close to 5. This means that the lower energy consumption and the higher the proportion of renewable fuel, the higher the sum total E.

The purpose of this revision has been to make the requirement more energy-focused while retaining the character of the energy requirement in promoting low energy consumption and low contribution to the GHG effect through a high proportion of renewable fuel, and in taking account of each specific flooring material.

The revision also streamlines what must be included in the energy calculation. Since steer ability is low for the manufacturing steps that take place before the flooring factory, the energy requirements are limited to cover;

- electricity and fuel consumed in drying and sawing for parquet, bamboo and solid wood flooring. Drying is included for wood flooring since this often takes place in-house. The energy for drying was also included in the previous criteria
- for flooring that includes manufactured board in its structure, the energy consumed in the manufacture of the board is to be included. The energy calculation is based on data from raw material handling (including conveyor to the production line), up until the finished product ready for any surface treatment. Energy consumption during the surface treatment is not included.

As the existing minimal limits states that at least 95% w/w of the raw materials in the flooring must be included in the calculation of energy consumption, the laminate flooring does not include the manufacture of structural and decorative papers. Energy consumption in the manufacture of chemical products such as adhesives and lacquers is also not included in the calculation.

Nordic Swam checked that this requirement level for the sum total of E has been tightened slightly, compared with previous requirements concerning the equivalent sum total (called P, first equation). the requirement is judged to have a steering effect, such that the floor covering in each flooring category that have the highest energy consumption and/or lowest proportion of renewable energy do not meet the requirement level. Since the sum total P also included a contribution from the proportion of certified wood and renewable raw materials, P and E are not comparable.

The revision of other national schemes arise the proposal of including an additional criteria focused on the **energy management during the production process**. This proposal is discussed under the next section of this report.

A.3.2 Waste production management

The minimization of production waste and the proper management of these residues is of key importance for reducing the overall environmental damages caused during the production stage. The minimization of the waste production ensures an efficient use of the resources, saving natural resources and probably helping to decrease the production costs.

The minimization of production waste can be achieved by developing and implementing a waste minimization management programme. The programme must ensure that during the manufacturing stage processes to minimise waste through recovery and reuse or reprocessing have been implemented. The waste produced during the manufacturing stage is mainly wood chips, waste wood from wood processing operations, waste from the forest harvesting and/or untreated fibre of wood and plant-based materials, which should be either recycled in the production or used as fuel in on-site combustion plants. All these materials are characterized by having high energy content and being considered as CO_2 storage. For these reasons, it is important to prevent their landfilling or incineration without energy recovery. The good-practices (recovery, reuse and reprocessing) are environmentally beneficial because, among other reasons, they prevent further harvesting of virgin trees and save energy (recycling uses less energy than that required by virgin materials).

A.4 USE PHASE

A.4.1 Release of dangerous substances

As commented previously, the emission of harmful substances and in particular VOCs and formaldehyde, can be regulated either limiting the content of substances that can potentially be released or limiting the emissions of these substances of concern from the components or the finished products during the use and end-of-life phases.

The second approach is preferred in most of the national environmental schemes revised in this study and also by the industry. In this sense, the regulation of formaldehyde emissions is underpinned by a number of standards that have been developed at national and international level. The European standards developed in 2000 by the European Panel Industry define several formaldehyde emissions ratings. Original ratings included E1, measuring 9mg/100g and below, E2, measuring greater than 9mg/100g to below 30mg/100g, and E3, measuring a greater than 30 mg/100g ratio. Pressure for more stringent standards led to a new ratings classification, E0, based on emissions measuring 0.5mg/l and below. European test methodology is based on the Perforator Test Method, which measures the formaldehyde levels inside the wood specimen. More information about the limits and the measures has been included in section 5.7.2.1.

Japan has also defined formaldehyde emissions ratings. The Japanese Formaldehyde Adhesive Emission Standards, defined by the set forth by the Japanese Industrial Standards (JIS) and Japanese Agricultural Standards (JAS) departments, use a different testing methodology, the Desiccator Test Method which measures emissions released from the wood. Ratings are assigned in four categories, F*, F**, F***, and F****, with F**** having the lowest level of formaldehyde emissions below 0.005 mg/m^2h. Comparing these two standards is difficult due to the different methods and to different units of measurement.

The United States has been slow to address this concern, but a rating system released in 2007 by the California Air Regulatory Board (CARB) aims to correct that. The Airborne Toxic Control Measure (ATCM) specifies staggered implementation dates ranging from 2009 to 2010 (depending on product) for a two-phase plan that calls for compliance on emissions levels in particleboard, MDF, thin MDF and hardwood plywood. CARB studies suggest that up to 5% of formaldehyde emissions are generated by composite wood products. CARB plan set in January 2010 forces formaldehyde emissions in adhesives even lower, to 0.05 ppm, a higher standard than that of the European E0.

The cost of trying to regulate formaldehyde emissions from wooden panels presents a problem of staggering proportion in terms of the volume of wood that is imported from overseas and the sheer volume of product that would have to be monitored. In addition, the industry has voiced some concerns about costs and the difficulty of testing finished products. However, this approach is preferred in most of the national and international schemes as it just regulates the formaldehyde that is given off from the panels and gives freedom to the producers to select the most convenient chemicals for each manufacturing process.

The proposed EU Ecolabel criterion aims at combining low-emission level requirements with low production and testing costs. For this reason, two different requirements are proposed depending on the nature of the panel which compliance can also be demonstrated by two different methods. Additionally, exemptions are proposed for those panels which suppliers can certify their low-emission (lower than 50% of the E1 emission level) and/or their manufacturing by using non-based formaldehyde resins.

The required free-formaldehyde emission level is set up at 50% of E1 value for non-MDF panels and 60% for MDF panels. These limits are in line with the strictest schemes while at the same time take into account the additional efforts required to decrease the free formaldehyde emissions in the MDF panels. Finally for finished flooring products where the only source of formaldehyde emissions is through board and/or surface coatings and the products met the criteria restricting the VOC content and formaldehyde content in both surface treatments and panels (hazardous substances used in engineered wood, cork and bamboo products) no finished testing will be required.

EU Ecolabel team recognizes the magnitude of the changes proposed for this criterion and therefore particularly welcomes any input during the consultation period.

The method most commonly attributed to VOC emission testing is the ISO 16000 series of standards. Due to the lack of large chamber facilities in many areas of Europe, it is relevant to assess whether or not existing chambers that are set up for formaldehyde emission testing according to EN 717-1 may also be suitable for the ISO 16000 test. It has been commented that although EN 717-1 chambers can be constructed of plastics that have been shown to not absorb formaldehyde, if the same plastics were to be used in VOC emission tests, they may selectively absorb certain VOCs and invalidate test results. Also it must be commented that some technical aspects of the procedure defined in ISO 16000 lack certain details that result in a relatively poor level of reproducibility. Consequently, under the remit of the Construction Products Regulation (305/2011), and more specifically EC Mandate 366, a working group is defining a new technical standard (CEN/TS 16516) which modifies the ISO 16000 approach in such a manner as to improve reproducibility between tests and testing institutions.

The draft CEN/TS 16516 standard attempts to clarify a number of areas of uncertainty or compromise between different parameters used in EN 717-1 and ISO 16000. The proposed standard does not specify limits for VOCs, only the test procedure to be used so that the product groups can be labelled with the CE marking. Member States have to establish the desire values to their national labelling schemes. Individual Member State regulations exist already or are being considered in France[209], Germany[210] and Belgium[211].

[209] Decret no 2011-321 du 23 mars 2011 relatif a l'étiquetage des produits de construction ou de revetement de mur ou de sol et des peintures et vernis sur leurs émissions de polluants volatils.

Several types of VOC are proposed to be measured in the national schemes and for which national or international standards have been developed. For example, under the German eco-label scheme (Blue Angel), TVOC, TSVOC and total VOC without LCI values are defined. These values are also defined in other schemes such as the Austrian Ecolabel, EU Ecolabel or the Belgian GPP scheme. However, there is a debate about the relevance of total VOC values since they do not necessarily imply that particularly harmful VOC compounds are present.

Another approach is followed in. The emissions of 10 VOC substances plus the total VOC content are to be measured by the ISO 16000 method and compared to prescribed limits shown in the table below. The test results will determine if the product is to be labelled as: A+, A, B or C class. Among these substances are formaldehyde, acetaldehyde, toluene, tetrachloroethylene, xylene or styrene.

The EU approach has been strongly influenced by the previous work carried out by the ANSES and AgBB institutions in France and Germany respectively. JRC in 2013 compiled a list of substances whose emission in indoor air environments may cause adverse effects on humans and sets out a framework for agreeing on such substances and their acceptable limits. It describes the LCI[212] concept and how these values have been assigned to a number of priority substances. The report states that a total of 177 VOCs of interest have been identified, 82 of which already have interim EU-LCI values assigned and 95 of which have yet to be assigned a value. The list of 82 substances can be found in Annex IV of this document. So far the integrated EU approach has yet to tackle TVOCs and SVOCs. Comparing the EU-LCI list of 82 VOCs to the list of 35 VOCs with defined the US standard; it is surprising that only 6 components are considered of interest in both databases.

A comparison of the methodologies and benchmarks set by the national schemes for limiting the emission of VOCs during the use phase of the product varies significantly. Some of these values and methods are summarized in Table 7. As seem, the new proposed revision of the Nordic Swam version 6.0 presents the strictest limit for TVOC emission after 28 days. This limit is around half of the

[210] Evaluation procedure for VOCs from building products. Ed. AgBB, Committee for Health-related Evaluation of Building Products. Berlin 2012.

[211] Draft Royal Decree establishing threshold levels for the emissions to the indoor environment from construction products for certain intended uses. Notified to the European Commission: 2012/568/b.

[212] LCI = Lowest Concentration of Interest (of individual VOCs). The LCI concept was first developed by the European Collaborative Action on 'Indoor Air Quality and its Impact on Man' when considering the best way to evaluate emissions from solid flooring materials. It was defined (see ECA Report No.18, 1997) as "the lowest concentration above which, according to best professional judgement, the pollutant may have some effect on people in the indoor environment".

benchmarks proposed by the previous version. The limit values for TSVOC are, however, rather homogeneous getting a value of 0.03mg/m^3

One of the questions arisen is the relevance of environmental and health requirements and the uncertainties about whether an additional requirement concerning emissions in finished products would bring greater health benefits, since this set of criteria already sets strict requirements concerning constituent chemicals, individual substances and emissions of formaldehyde. In addition, VOC limits in chemical used in the products also entail a reduction in TVOC and SVOC emissions. Considering this rationale, an alternative is proposed that exempt for testing those wooden floorings made of a certified low-emitting panel board and a low-emitting surface treatment.

Even though this is a topic for discussion in the coming ad-hoc working groups, the comparison of the values and methods proposed by the national schemes suggests that the current EU Ecolabel criteria could be stricter in limiting the TVOC after 28 days. In this sense, current values are proposed to be lowered to 0.16 mg/m³air for TVOC, 0.016 mg/m³air for TSVOC and remain constant for total VOC without LCI.

8 APPENDIX II: SUMMARISED OUTCOMES OF THE QUESTIONNARIES ON CURRENT EXISTING SCOPE AND ECOLABEL CRITERIA

The results of the questionnaire (collected between March and April 2014) are summarized in this table which was sent to relevant stakeholders with the aim to know their opinion about current Ecolabel criteria that need to be changed, withdrawn or prolonged.

Table 52. Outcomes of the questionnaires on current existing scope and Ecolabel criteria

PRELIMINARY DISCUSSION POINTS	AVERAGE %		
	YES	NO	NA
1. Do you know what the Ecolabel scheme is?	100%	-	-
2. Do you know that there is an Ecolabel scheme for wooden floor coverings?	100%	-	-
3. Do you know any other environmental labels on wooden floorings?	80%	20%	-
4. Has your organization identified an increasing interest or a need for environmental labelled products on the current market?	80%	20%	-
5. Does your organization hold or does your organization intend to apply for any other environmental label on wooden flooring?	40%	60%	-
6. Is your organization interested in applying for EU Ecolabel?	20%	80%	-
7. Can you provide any relevant Life Cycle Assessment or Environmental Product Declaration or any environmental related document?	60%	20%	20%
8. Do you agree to provide customers third- party verified environmental performance data about environmental performance of the final product (e.g. Global Warming Potential expressed in kg CO_2 eq per functional unit)	40%	-	60%

RAW MATERIALS		AVERAGE %		
		YES	NO	n.A
Sustainable Forest management	1. Do you agree that the current criteria should be modified?	40%	20%	40%
	2. Is the current definition and scope appropriate and suitable for this product category? Does it reflect the current and coming market conditions?	20%	20%	60%
	3. Is any relevant wooden floor covering excluded by this definition?	-	40%	60%
	4. Do you consider the current formulation of assessment and verification procedure (listed above) is sufficient and appropriate?	20%	20%	60%
	5. Do you agree with removing this sentence *"The producer must ensure that all wood originate from legal sources."* from the criteria 1.1 due to its redundancy?	20%	40%	40%
	6. Do you agree that the chain of custody is a valid verification tool on sustainable managed forests?	60%	-	40%
	7. Is it feasible to extent set these kinds of criteria to other biomass materials?	-	20%	60%
	8. In your opinion, is it necessary to develop any other new requirement for this criterion?	20%	-	-
Recycled wood and plant materials	9. Do you agree that the present criteria should be modified?	20%	-	80%
	10. Do you consider the current formulation of assessment and verification procedure (listed above) sufficient and appropriate?	-	-	100%
	11. Do you agree to add a minimum percentage quantity of recycled wood and/or plant material as input?	-	20%	80%

	12. In your opinion, is it necessary to develop any other new requirement for this criterion?	20%	-	80%
Impregnating substances and preservatives	13. Do you agree that the present criteria should be modified?	-	-	100%
	14. Which impregnating substances and preservatives are present in WFC?	-	-	100%
	15. Do you consider the current formulation of assessment and verification procedure (listed above) sufficient and appropriate?	40%	-	60%
	16. Is the request of providing the data sheet of each substance used in the final product preventing manufactures from applying for the EU Ecolabel?	-	40%	60%
	17. In your opinion, is it necessary to develop any other new requirement for this criterion?	-	20%	80%
GOM wood	18. Do you agree that the present criteria should bemodified?	40%	-	60%
	19. In your opinion, is it necessary to develop any other new requirement for this criterion?	20%	-	80%

USE OF DANGEROUS SUBSTANCES		AVERAGE %		
		YES	NO	NA
Dangerous substances for the raw wood and plant treatments	1. Is this criterion still valid regarding the current production methods?	20%	-	-
	2. Which substances or functional groups of substances contained in WFC products are of special concern? Could you indicate them?	-	-	100%
	3. A. Do you have developed an inventory of substances (and their concentration levels) found in your products?	40%	-	60%
	4. B. Have you screened them and/or any components using CLP hazard classifications and/or DSD risk phrases?	20%	-	80%
	5. If you answer "yes" to question 3: Would you be willing to share further information and experience with us on hazardous substance screening?	40%	-	60%
	6. Is there any substance classified as of special concern that would be totally restricted by this list and has no substitutes with better environmental performance?	-	-	100%
	7. Are there any information gaps?	-	20%	80%
Dangerous Substances in the coating and surface treatments	8. Do you consider the current formulation of assessment and verification procedure sufficient and appropriate?	40%	-	60%
	9. Up to what extent do you consider feasible to decrease VOCs content in adhesives?	-	-	-
	10. Up to what extent is considered feasible to limit the content of free formaldehyde from untreated raw wood-based materials?	-	-	-
	11. Do you have additional proposals regarding revision of this criterion?	-	20%	80%
	12. In your opinion, is it necessary to develop any other new requirement for this criterion?	-	-	100%

PRODUCTION PROCESS		AVERAGE %		
		YES	NO	N A
Energy consumption	Do you agree that the present criteria should be modified?	-	40%	60%
	Do you agree to revise and eventually split the P value for laminate floor coverings?	20%	-	80%
	Do you consider the current formulation of assessment and verification procedure (listed above) sufficient and appropriate?	20%	20%	60%

	Are you aware if the energy consumption has been extensively assessed for WF production? Which studies on energy consumption or other LCA issues can be regarded as relevant?	-	20%	80%
	Is there any methodology used by flooring industry to determine energy consumption? Are there any thresholds/requirements recommended by industry?	20%	-	80%
	Could stricter maximum energy consumption requirements have negative effects on other env impacts due to for example a restricted choice of materials or specific manufacturing processes?	20%	-	80%
	In your opinion, is it necessary to develop any other new requirement for this criterion?	-	-	100%
Waste management	Do you agree that the present criteria should be modified?	20%	-	80%
	Do you consider the current formulation of assessment and verification procedure (listed above) sufficient and appropriate?	-	20%	80%
	Up to what extent do you consider feasible to recover the by-products originated from the process?	-	-	100%
	What other waste treatment options (e.g. recycling) are available and appropriate?	-	20%	80%
	In your opinion, is it necessary to develop any other new requirement for this criterion?	20%	-	80%

USE PHASE & PACKAGING & FITNESS		AVERAGE %		
		YES	NO	N A
US E PHASE	Do you agree that the present criteria should be modified?	-	40%	80%
	Do you consider the current formulation of assessment and verification procedure (listed above) sufficient and appropriate?	20%	20%	60%
	Up to what extent do you consider feasible to decrease formaldehyde release in the use phase?	-	-	-
	Up to what extent do you consider feasible to decrease TVOCs content in the use phase?	-	-	-
	In your opinion, is it necessary to develop any other new requirement for this criterion?	20%	20%	60%
PACKAGING	Do you agree that the present criteria should be modified?	-	40%	60%
	Do you consider the current formulation of assessment and verification procedure (listed above) sufficient and appropriate?	40%	-	60%
	Up to what extent do you consider feasible to reduce packaging materials?	-	-	-
	Up to what extent do you consider feasible to increase recycled materials content in packaging?	-	-	-
	Up to what extent do you consider feasible to increase the reusability of packaging materials?	-	-	-
	Do you agree to introduce a new criterion on the maximum packaging quantity to be used in relation to the mass of the final product?	-	20%	80%
	In your opinion, is it necessary to develop any other new requirement for this criterion?	-	20%	80%
FITNESS FOR USE	Do you agree in setting additional requirements in criterion 6 regarding ergonomics?	-	40%	60%
	If yes, do you have any proposals on the aspects that shall be additionally covered and what verification and which verification and assessment procedure could be proposed?	-	-	-
	It is feasible to set up a minimum guaranteed durability (in years) after manufacturing?	-	20%	80%

	Which is the average lifespan for WFC?	-	-	-
	In your opinion, is it necessary to develop any other new requirement for this criterion?	-	20%	80%

9 ANNEX I: SUSTAINABLE FOREST CRITERIA

a) Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles

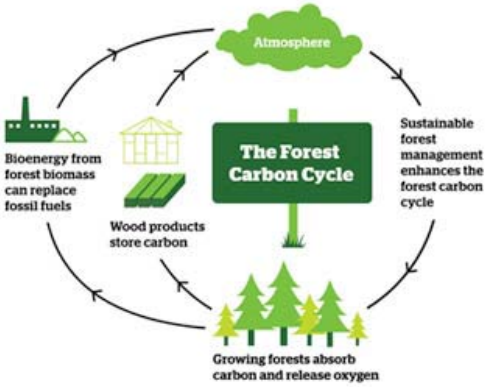


Figure 43 - The Forest Carbon Cycle

Approximately 25% of the world's forests are in Europe. They cover 45% of Europe's land area and continue to expand at a rate of 0.08% per year. In fact, Europe is the only World region having a positive net change in forest area for the past two decades. North Europe and the Russian Federation (50% of the forests) are the European regions with the largest forest cover, while South-East Europe is the least forested European region. Half of these forests are predominantly coniferous, 25% are predominantly broadleaved, and 25% are mixed.

Europe is the World region with the second highest growing stock (114.2 billion m^3 of which 75.7% is available for wood supply); being Central-East Europe and Central-West Europe the regions with the highest growing forests. Since the growth of European forests has been bigger than cuttings and other biomass removals Europe forests are major carbon sinks.

The sustainable forest criteria were defined by Forest Europe in the European Forest Conference developed during three steps, known as the Helsinki process[213].

This criterion is characterized by the following a set of indicators, which are monitored periodically to assess current situation and change:

[213] The Helsinki Process, which began in 1990, developed the general guidelines for the sustainable management of forests in Europe. The Process has sought to identify measurable criteria and indicators for the evaluation of how European countries have progressed in their efforts to follow the principles of sustainable forest management and conservation of the biological diversity of European forests. There have been four meetings in this process, two at the ministerial level and two at the expert level. More information at: http://www.iisd.ca/forestry/hel.html and Forest Europe website: http://www.foresteurope.org/

Indicator	*Explanation*
1.1 Forest area	Area of forest and other wooded land, classified by forest type and by availability for wood supply, and share of forest and other wooded land in total land area
1.2 Growing Stock	Growing stock on forest and other wooded land, classified by forest type and by availability for wood supply
1.3 Age structure and /or diameter dist	Age structure and/or diameter distribution of forest and other wooded land, classified by forest type and by availability for wood supply
1.4 Carbon Stock	Carbon stock of woody biomass and of soils on forest and other wooded land

b) Maintenance of forest ecosystems' health and vitality

Although air quality in Europe has improved, forests are still under stress. Air pollution and depositions, especially of sulphur, have been reduced in the last decade but emissions of nitrogen compounds are still high indicating the need for further emission reductions. European forest soils tend to acidification by 0.03 pH units on average and eutrophication. Yet, the development of pH and base saturation of soils did not show a uniform pattern within Europe since both increase in acid soils and decrease in the rest of the soils. Additionally, it was found that there was an increase in organic carbon in the organic and upper soil layer of the majority of the plots analysed.

Another factor that indicates the condition of forests health is tree defoliation. Around 20% of European trees are considered to have a mean defoliation of 25 % or more, what classifies them as damaged or dead. These high levels reduce trees potential to withstand adverse environmental impacts. Yet the defoliation rates vary among regions and tree species being higher in central Europe and along the Mediterranean coast in Croatia, Italy and France. Lower mean defoliation occurs in Northern Europe. The drivers of trees defoliation are insect attacks and fungal diseases, in combination with increased vulnerability caused by deposition loads, weather conditions, and other anthropogenic factors.

Forests are subject to abiotic, biotic and human induced damaging agents. In total 1 % of Europe's forests (6% without Russia) are affected by forest damage, although the severity of the damage is often not recorded. This damage is most frequently cause by insects and diseases. Nevertheless storms, wind and snow are also damage drivers in Central-West, Central-East, North and South- West Europe, while fires have mainly been reported in the Russian Federation, and South-West and South-East Europe. This criterion is characterized by the following set of indicators, which are monitored periodically to assess current situation and change:

Indicator	*Explanation*
2.1 Deposition of air pollutants	Deposition of air pollutants on forest and other wooded land, classified by N, S and base cations
2.2 Soil condition	Chemical soil properties (pH, CEC, C/N, organic C, base saturation) on forest and other wooded land related to soil acidity and eutrophication, classified by main soil types
2.3 Defoliation	Defoliation of one or more main tree species on forest and other wooded land in each of the defoliation classes "moderate", "severe" and "dead"
2.4 Forest damage	Forest and other wooded land with damage, classified by primary damaging agent (abiotic, biotic and human induced) and by forest type

c) Maintenance and encouragement of productive functions of forests (wood and non-wood)

Wood is one of the main forest product. To secure current and future wood availability and to shape a stable and growing stock from forests, the relation between net annual increment and felling is decisive. In most European countries utilization rates do not exceed increment and thus comply with sustainable forest management. It is estimated that approximately 40% of the annual increment is used which represents 680 million m^3 of felling. Trends show that the felling rate has decrease in the

Russian Federation from 41% in 1990 to around 20 % since 2000. In Europe without the Russian Federation, the felling rate increased from 58 % in 1990 to 62 % in 2010.

Europe remains one of the largest producers of roundwood in the world. In 2010, more than 578 million m^3 of roundwood were produced with a market value of EUR 21.1 billion. The demand for wood fuel is rapidly increasing in many European countries.

Apart from wood, non-wood products derived from forests are important sources of local income, among them are Christmas trees, fruits and berries, and cork were the most important ones. The market value of non-wood goods represented 15% of the value of marketed roundwood in countries that reported both values.

Forests also provide multiple services including soil protection, water, regulation of global carbon cycle, genetic resources, biodiversity, recreation, hunting, cultural services, etc. These services can be a source of significant income for private and public landowners. Though its value is still difficult to quantify it is estimated at EUR 817 million.

Most of the forest area in Europe is covered by a forest management plan or its equivalent, created to manage the multiple array of products and services of the forests and attain sustainability goals in the long term. This criterion is characterized by the following set of indicators, which are monitored periodically to assess current situation and changes:

Indicator	***Explanation***
3.1 Increment and fellings	Balance between net annual increment and annual fellings of wood on forest available for wood supply
3.2 Roundwood	Value and quantity of marketed roundwood
3.3 Non-wood goods	Value and quantity of marketed non-wood goods from forest and other wooded land
3.4 Services	Value of marketed services on forest and other wooded land
3.5 Forests under management plans	Proportion of forest and other wooded land under a management plan or equivalent

d) Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems

Protected areas are one of the oldest instruments for protecting natural resources. They help to maintain and enhance biodiversity, as well as to conserve landscape and provide recreation opportunities. In Europe the area of protected areas is expanding. Approximately, about 10% of its forests, 17 million of ha, are preserved with the main objective of conserving biodiversity, and about 9% with the main objective of protecting landscape and specific natural elements; both accounts for an area of 39 million ha. The strictness of and measures for protection varies considerably among countries: in North Europe and in some Eastern European countries, restrictive protection with no or minimal intervention dominates, whereas in Central and Southern European countries, active management in protected areas is emphasized.

Forest management practices are also changing and becoming more oriented towards biodiversity protection. For instance the area of single forests trees species is decreasing across Europe, natural regeneration is increasing; and deadwood components and important vulnerable small biotopes are kept in forests managed for wood production. Besides, the share of introduced trees species remains stable and invasive trees occupies a small percentage of forests area. In several countries, long-term monitoring has indicated that adoption of new forest management measures has reduced the decline of threatened species.

Forest management is also focused in the conservation of genetic resources since genetic diversity ensures that forest trees can survive, adapt and evolve under changing environmental conditions. Almost all European countries have established networks of stands or large forest areas to conserve

forest genetic diversity. In total, 476.000 hectares and 7.700 hectares of forests were managed for in situ and ex situ gene conservation, respectively, and 870.000 hectares for seed production in Europe, without the Russian Federation.

To maintain and enhance biological diversity in European forests the degree in forest connectivity is also important. In Europe, at landscape level, fragmentation and defragmentation are local processes that vary in each country, it is quite impossible to identify a unique trend. Yet, the assessment of forest landscape patterns indicates that expanding forest area, by natural succession or restoration, does not necessarily enhance the forest connectivity.

Most of these forests landscapes, 70%, have been altered by humans and are classified as semi-natural. Undisturbed forest amounts to 26% and is located primarily in remote and inaccessible areas in eastern and northern Europe, and in the Russian Federation. Plantations cover 4% of the forest area and are located mainly in Central-West Europe. To assess current status of forest biological diversity and the cumulative changes brought about by forest use, the following indicators are established:

Indicator	***Explanation***
4.1 Tree species composition	Area of forest and other wooded land, classified by number of tree species occurring and by forest type
4.2 Regeneration	Area of regeneration within even-aged stands and uneven-aged stands, classified by regeneration type
4.3 Naturalness	Area of forest and other wooded land, classified by "undisturbed by man", by "semi-natural" or by "plantations", each by forest type
4.4 Introduced tree species	Area of forest and other wooded land dominated by introduced tree species
4.5 Deadwood	Volume of standing deadwood and of lying deadwood on forest and other wooded land classified by forest type
4.6 Genetic resources	Area managed for conservation and utilisation of forest tree genetic resources (in situ and ex situ gene conservation) and area managed for seed production
4.7 Landscape pattern	Landscape-level spatial pattern of forest cover
4.8 Threatened forest species	Number of threatened forest species, classified according to IUCN Red List categories in relation to total number of forest species
4.9 Protected forests	Area of forest and other wooded land protected to conserve biodiversity, landscapes and specific natural elements, according to MCPFE Assessment Guidelines

e) Maintenance, conservation and appropriate enhancement of protective functions in forest management (notably soil and water)

Forest protective functions are becoming increasingly important when assessing sustainability in forests. European forests play a vital role in preventing soil erosion, protecting water supplies and maintaining other ecosystem functions. More than 20 % of Europe's forests directly protect soil, water and other ecosystem services. Trends show a slight increase of a 0.6 % in protective forest area. Forest also plays a very important role in protecting human infrastructures, especially in mountainous areas or areas with extreme climate. The total area of forests with protective functions for infrastructures is 2%. This role is increasing in the Central-West Europe Region while decrease in Central-East Europe. This criterion is characterized by the following set of indicators, which are monitored periodically to assess current situation and trends of European forests:

Indicator	***Explanation***
5.1 Protective forests – soil, water and other ecosystem functions	Area of forest and other wooded land designated to prevent soil erosion, to preserve water resources, or to maintain other forest ecosystem functions, part of MCPFE Class "Protective Functions"

5.2 Protective forests – infrastructure and managed natural resources	Area of forest and other wooded land designated to protect infrastructure and managed natural resources against natural hazards, part of MCPFE Class "Protective Functions"

f) Maintenance of other socio-economic functions and conditions

Outside the Russian Federation, where forests are publicly owned, European Forests are equally divided between private and public ownership. While the private forest area has increased by 15% over the last years, the public-private share has remained the same, due to the increase of the forest area. The efforts towards privatization and restitution of forest land in countries formerly under centrally planned economies (Baltic States and several countries of Central-East and South-East Europe) are the driving forces behind the changes in ownership structure.

From an economical point of view, the forest sector, including the subsectors of forestry, wood industry, and pulp and paper industry, contributes on average to 1% of the GDP, a number that is decreasing over time. However, during the last few years, most regions have shown an increase in net added value and net entrepreneurial income from forestry enterprises. Among the three forests subsectors, Europe's pulp and paper industry had the weakest performance, since its added value has declined by 15% since 2000. Other forests services and products have increased, like the commerce of wood for energy consumption recreational activities, and cultural and spiritual values.

In terms of employment, around 4 million people work in the European forest sector, a number that is decreasing. The forestry workforce is ageing, and it is a challenge to recruit new workers. Accident rates are still high and few improvements have been made in the last decade.

The indicators that characterized this criterion and help to monitor the current situation and changes over time are:

Indicator	***Explanation***
6.1 Forest holdings	Number of forest holdings, classified by ownership categories and size classes
6.2 Contribution of forest sector to GDP	Contribution of forestry and manufacturing of wood and paper products to gross domestic product
6.3 Net revenue	Net revenue of forest enterprises
6.4 Expenditures for services	Total expenditures for long-term sustainable services from forests
6.5 Forest sector workforce	Number of persons employed and labour input in the forest sector, classified by gender and age group, education and job characteristics
6.6 Occupational safety and health	Frequency of occupational accidents and occupational diseases in forestry
6.7 Wood consumption	Consumption per head of wood and products derived from wood
6.8 Trade in wood	Imports and exports of wood and products derived from wood
6.9 Energy from wood resources	Share of wood energy in total energy consumption, classified by origin of wood
6.10 Accessibility for recreation	Area of forest and other wooded land where public has a right of access for recreational purposes and indication of intensity of use
6.11 Cultural and spiritual values	Number of sites within forest and other wooded land designated as having cultural or spiritual values

10 ANNEX II: HAZARDOUS SUBSTANCES STATEMENTS

Hazard statement according to CLP 1272/2008 for hazardous substances.

Table 53- Hazard statement according to CLP 1272/2008/EEC

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
H317 May cause allergic skin reaction	R43
H330 Fatal if inhaled	R23; R26
H331 Toxic if inhaled	R23
H334 May cause allergy or asthma symptoms or breathing difficulties if inhaled	R42
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
EUH059 Hazardous to the ozone layer	R59
EUH070 Toxic by eye contact	R39-41

11 ANNEX III: LIST OF INGREDIENTS OF PESTICIDES CLASSIFIED AS CLASS 1A (EXTREMELY HAZARDOUS) OR CLASS 1B (HIGHLY HAZARDOUS) BY WHO

Source of data: http://www.inchem.org/documents/pds/pdsother/class_2009.pdf

Table 54 - Extremely hazardous (class 1a) technical grade active ingredients in pesticides

Common name	CAS no	UN no	Chem type	Phys state	Main use	GHS	LD_{50} mg/kg	Remarks
Aldicarb [ISO]	116-06-3	2757	C	S	I-S	1	0.93	DS 53; EHC 121; HSG 64; IARC 53; ICSC 94; JMPR 1993, 1996a
Brodifacoum [ISO]	56073-10-0	3027	CO	S	R	1	0.3	DS 57; EHC 175; HSG 93
Bromadiolone [ISO]	28772-56-7	3027	CO	S	R	1	1.12	DS 88; EHC 175; HSG 94
Bromethalin [ISO]	63333-35-7	2588		S	R	1	2	
Calcium cyanide [C]	592-01-8	1575		S	FM	2	39	Adjusted classification; see note 1; ICSC 407
Captafol [ISO]	2425-06-1			S	F	5	5000	Adjusted classification; see note 2; HSG 49; IARC 53; ICSC 119; JMPR 1978, 1986a; see note 3
Chlorethoxyfos [ISO]	54593-83-8	3018	OP	L	I	1	1.8	Extremely hazardous by skin contact (LD_{50} = 12.5 mg/kg); *ICSC 1681*
Chlormephos [ISO]	24934-91-6	3018	OP	L	I	2	7	*ICSC 1682*
Chlorophacinone [ISO]	3691-35-8	2588		S	R	1	3.1	DS 62; EHC 175
Difenacoum [ISO]	56073-07-5	3027	CO	S	R	1	1.8	EHC 175; HSG 95
Difethialone [ISO]	104653-34-1	2588		S	R	1	0.56	EHC 175
Diphacinone [ISO]	82-66-6	2588		S	R	1	2.3	EHC 175
Disulfoton [ISO]	298-04-4	3018	OP	L	I	1	2.6	DS 68; JMPR 1992, 1997a; *ICSC 1408*
EPN	2104-64-5	2783	OP	S	I	2	14	See note 4; ICSC 753
Ethoprophos [ISO]	13194-48-4	3018	OP	L	I-S	2	D26	DS 70; JMPR 2000; *ICSC 1660*; *[Oral LD_{50} = 33 mg/kg]*
Flocoumafen	90035-08-8	3027		S	R	1	0.25	EHC 175; ICSC 1267
Hexachlorobenzene [ISO]	118-74-1	2729	OC	S	FST	5	D10000	Adjusted classification (notes 3 and 5); IARC 79; ICSC 895; *EHC 195*
Mercuric chloride [ISO]	7487-94-7	1624	HG	S	F-S	1	1	See note 3; ICSC 979
Mevinphos [ISO]	26718-65-0	3018	OP	L	I	1	D4	DS 14; ICSC 924; JMPR 1998b; *[Oral LD_{50} = 3.7 mg/kg]*
Parathion [ISO]	56-38-2	3018	OP	L	I	2	13	See note 3; DS 6; HSG 74; IARC 30, Suppl. 7; ICSC 6; JMPR 1996b
Parathion-methyl [ISO]	298-00-0	3018	OP	L	I	2	14	See note 3; DS 7; EHC 145; HSG 75; ICSC 626; JMPR 1985c, 1996b
Phenylmercury acetate [ISO]	62-38-4	1674	HG	S	FST	2	24	Adjusted classification; see notes 3 and 6; ICSC 540
Phorate [ISO]	298-02-2	3018	OP	L	I	1	2	DS 75; JMPR 1997b, 2005; *ICSC 1060*
Phosphamidon	13171-21-6	3018	OP	L	I	2	7	See note 3; DS 74; ICSC 189; JMPR 1987b CAS Nos for E and Z isomers 297-99-4 and 23783-98-4
Sodium fluoroacetate [C]	62-74-8	2629		S	R	1	0.2	DS 16; *ICSC 484*
Sulfotep [ISO]	3689-24-5	1704	OP	L	I	1	5	ICSC 985
Tebupirimfos [ISO*]	96182-53-5	3018	OP	L	I	1	1.3	Extremely hazardous by skin contact (LD_{50} 9.4 mg/kg in rats)
Terbufos [ISO]	13071-79-9	3018	OP	L	I-S	1	c2	JMPR 1991, 2004

EHC = Environmental Health Criteria Monograph; DS = Pesticide Data Sheet; HSG = Health and Safety Guide; IARC = IARC Monographs on the Evaluation of Carcinogenic Risks to Humans; ICSC = International Chemical Safety Card; JMPR = Evaluation by the Joint FAO/WHO Meeting on Pesticide Residues.

Notes to Class Ia

1. Calcium cyanide is in Class Ia as it reacts with moisture to produce hydrogen cyanide gas. The gas is not classified under the WHO system (see Table 8).
2. Captafol is carcinogenic in both rats and mice.
3. The international trade of captafol, hexachlorobenzene, mercury compounds, parathion, parathion-methyl, and phosphamidon is regulated by the Rotterdam convention on Prior Informed Consent (see http://www.pic.int/), which entered into force on 24 February 2004. See Table 7, p. 51
4. EPN has been reported as causing delayed neurotoxicity in hens.
5. Hexachlorobenzene has caused a serious outbreak of porphyria in humans. The use and production of hexachlorobenzene is severely restricted by the Stockholm convention on persistent organic pollutants, which entered into force on 17 May, 2004. See http://www.pops.int/
6. Phenylmercury acetate is highly toxic to mammals and very small doses have produced renal lesions: teratogenic in the rat.

Table 55 - Highly hazardous (class 1b) technical grade active ingredients in pesticides

Common name	CAS no	UN no	Chem type	Phys state	Main use	GHS	LD_{50} mg/kg	Remarks
Acrolein [C]	107-02-8	1092		L	H	2	29	EHC 127; HSG 67; IARC 63; ICSC 90
Allyl alcohol [C]	107-18-6	1098		L	H	3	64	Highly irritant to skin and eyes; ICSC 95; *Adjusted classification (see note 3)*
Azinphos-ethyl [ISO]	2642-71-9	2783	OP	S	I	2	12	DS 72; JMPR 1974
Azinphos-methyl [ISO]	86-50-0	2783	OP	S	I	2	16	DS 59; ICSC 826; JMPR 1992, *2009b*
Blasticidin-S	2079-00-7	2588		S	F	2	16	
Butocarboxim [ISO]	34681-10-2	2992	C	L	I	3	158	JMPR 1986a; *Adjusted classification (see note 3)*
Butoxycarboxim [ISO]	34681-23-7	2992	C	L	I	3	D288	*Adjusted classification (see note 3)*
Cadusafos [ISO]	95465-99-9	3018	OP	L	N,I	2	37	JMPR 1992
Calcium arsenate [C]	7778-44-1	1573	AS	S	I	2	20	EHC 18, 224; IARC 84; ICSC 765; JMPR 1969
Carbofuran [ISO]	1563-66-2	2757	C	S	I	2	8	DS 56; ICSC 122; JMPR 1997b, 2003b, *2009a; See note 2.*
Chlorfenvinphos [ISO]	470-90-6	3018	OP	L	I	2	31	ICSC 1305; JMPR 1995b
3-Chloro-1,2-propanediol [C]	96-24-2	2689		L	R	3	112	*Adjusted classification (see notes 1 and 3)*
Coumaphos [ISO]	56-72-4	2783	OP	S	AC,MT	2	7.1	ICSC 422; JMPR 1991
Coumatetralyl [ISO]	5836-29-3	3027	CO	S	R	2	16	
Cyfluthrin [ISO]	*68359-37-5*		*PY*	*S*	*I*	*2*	*c15*	*JMPR 2008; See note 9, p. 8*
Beta-cyfluthrin [ISO]	*68359-37-5*		*PY*	*S*	*I*	*2*	*c11*	*JMPR 2008; See note 9, p. 8*
Zeta-cypermethrin [ISO]	52315-07-8	3352	PY	L	I	3	c86	See note 9, p. 8; HSG 22; ICSC 246; *JMPR 2008; Adjusted classification (see note 3)*
Demeton-S-methyl [ISO]	919-86-8	3018	OP	L	I	2	40	DS 61, EHC 197; ICSC 705; JMPR 1990
Dichlorvos [ISO]	62-73-7	3018	OP	L	I	3	56	Volatile, DS 2; EHC 79; HSG 18; IARC 20, 53; ICSC 690; JMPR 1994; *Adjusted classification (see note 3)*
Dicrotophos [ISO]	141-66-2	3018	OP	L	I	2	22	ICSC 872
Dinoterb [ISO]	1420-07-1	2779	NP	S	H	2	25	
DNOC [ISO]	534-52-1	2779	NP	S	I-S,H	2	25	JMPR 1965a; EHC 220; *ICSC 462*. See note 2.
Edifenphos [ISO]	17109-49-8	3018	OP	L	F	3	150	JMPR 1982. *Adjusted classification (see note 3)*
Ethiofencarb [ISO]	29973-13-5	2992	C	L	I	3	200	JMPR 1983. *Adjusted classification (see note 3)*
Famphur	52-85-7	2783	OP	S	I	2	48	
Fenamiphos [ISO]	22224-92-6	2783	OP	S	N	2	15	DS 92; ICSC 483; JMPR 1998b, 2003b
Flucythrinate [ISO]	70124-77-5	3352	PY	L	I	3	c67	JMPR 1986b; see note 9, p.8; *Adjusted classification (see note 3)*
Fluoroacetamide [C]	640-19-7	2588		S	R	2	13	*ICSC 1434*. See note 2
Formetanate [ISO]	22259-30-9	2757	C	S	AC	2	21	
Furathiocarb	65907-30-4	2992	C	L	I-S	2	42	
Heptenophos [ISO]	23560-59-0	3018	OP	L	I	3	96	*Adjusted classification (see note 3)*
Isoxathion [ISO]	18854-04-8	3018	OP	L	I	3	112	*Adjusted classification (see note 3)*
Lead arsenate [C]	7784-40-9	1617	AS	S	L	2	c10	*EHC 18*, 224; IARC 84; ICSC 911; JMPR 1969
Mecarbam [ISO]	2595-54-2	3018	OP	Oil	I	2	36	JMPR 1987a
Mercuric oxide [ISO]	21908-53-2	1641	HG	S	O	2	18	ICSC 981; CICAD 50. See note 2
Methamidophos [ISO]	10265-92-6	2783	OP	S	I	2	30	HSG 79; ICSC 176; JMPR 1991, 2003b; See note 2
Methidathion [ISO]	950-37-8	3018	OP	L	I	2	25	JMPR 1998b; *ICSC 1659*
Methiocarb [ISO]	2032-65-7	2757	C	S	I	2	20	JMPR 1999
Methomyl [ISO]	16752-77-5	2757	C	S	I	2	17	DS 55, EHC 178; HSG 97; ICSC 177, JMPR 1989, 2002
Monocrotophos [ISO]	6923-22-4	2783	OP	S	I	2	14	See note 2; HSG 80; ICSC 181; JMPR 1996b
Nicotine [ISO]	54-11-5	1654		L		1	D50	ICSC 519
Omethoate [ISO]	1113-02-6	3018	OP	L	I	2	50	JMPR 1997a
Oxamyl [ISO]	23135-22-0	2757	C	S	I	2	6	DS 54; JMPR 1986b, 2003b
Oxydemeton-methyl [ISO]	301-12-2	3018	OP	L	I	3	65	JMPR 1990, 2003b; *Adjusted classification (see note 3)*
Paris green [C]	12002-03-8	1585	AS	S	L	2	22	Copper-arsenic complex
Pentachlorophenol [ISO]	87-86-5	3155		S	I,F,H	2	D80	See note 2; Irritant to skin; EHC 71; HSG 19; IARC 20, 53; ICSC 69

Common name	CAS no	UN no	Chem type	Phys state	Main use	GHS	LD_{50} mg/kg	Remarks
Propetamphos [ISO]	31218-83-4	3018	OP	L	I	3	106	*Adjusted classification (see note 3)*
Sodium arsenite [C]	7784-46-5	1557	AS	S	R	2	10	EHC 224; IARC 84; *ICSC 1603*
Sodium cyanide [C]	143-33-9	1689		S	R	2	6	ICSC 1118; CICAD 61
Strychnine [C]	57-24-9	1692		S	R	2	16	ICSC 197
Tefluthrin	79538-32-2	3349	PY	S	I-S	2	c22	See note 9, p. 8
Thallium sulfate [C]	7446-18-6	1707		S	R	2	11	DS 10, EHC 182; ICSC 336
Thiofanox [ISO]	39196-18-4	2757	C	S	I-S	2	8	
Thiometon [ISO]	640-15-3	3018	OP	Oil	I	3	120	DS 67; ICSC 580; JMPR 1980; *Adjusted classification (see note 3)*
Triazophos [ISO]	24017-47-8	3018	OP	L	I	3	82	JMPR 1994, 2003b; *Adjusted classification (see note 3)*
Vamidothion [ISO]	2275-23-2	3018	OP	L	I	3	103	JMPR 1989; *ICSC 758; Adjusted classification (see note 3)*
Warfarin [ISO]	81-81-2	3027	CO	S	R	2	10	DS 35, EHC 175; HSG 96; ICSC 821
Zinc phosphide [C]	1314-84-7	1714		S	R	2	45	DS 24, EHC 73; ICSC 602

EHC = Environmental Health Criteria Monograph; DS= Pesticide Data Sheet; HSG = Health and Safety Guide; IARC = IARC Monographs on the Evaluation of Carcinogenic Risks to Humans; ICSC = International Chemical Safety Card; JMPR = Evaluation by the Joint FAO/WHO Meeting on Pesticide Residues.

Notes to Class Ib

1. 3-Chloro-1,2-propanediol in nonlethal dosage is a sterilant for male rats. This compound is also known as alpha chlorhydrin.
2. The international trade of carbofuran, DNOC, fluoroacetamide, mercury compounds, methamidophos, monocrotophos and pentachlorophenol is regulated by the Rotterdam convention on Prior Informed Consent (see http://www.pic.int/), which entered into force on 24 February 2004. See Table 7, p. 51.
3. As a precautionary measure, the classification of certain liquid pesticides has been adjusted to avoid those pesticides being assigned to a less hazardous Class in the process of aligning the WHO Classification with the GHS. Details of how the WHO Classification has been aligned with the GHS Acute Toxicity Hazard Categories are described in the introductory notes for Part II.