About Nordic Ecolabelled

Durable wood – Alternative to conventionally impregnated wood



Version 2.0

Background to ecolabelling for consultation
23 June 2014

Nordic Ecolabelling

Content

1	**Summary**	**3**
2	**Basic facts about the criteria**	**5**
3	**About the criteria revision**	**14**
4	**Environmental impact and Nordic Ecolabelling as an influential tool**	**15**
4.1	Relevance, Potential and Steerability (RPS) through Nordic Ecolabelling	15
4.2	Environmental impact of durable wood	16
5	**Background for the requirements**	**21**
5.1	Description of the product	21
5.2	Chemical requirements	21
5.3	Sustainable forestry	32
5.4	Biological durability	35
5.5	Climate impact	37
5.6	Wood during use and disposal	39
5.7	Quality and regulatory requirements	40
5.8	Marketing	41
6	**Changes compared to previous version**	**42**

Appendix 1 Different treatment methods for durable wood
Appendix 2 MECO analysis – durable wood
Appendix 3 Properties of active substances related to pressure impregnation
Appendix 4 Product group definition – assessment of new product types
Appendix 5 Background to energy requirements in raw material phase
Appendix 6 Background to requirements on undesirable substances in chemical products

086 Durable wood – Alternative to conventionally impregnated wood, version 2.0, 23 June 2014

This document is a translation of an original in Norwegian. In case of dispute, the original document should be taken as authoritative.

Addresses

In 1989, the Nordic Council of Ministers decided to introduce a voluntary official ecolabel, the Nordic Ecolabel. These organisations/companies operate the Nordic ecolabelling system on behalf of their own country's government. For more information, see the websites:

Denmark
Ecolabelling Denmark
Danish Standards Foundation
Kollegievej 6
DK-2920 CHARLOTTENLUND
Tel: +45 72 300 450
Fax: +45 72 300 451
info@ecolabel.dk
www.ecolabel.dk

Finland
Ecolabelling Finland
Box 489
FI-00101 HELSINKI
Tel +358 424 2811
Fax +358 424 281 299
joutsen@ecolabel.fi
www.ecolabel.fi

Iceland
Ecolabelling Iceland
Umhverfisstofnun
Suðurlandsbraut 24
IS-108 REYKJAVIK
Tel: +354 591 20 00
Fax: +354 591 20 20
svanurinn@ust.is
www.svanurinn.is

Norway
Miljømerking
Henrik Ibsens gate 20
NO-0255 OSLO
Tel: +47 24 14 46 00
Fax: +47 24 14 46 01
info@svanemerket.no
www.svanemerket.no

Sweden
Ecolabelling Sweden
SE-118 80 STOCKHOLM
Tel: +46 8 55 55 24 00
Fax: +46 8 55 55 24 01
svanen@ecolabel.se
www.ecolabel.se

This document may only be copied in its entirety and without any type of change. It may be quoted from provided that Nordic Ecolabelling is stated as the source.

1 Summary

This document describes the environmental impacts associated with durable wood and proposes and justifies revised criteria for the "Nordic Ecolabelling of Durable wood – Alternative to conventionally impregnated wood."

In order to extend the service life of wood in an outdoor environment, it is treated in various ways. The impregnation agents traditionally used contain active substances that provide protection for the wood through the toxicity of additives (heavy metals and other biocides). One negative side-effect of using toxins is that the substances often have adverse health and environmental properties that can affect humans and the environment during leaching over time. There are alternative methods for achieving durable wood that do not involve the use of heavy metals or other biocides.

Heartwood with naturally long durability, chemically or thermally modified wood, and wood subjected to supercritical impregnation may be Nordic Ecolabelled. The wood must, as a minimum, meet the durability requirements concerning wooden structures above ground that are exposed to moisture and/or weather. Nordic Ecolabelled durable wood is an alternative to conventionally impregnated wood and is characterised by:

- having no added heavy metals and low levels of biocides
- not causing problems or requiring special processing in the waste phase
- being produced from sustainable forestry
- having sufficient biological durability

The following may not carry the Nordic Ecolabel:

- wood which is impregnated with heavy metals
- wood impregnated with biocides in concentration above 200 g/m^3 wood
- wood that is surface treated (for example stained or painted)
- wood plastic composites (WPC)

General

The product group has been expanded from being an environmental pioneer, which means a new product group for Nordic Ecolabelling with simplified requirements, to a regular product group. As such, many of the standard requirements for Nordic Ecolabelling are now included, particularly in the areas of chemistry, quality and regulatory requirements.

Product group definition

The product group definition has been reviewed, with particular consideration given to the inclusion of wood-plastic composites and wood treated with supercritical CO_2 and small quantities of biocides. Nordic Ecolabelling is opening up for the possibility of using small quantities of biocides in concentrations below 200 g/m^3 wood in the case of impregnation with supercritical CO_2. Nordic Ecolabelling will make a final decision on this inclusion after considering the comments received during the consultation. Nordic Ecolabelling will not open up for ecolabelling of wood-plastic composites.

A new restriction is also introduced in the product group definition, stating that wood that is surface-treated (eg. painted or stained after modification) cannot carry the Nordic Ecolabel. Requirements for surface treatment are therefore removed.

Chemical requirements

The chemical requirements have been expanded in several ways, and they have been updated in line with the CLP Regulation (EC) No 1272/2008. Three new chemical requirements have been introduced. The first relates to a ban on chemical substances that are classified as carcinogenic, mutagenic or toxic for reproduction. The second is a list of prohibited substances that have problematic properties in terms of health and/or the environment. The third is a ban on the use of nano particles in chemical substances or in the finished product. The classification requirements for chemical products have been expanded from only setting requirements concerning health classification to also including classification for environmentally harmful effects.

The requirements relating to sustainable forestry (section 5.4) now include a requirement concerning use of biocides on the timber after felling.

Biological durability

It has been researched whether any relevant new tests for durability have been created that could be included in the requirement. No such tests have been found, and the requirement thus remains unchanged. The requirement allows for alternative methods to be used if an independent and competent test institution judges the methods to be equivalent in terms of quality. Sound new test methods may therefore be used if they become established.

Energy consumption and emissions of greenhouse gases

An attempt has been made to gather relevant energy data for the raw material and production phases, with a goal of establishing level requirements for energy consumption, which is an important factor in the life cycle of durable wood. In examining the data and considering possible requirement levels, it became clear that the data is associated with a great deal of uncertainty. It was also judged that the manufacturers have low steerability when it comes to affecting energy consumption for the drying of sawn timber, since this is often carried out by a supplier, and it would often require major investments for the manufacturers to switch energy sources. These circumstances make it difficult to set requirement levels for permitted energy consumption in this version of the criteria. Instead, monitoring requirements have been introduced concerning energy consumption during drying and manufacturing, and transport distances for the wood raw material. There is also a requirement that the manufacturers must have a plan for energy savings at its production facility. The goal is to collect good data so that level requirements can be set in the next revision.

2 Basic facts about the criteria

Products eligible for ecolabelling

Wood is a biological material and must be used properly and/or treated in order to avoid degradation. To extend the service life of wood, it can be protected and treated in various ways: constructive wood protection[1], surface treatment or impregnation, or a combination of these. The impregnation agents traditionally used contain active substances that provide protection for the wood through the toxicity of additives (heavy metals and other biocides). One negative side-effect of using toxins is that the substances often have adverse health and environmental properties that can affect humans and the environment through leaching over time during the use and waste phases.

There are, however, alternative methods for achieving durable wood that do not involve the use of heavy metals or other biocides, often referred to as modified wood. A general definition is that wood modification involves a chemical, biological or physical treatment of the wood that helps to improve the properties of that wood. In addition, the modified wood must not be toxic or emit toxic substances during use[2]. The criteria for the Nordic Ecolabelling of Durable wood relate to these alternative methods. The most relevant alternatives available on the Nordic market are thermally and chemically modified wood. Appendix 1 provides an introduction to the various wood modification methods.

Durable wood has many potential applications, including cladding, terraces, steps, fences, bridges, outdoor furniture and jetties. The durability class of the wood determines the potential areas of use (see section 5.4).

Heartwood with naturally long durability, chemically or thermally modified wood, and wood subjected to supercritical impregnation may be Nordic Ecolabelled. The wood must, as a minimum, meet the durability requirements concerning wooden structures above ground that are exposed to moisture and/or weather.

The product group definition has been amended since the previous version, the biggest change being the possibility of using biocides in concentrations below 200 g/m^3 wood when impregnating with supercritical CO_2. This is new, and Nordic Ecolabelling is aware that this is a relaxation of one of the main requirements in the criteria. As such we would particularly like comments on this during the consultation. The suggested limit value for biocides is low in comparison with the quantities used in conventional wood impregnation. It is also Nordic Ecolabelling's opinion that supercritical wood impregnation has many environmental advantages compared with conventional impregnation (see more details under requirement O3 in section 5.2 and Appendix 4). Nordic Ecolabelling will make a final decision on this inclusion after considering the comments received during the consultation.

[1] Constructive wood protection aims to keep the wood dry (moisture content < 20%), so that one of the conditions for a rot attack does not occur. http://www.svensktlimtra.se
[2] Plesser, Thale Sofie Wester et al., Miljøanalyse av trefasader, SINTEF Byggforsk, ISBN 978-82-536-1339-0, 2013

Products that cannot be Nordic Ecolabelled

The following may not carry the Nordic Ecolabel:

- wood which is impregnated with heavy metals
- wood impregnated with biocides in concentration above 200 g/m^3 wood
- wood that is surface treated (for example stained or painted)
- wood plastic composites (WPC)

Wood-plastic composites were given particular consideration during the revision. The main reasons for not including them are listed below (for more details, see Appendices 2 and 4). Composites will be reassessed during the next revision, since advances are expected in the future and better environmental products may be developed. One benefit of wood-plastic composites in the use phase is that they do not require surface treatment.

- Wood-plastic composites (WPC) can be manufactured using virgin or recycled thermoplastics. Since plastic is based on fossil raw material, there are substantial CO_2 emissions associated with the material, compared to pure wood products. Virgin plastic may account for over 50% of the composite's climate impact over its life cycle. The emissions are lower if recycled plastic is used and there is therefore considerable potential to reduce the environmental impact of the product by using a high proportion of recycled plastic. A study of various composite products has, however, concluded that it is currently often difficult to achieve a sufficient quality when using recycled plastic, which is why the majority of manufacturers in the Nordic region use virgin plastic. As of today, there is consequently little steerability towards using a high proportion of recycled plastic.
- Wood-plastic composites involve significantly higher energy consumption in the production phase than other pure wood products that are covered by the criteria for durable wood.
- The opportunities for material recovery are more limited for WPC than for pure wood products. The mix of wood, plastic and various additives causes a degradation of the plastic, and plastic from end-of-life composite cannot be separated out and used in other types of product. Theoretically, used composite can be recycled in new composite products of the same type, but there are currently no established take-back systems for collection.

Surface treatment of modified wood has also been considered. Surface treatment means the treatment of surfaces after the timber is modified (such as staining or painting). Experiences from version 1 of the criteria are that such treatment seldom is carried out by manufacturers of durable wood. Surface treatment of wood in the use phase can have a large impact on the products environmental impact over it's life cycle (see details in section 4.2). Durable wood is modified to provide good resistance and the need for surface treatment by the manufacturer should thus be minimal. Nordic Ecolabelling therefor prefers that such treatment is not performed since an important environmental and practical benefit of durable wood is a low need for maintenance/surface treatment. For these reasons, surface-treated modified wood is excluded from the criteria.

Justification for Nordic Ecolabelling

The Nordic region has a long tradition of using wood outdoors for many purposes. The durability and service life of the wood are affected by climatic and biological conditions. In order to extend the service life of the wood, it is treated in various ways.

Originally, the most familiar environmental problems from durable wood were associated with the use of copper, chromium and arsenic (CCA) and creosote as impregnation agents. Today, CCA impregnation is prohibited in the Nordic region, while the use of creosote is only permitted in an industrial context, and so the chemical impact from conventionally impregnated wood has been reduced. However, significant quantities of copper and other biocides are used in conventionally pressure impregnated timber, which causes a sizeable environmental impact from the use and leaching of substances harmful to health and the environment. The most widely used impregnation agents are currently water-borne preservatives that normally contain copper salts together with organic fungicides as the active substances. The quantity of copper used in the impregnation agents increased as a consequence of the ban on CCA impregnation, which entered into force in 2002. Water-soluble copper compounds (copper salts) are toxic to humans and can be highly toxic, even in small quantities, to aquatic organisms. The compounds can also cause long-term adverse effects in the aquatic environment[3]. Copper does readily bond to organic substances/organic compounds, and remains less available and thus less harmful as long as it is in this bound state. The Earth's copper reserves from ore are estimated at around 350 million tonnes, making it a limited resource, considering the annual consumption of around 10 million tonnes. It is therefore important to make effective re-use of copper.[4]

Increased use of alternative methods for wood impregnation has the potential to achieve significant environmental gains by reducing the use of toxic chemicals. In addition, there is potential to reduce the consumption of the Earth's limited copper reserves, which are also required for other purposes, such as electric cables, transformers and water pipes.

Other key environmental considerations are ensuring that wood comes from sustainably managed forests, and ensuring that the products have sufficient biological durability and a low need for maintenance.

Ecolabelling is a targeted tool for identifying environmentally positive alternatives within the product group and for influencing the environmental aspects listed above. This is why Nordic Ecolabelling has criteria for durable wood.

Nordic Ecolabelled durable wood is an alternative to conventionally impregnated wood and is characterised by:

- having no added heavy metals and low levels of biocides
- not causing problems or requiring special processing in the waste phase
- being produced from sustainable forestry
- having sufficient biological durability

[3] Norwegian Pollution Control Authority, Vurdering av virkemidler for å redusere utslippene av kobber. 2005
[4] Store norske leksikon: http://snl.no/kobber

Criteria version and validity

Version 1 of the criteria document was adopted by the Nordic Ecolabelling Board in April 2004 and remained valid until April 2007. The criteria were developed as an "environmental pioneer" and have been amended twice. The first amendment came in June 2006, when the requirement for the proportion of certified wood was changed from 90% to 70%. The exemptions concerning certified forestry were also removed and the wording concerning alternative test methods was adjusted.

The second amendment came in March 2009, when the classification of furfuryl alcohol was changed by authorities. An exemption for furfuryl alcohol, classified as carcinogenic: R40 in requirement R4, was introduced on condition that the new requirements R5 (maximum allowable concentration for chemical substances classified by R40) and R8 (chemical residues) must be fulfilled. In addition, the criteria have been extended and version 1.5 is valid until the 31 December 2015.

The Nordic market

The manufacturers of durable wood primarily sell their products to builder's merchants and directly to construction projects. The builder's merchants sell the products either to private consumers or to developers. The customers may thus be anybody from developers, makers of outdoor furniture and gardeners to public sector buyers, wholesalers, importers and private consumers.

The market for durable wood is largely dominated by conventionally copper impregnated wood (pressure impregnated). There is also some use of creosote treated wood (for industrial purposes) and wood impregnated with organic solvent plus the addition of pesticides/biocides. Figure 1 shows the amount of impregnated wood produced in 2009 in the Nordic region, according to the impregnation agent[5]. Water-borne substances accounted for the greatest proportion.

Table 2 Production of treated wood in 2009 by type of preservative, m³.
Figures in brackets show the production of treated spruce. These figures are included in the total.

Country	Creosote	Water-borne	LOSP*	Total
Denmark	0	93 950 (32 550)	2 100 (0)	96 050 (32 550)
Finland	75 900	244 000		319 900
Iceland	0	0	0	0
Norway	16 000	398 400	30 300	444 700
Sweden	66 800	1 228 650 (428 650)	18 650	1 314 100 (428 650)
Total	**158 700**	**1 965 000** **(461 200)**	**51 050** **(0)**	**2 174 750** **(461 200)**

*LOSP = Light Organic Solvent Preservatives

Figure 1: Production of conventionally impregnated wood in the Nordic region, 2009 (source: Nordic Wood Preservation Council)

[5] Nordic Wood Preservation Council: www.ntr-nwpc.com (February 2014)

There is, however, a growing market for alternatives to pressure impregnated wood in the Nordic region. A general observation is that there are currently only a limited number of manufacturers making alternatives to pressure impregnated wood in the Nordic region, and the industry is new and developing. Interest in such alternatives is growing, including internationally. This is particularly the case with professional customers who have an environmental focus. In recent years, many architects and landscape architects have begun to embrace the use of alternatives to pressure impregnated wood, for example as facade cladding and other exterior uses. The purchase price of modified wood remains somewhat higher than for ordinary pressure impregnated wood, but the prices are expected to drop as volumes increase. Also, modified wood typically requires less maintenance over the life span, resulting in lower maintenance costs.

The following alternatives to pressure impregnated wood are the most common in the Nordic market (not ranked by market share):

- Thermally modified wood
- Chemically modified wood
- Untreated wood with natural durability, such as pine heartwood
- Wood plastic composite (WPC)
- Wood impregnated with supercritical CO_2 and small quantities of biocides

ThermoWood, for example, has seen steadily rising sales over the past decade, as shown in figure 2. The sales relate partly to the Nordic region, but the majority is exported to other parts of Europe.

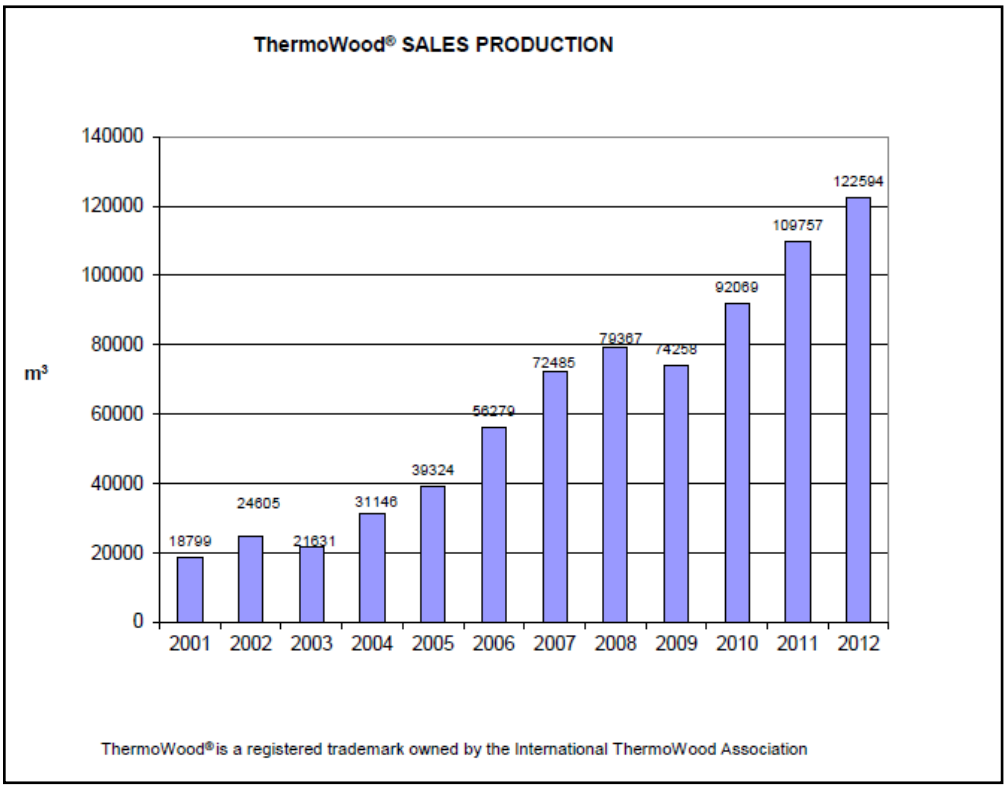


Figure 2: Increase in production volume of thermally modified wood over the period 2001-2012[6]

Industry organisations

The Nordic Wood Preservation Council (NTR) and its national member organisations Metsäteollisuus and Kestopuuteollisuus in Finland, Skogsindustrierna and Svenska Träskyddsföreningen in Sweden, Treindustrien in Norway and Dansk Træbeskyttelse in Denmark are important partners for the Nordic wood industry in the areas of wood promotion and marketing, market surveillance, standardisation, quality control, research and development. Europe has the European Organisation of the Sawmill Industry (EOS), the European Confederation of Woodworking Industries (CEI-Bois) and the European Institute for Wood Preservation (WEI). Under the "European Wood Initiative", the industry organisations work together in Norway, Sweden, Finland, Austria, Germany and France to improve access to Asian markets. NTR and its member organisations work on the testing of wood preservatives for industrial use, as well as standards and quality control relating to impregnated wood.

There is no industry organisation specifically for modified wood. Manufacturers of thermally modified wood in the Nordic region tend, however, to be affiliated to the International ThermoWood Association, which had 13 members as of March 2014. ThermoWood® is a registered trademark owned by the International ThermoWood Association. The goal of the organisation is to generally promote the use of ThermoWood® products. The members collaborate on standardisation, quality control and research in order to increase the use of the products.

The section below describes the market situation for alternatives to pressure impregnated wood in the Nordic countries.

[6] International ThermoWood Association: www.thermowood.fi (February 2014)

Market overview Finland
The market for thermally modified wood has grown relatively strongly in Finland. Thermally modified wood has many applications both indoors and outdoors. Overall, the market for thermally modified wood is quite small. However, Finland is a world leader in the production of thermally modified wood. There are nine manufacturers, and production has risen significantly from around 25 000 m^3 in 2002 to around 123 000 m^3 in 2012 and 85% of production is exported. The exports head primarily to other Nordic countries, to Central Europe and to the UK. The production is worth approximately EUR 50 million. The largest manufacturer of thermally modified wood is Lunawood Oy, which produced 45 000 m^3 in 2011.

There is also a new and growing market for composite products in wood fibre and plastic. The global market for composite products is relatively large, and in Europe it amounts to around EUR 500 million.

Market overview Sweden
The market in Sweden has long been quite stable. Builder's merchants, builders, public sector buyers and consumers influence the industry since they govern what is manufactured (pressure impregnated versus thermally modified). Industry organisations and other systems such as ThermoWood influence the industry through their membership numbers and large market share.

Sales of thermally modified wood are low compared with pressure treatment. Sweden has four manufacturers of thermally modified wood (Moelven, Heat Treated Wood i Hudiksvall, Scandinavian FineWood and Termo Plus i Arvidsjaur). Their total sales are at least SEK 700 million, with Moelven being by far the largest. The Swedish licensees are affiliated to the ThermoWood system[7].

A particular trend that has been noted is the emergence of a relatively recently developed supplementary wood preservative (Sioo), which is a commercialised research project (silicate-like silicon particles, can be particles on a nanoscale before application). The preservative is said to also complement thermally treated wood to produce a highly durable end product[8]. The company OrganoWood AB, which was launched in 2010, produces and manufactures this type of modified wood.

There are no manufacturers of furfurylated or acetylated wood in Sweden.

Market overview Norway
According to an article from June 2012 on the Treteknisk website[9] the production and import of modified wood accounted for 5-8% of the total consumption of durable wood in Norway.

Norway has seen an increasing interest in furfuryl alcohol modified wood (FM wood) in recent years. Norwegian company Kebony is the only manufacturer in the Nordic region, and has made a strong breakthrough via particular chains of builder's merchants. In 2010, Kebony produced around 10 000 m^3 FM wood and saw a doubling in sales[10]. The company has a production capacity of 25 000 m^3. FM wood has the same applications as

[7] Gustav Åström, owner of Heatwood Hudiksvall, Peter Johnson, Product Manager at Moelven Wood, Johan Pal of Träcentrum Nässjö, Mangus Wålinder, Project Manager, SP Trätek EcoBuild
[8] Herje Boström, MD of Sioo
[9] http://www.trefokus.no/fullstory.aspx?m=329&amid=13078
[10] interview with the licensee.

thermally modified wood, but has a higher use class and is therefore particularly suitable for outdoor use, and can also be used in contact with water and the ground.

There are also several manufacturers of thermally modified wood in Norway (Granvin Bruk, Sørtre Bruk AS, Moelven Timber AS, BT Pall & Emballasje/Waba Europaller AS).

Market overview Denmark
Denmark has seen the market for thermally modified wood grow quite considerably in recent years. ThermoWood is sold in the construction market, primarily as cladding and decking, but also for outdoor furniture/play apparatus (sandboxes and children's furniture). Manufacturer Royal Træ has also developed a product comprising thermally modified wood that is then treated with linseed oil for greater protection.

Another relatively new impregnation method uses supercritical carbon dioxide as the carrier for small quantities of biocides with which the wood is impregnated. Hampen Træforarbejdning A/S in Jutland, Denmark, has one of the world's first facilities for impregnating spruce in this way, known as Superimpregnation, on a reasonably large scale.

Nordic Ecolabel licences

The table below shows the licences held in the Nordic region as of June 2014.

Table 1. Number of licences and registrations in the Nordic region as of April 2014

Manufacturer (country)	Products	Licence number
Moelven Danmark A/S (Denmark)	Finnforest ThermoWood (pine, for use above ground)	586 003
Royal Træ (Denmark)	Royal Termo Træ for outdoor use	586 006
Kebony AS (Norway)	Kebony Pine, Kebony Maple, Kebony SYP, Kebony Radiata	286 001
Oy Lunawood Ltd (Sweden)	Lunawood®	386 005
Accsys Technologies (Sweden)	Accoya Radiata Pine and Accoya Scots Pine	30860007

There are a total of 5 licences in the Nordic region, with two in Sweden, two in Denmark and one in Norway. One of the Swedish licences belongs to the Finnish manufacturer Oy Lunawood Ltd and is registered in Finland. The system of registering licences in the Nordic countries has now ceased, and in version 2 of the criteria there will only be Nordic licences.

Other labels

FSC/PEFC – raw material labelling
Certification bodies the Forest Stewardship Council (FSC) and PEFC (Promoting Sustainable Forest Management) are the biggest names in durable wood. The purpose of labelling the source material is to guarantee that the wood comes from sustainable forestry.

Environmental classification of construction and building materials
There are many different systems used in the Nordic region for the environmental classification of construction and building materials. Some of the best-known are LEED, BREEAM and DGNB. Many of these set material requirements or award points for eco-friendly materials.

The European Committee for Standardisation is also developing standards and tools for the assessment of a building's sustainability and environmental quality (CEN TC 350). The work is based on international standards for LCAs and environmental declarations, and also includes conditions related to the indoor environment and life cycle costs[11]. The purpose of the standardisation is to create general and horizontal standards for the assessment of a building's environmental performance over its life cycle[12].

Other assessment systems/labels
There are a number of national registration systems and environmental assessment systems for building products and building materials that are widely used in the market. Sweden has:

- BASTA Online, which involves self-registration and self-declaration, followed by random sample-based audits by an independent third party
- Sunda Hus
- Byggvarubedömningen, an environmental assessment/evaluation system for building materials that the manufacturers sign up to.

Norway has SINTEF Byggforsk Teknisk Godkjenning, which attests that a building product has been found fit for purpose in terms of quality and technical specifications. Since 2010, the system has also assessed whether the product contains substances on the Norwegian Priority List, or on the REACH Candidate List. Another system in Norway is ECOproduct, which is both a method for environmental assessment and a database of already assessed products. An environmental product declaration (EPD) forms the basis for assessment of a product.

There is no EU Ecolabel criteria document for durable wood.

Manufacturers of thermally modified wood often have ThermoWood, PEFC/FSC and/or ISO 9001 certification.

It is possible for the manufacturers to produce an environmental declaration for their products. Environmental product declarations (EPDs) do not set requirements for the products, but provide documentation of the product's environmental impact associated with production, use and disposal[13]. EPDs are based on the principles of the ISO standard for type III environmental declarations, ISO 14025, and on a life cycle analysis (LCA) of the product. In order to produce an EPD, Product Category Rules (PCR) must be drawn up, or in existence for the product category. The relevant PCR for durable wood is "NPCR 015 Solid wood products, 2009".

Legislation/standards
EU legislation has a steering effect in relation to durable wood. This relates primarily to REACH, the EU Biocidal Product Regulation (EU/528/2012), and the EU Timber Regulation (EU/995/2010). REACH requires manufacturers to register the chemical substances used in the products manufactured. If it is discovered that illegal timber has been imported into the European market, this can lead to sanctions such as fines, confiscation of material and professional bans.

[11] Annual Report 2009, Byggvareindustriens Forening
[12] CEN/TC 350 Sustainability of Construction Works, European Committee for Standardisation
[13] http://www.sintef.no/Projectweb/Miljodeklarasjoner/Hva-er-miljodeklarasjoner-EPD/

3 About the criteria revision

Purpose of the criteria revision

The revision has had the following focus areas:

- The criteria are to be changed from being an environmental pioneer, which means a new product group for Nordic Ecolabelling with simplified requirements, to a regular product group.
- The product group definition is to be reviewed and consideration given to adding new products. In particular, there should be an assessment of whether composite products made from wood and plastic should be included. Biocide and fire retardant impregnated wood are generally not included in the criteria, but new products such as wood treated with supercritical CO_2 and small quantities of biocides are to be given initial consideration in the revision.
- Requirements concerning chemicals (residues and classification of constituent substances), durability (test systems included) and forest certification are to be assessed and updated where appropriate.
- There is to be an assessment of whether energy requirements/climate requirements could be introduced for the production process, with a focus on energy efficiency.
- Requirements concerning waste, quality and user instructions are to be reviewed.
- The background document is to make clearer what Nordic Ecolabelling brings in terms of sustainability and reduced chemical and energy consumption from a life cycle perspective.

About this criteria revision

The revision was conducted by the secretariats of Nordic Ecolabelling, and involved a complete evaluation of the criteria.

The revision began in autumn 2012. The revision was carried out as an internal project within Nordic Ecolabelling. As part of the revision process, stakeholders and licensees were contacted via physical meetings and telephone calls. Contact was also made with other experts in the field of durable wood in order to gather information. Available Life Cycle Analyses were studied and information was gathered from licensees and stakeholders.

4 Environmental impact and Nordic Ecolabelling as an influential tool

Section 4.1 describes how Nordic Ecolabelling is a targeted tool for reducing the environmental impact from the production and use of durable wood. The section also contains a description of the potential environmental impact of this product group.

4.1 Relevance, Potential and Steerability (RPS) through Nordic Ecolabelling

The Nordic Ecolabel is a type I ecolabel that follows the standard ISO 14024 and must therefore ensure account is taken of the various relevant environmental impacts in the product's life cycle, and where there is potential for the manufacturers to reduce the environmental impact.

Based on a MECO analysis (Materials, Energy, Chemicals and Other, see Appendix 2), an RPS analysis has been performed that evaluates environmental impact relevance (R), improvement potential (P) and the possibility of introducing steerable criteria (S) for durable wood. The RPS analysis is used to assess the areas in which Nordic Ecolabelling is able to set different requirements.

Relevance

The MECO analysis and background information show that there is an environmental impact associated with the production and use of durable wood. This environmental impact is described in section 4.2. There is therefore a high relevance in setting environmental requirements for all the phases of the products' life cycle. The environmental impact is particularly great in the raw material phase and in the production and use phases.

Potential and Steerability

In terms of the choice of raw materials there is considerable potential for differentiating between wood raw material from poorly run forests and wood from forests managed in a more sustainable way. The manufacturers of durable wood also have extensive steerability over this and can ensure that they purchase sustainable wood. There is, however, low steerability concerning which type of wood the producers use, because the wood type is often critical for the quality of the end product.

In terms of energy used in drying the wood in the raw material phase, there is potential to reduce consumption, through heat recovery, energy optimisation and improved technology. The drying usually takes place at the premises of a supplier to the producers of durable wood, which are to a large degree reliant on special types of wood for their product. The opportunity for the manufacturers to influence the energy consumption of their suppliers is judged to be low, since the manufacturers of modified wood are relatively small customers of the wood suppliers, and may have difficulty convincing a wood supplier to invest in new systems/change energy supply. There is thus little steerability.

The potential to improve the efficiency of the manufacturers' treatment processes is also judged to be low. The technologies and production equipment are relatively new, and there are therefore reasons to believe that the energy efficiency of the processes is already as high as it can be. In addition, there are only a few manufacturers in the market within

each of the treatment processes. The potential for a reduction in greenhouse gas emissions by switching to bio-based energy sources is judged to be moderate to high. Steerability is, however, likely to be low, since it would take major investments to switch to a different energy source, which could prove a financial challenge for the manufacturers.

The potential for using less toxic chemicals to treat durable wood, and for creating durable wood with a low need for maintenance, is considered to be high. Steerability in reducing the use of toxic chemicals is judged to be high in professional manufacturers of durable wood, which are also able to easily control work environment conditions at the factory. For wood where the end user must carry out much of the chemical application/maintenance, steerability is considered to be lower.

The potential for environmental improvements in the waste phase is judged to be moderate to low. The difference between pressure impregnated wood and modified wood has become less pronounced with the move away from CCA impregnation, and much of the pressure impregnated wood uses copper, which is not considered hazardous waste in all the Nordic countries. Steerability over how Cu impregnated wood is treated at the waste facility is judged to be low, since it is difficult to differentiate between end-of-life CCA and copper impregnated wood, and both are often treated as hazardous waste if there is doubt about whether CCA impregnated wood is present.

The environmental impact from transport varies considerably, and is determined by how far the wood has to travel to the production site. In some cases, there is thus high potential for reducing the impact from transport. Steerability is, however, often judged to be low, since the products, as mentioned before, are often dependent on a particular type of wood.

Summary

The MECO and RPS analyses show that it is relevant to set requirements in all phases of the life cycle: raw material extraction, production, use, disposal and transport. Potential and steerability, on the other hand, vary in terms of whether ecolabelling can make a significant difference within the various life cycle phases and environmental themes.

4.2 Environmental impact of durable wood

The environmental impact of durable wood relates primarily to the following:

- Wood raw material
- Chemicals used for impregnation/modification/treatment and maintenance
- Energy consumption and CO_2 emissions, mainly from the raw material and production phases, and transport
- Waste management for end-of-life products

Below is a brief description of the potential environmental impacts associated with the themes above. Readers are also directed to the MECO analysis in Appendix 2, which is a qualitative assessment of Materials, Energy, Chemicals and Other to show where in the life cycle of durable wood the environmental impact can be found.

Raw materials

Wood

Various species of wood are the main raw material for durable wood products. Potential problems when using wood are that it may come from protected areas, areas of disputed ownership or genetically modified trees. It is also important that the forest is managed in a sustainable way and that operations do not destroy natural forest, biodiversity, special ecosystems or social assets. Forestry also has an important role to play in combating climate change. However, that is on condition that the forest is managed sustainably[14]. Sustainable forestry is important in being able to continue using the resources of the forest over the long term. Greater demand for wood from forest areas that are run sustainably will reduce the pressure on vulnerable areas. This is important for all forest environments where wood is harvested. The availability of wood from certified forests is currently limited, but it is expected to increase in years to come.

Another potential problem is that the wood raw material may come from the illegal felling of tropical timber. Tropical woods have many good properties and are therefore much sought after. Illegal felling of tropical timber is one of the greatest threats to the world's rainforests, which play a role in mitigating the effects of climate change. In addition, the rainforests are home to 50-80% of the planet's species and to 60 million people[15].

Chemicals for impregnation/modification/treatment

The environmental impact of impregnated wood has primarily been associated with toxins that were/are used as impregnation agents. The most common agents that have been used over the years to impregnate wood are creosote, arsenic, copper, chromium, boron, tin and a number of organic substances (fungicides)[16]. One negative side-effect of using toxins for impregnation is that the substances often have adverse health and environmental properties that can affect humans and the environment during leaching over time. The greatest emissions from impregnated material derive from materials that are still in use[17]. The Norwegian Environment Agency estimates that around 30% of heavy metals in impregnated wood leach out into the environment over a period of 30 years. A leaching experiment from 2011 using Danish and Norwegian pine impregnated with Wolmanit CX-8 showed that about 18% of the copper and all of the boric acid leached out[18]. The substances that remain in the wood can also cause problems during waste management.

2002 saw the introduction of a ban on CCA impregnated wood in the Nordic region. The leaching of chromium, arsenic and copper from CCA impregnated wood that is still in use remains an environmental problem, however, since the lifetime of impregnated wood is in the order of 30-50 years. For example, the Norwegian environmental authorities have calculated that around 25 tonnes of chromium leached from existing CCA wood in 2010. This was the most significant source of chromium emissions in 2010[19]. In the future, demolition and renovations will generate relatively large quantities of CCA impregnated wood that will have to be processed as hazardous waste. Today, the

[14] PEFC Norway: www.pefcnorge.org (March 2014)
[15] Rainforest Foundation Norway: www.regnskog.no/no/om-regnskogene (March 2014)
[16] Danish Environmental Protection Agency: www.mst.dk (March 2014)
[17] Information from the Norwegian Pollution Control Authority's report "Vurdering av virkemidler for å redusere utslippene av kobber", December 2005.
[18] Kängsepp, K. et al. 2011. Leaching of commonly used impregnation agents affected by wood properties.
[19] Miljøstatus i Norge: www.miljostatus.no (March 2014)

most common impregnation agents are copper-based. The substances often also contain other active substances such as boric acid and/or organic biocides/fungicides.

Although the chemical substances most used for pressure impregnation today are less harmful to health and the environment than the previous CCA impregnation, toxins are still used to protect the wood. Examples of the impregnation agents in the Nordic market today (2008) include Wolmanit CX-S, CX 87%, CX-10, CX-CS, CX-E 87% and CX-8 from BASF, all of which contain boric acid and various bivalent copper compounds. Wolmanit CX-8 is marked with both T (toxic) and N (environmentally harmful), while the other agents are marked with T. The agents Tanalith E 3491 and Tanalith EK (3496) produced by Arch Timber Protection Ltd are also marked as toxic and environmentally harmful. Tanalith E 3491, for example, contains boric acid, bivalent copper and tebuconazole.

A study of wood facades conducted by SINTEF Byggforsk and others in 2013 shows major differences in the emissions of substances that are harmful to health and the environment, depending on which treatment methods are used to make the wood durable. Untreated solid wood naturally has the lowest emissions, but thermally modified wood and furfurylated wood also have low emissions. Copper and Royal impregnated wood has higher emissions. Whether or not the wood undergoes surface treatment in the use phase also has a major effect on the environmental impact, see figure 3.

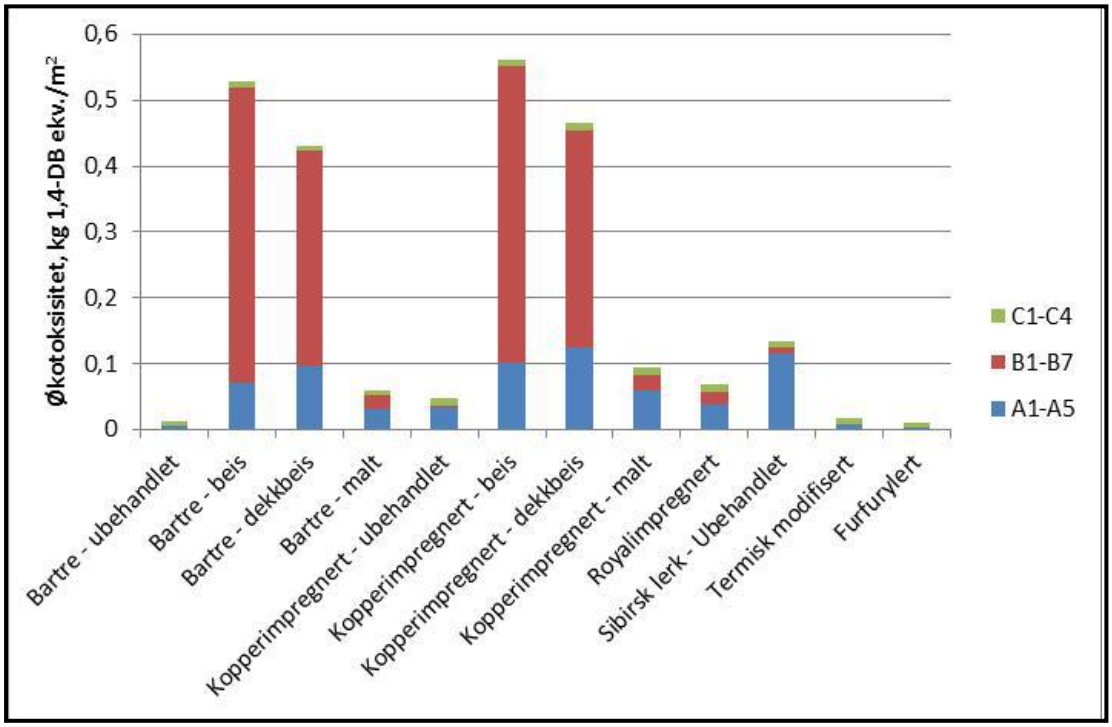


Figure 3. Emissions of compounds that are toxic to aquatic and terrestrial organisms. The figure illustrates emissions related to the treatment method for wood facades. It is taken from the study "Miljøanalyse av trefasader" (Environmental analysis of wood facades) conducted in Norway as a collaboration between SINTEF Byggforsk, the Norwegian Institute of Wood Technology and the Norwegian Forest and Landscape Institute[20]. Phases A1-A5 include raw material extraction, production and installation of the cladding including transport. Phases B1-B7 include the use phase (emissions from the surface treatment and maintenance). Phases C1-C4 include demolition and waste management.

[20] Plesser, Thale Sofie Wester et al., Miljøanalyse av trefasader, SINTEF Byggforsk, ISBN 978-82-536-1339-0, 2013

Energy consumption and CO_2 emissions

The greatest contributors to energy consumption and CO_2 emissions from durable wood and composites are extraction of raw materials (wood and plastic), processing of the raw materials, impregnation or modification of the wood and transport between the parts of the chain.

During processing of the wood in the raw material phase, drying accounts for the greatest energy consumption in the Nordic region, averaging out at around 1500 MJ/m^3 [21,22,23,24,25]. The climate impact is, however, low since the energy source in the Nordic region is based chiefly on renewable materials such as bark and wood chips. Extraction and transport usually account for around 10% of the energy consumption involved before finishing in the Nordic region. The environmental impact from transport can vary considerably depending on transport distance, while the climate impact may range from a few percent to around 20% of the total climate impact over the life cycle.

In the production phase there is a major difference in energy consumption for different treatment processes. Copper impregnated wood has a relatively low energy footprint since the technology does not usually use heat in the manufacturing process. Various EPDs suggest a very low energy consumption of 30-40 MJ/m^3 (large production volumes, figure uncertain) but there is also data for less efficient processes, where the energy consumption may be ten times greater (figure uncertain). Thermally modified wood tends to have somewhat higher energy consumption, around 500 MJ/m^3, compared with impregnated wood due to the need for high temperatures in the process (figure uncertain). Chemically modification using known technology such as furfurylation or acetylation have a much higher energy consumption compared with impregnated work and thermally modified wood. Energy consumption can be 4-5 times as high (figures uncertain, little data) compared with thermally modified wood.

The study of wood facades mentioned above shows that greenhouse gas emissions vary a great deal for different treatment methods. Maintenance (type of chemicals and frequency) also plays a substantial role in emissions of greenhouse gases, see figure 4.

[21] Silje Wærp et al., Livsløpsanalyser av norske treprodukter, MIKADO, SINTEF Byggforsk, 2009. Norway.
[22] Jungmeier, G. et al, Allocation in Multi Product Systems – Recommendations for LCA of Wood-based Products
[23] Andersson, B-I, (1996) Environmental declaration for sawn timber, Trätek.
[24] Jarnehammar, A. (2000): LCA for multi-layer parquet flooring in Life Sys Wood. Trätek.
[25] Adebahr, 1995, Energy consumption for roof building related to 1 m³ structural timber

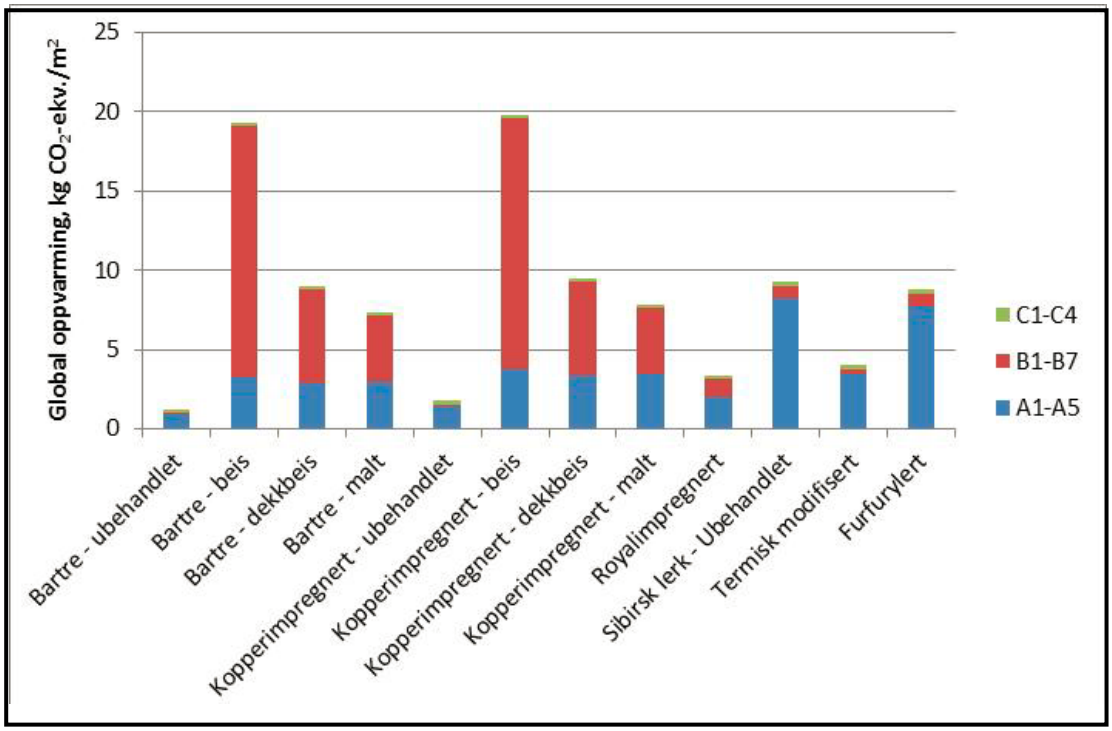


Figure 4. Emissions of greenhouse gases for each type of cladding. Total for the production, installation and use phases. The figures are from the report "Miljøanalyse av trefasader" (Environmental analysis of wood facades – SINTEF Byggforsk, the Norwegian Institute of Wood Technology and the Norwegian Forest and Landscape Institute)[26]. Phases A1-A5 include raw material extraction, production and installation of the cladding including transport. Phases B1-B7 include the use phase (emissions from the surface treatment and maintenance). Phases C1-C4 include demolition and waste management. According to the report, the results for Royal impregnated wood are too low, since energy use during impregnation with oil is not taken into account due to lack of data.

Waste management for end-of-life products

The environmental aspects of the waste phase are primarily associated with the necessary treatment of end-of-life wood due to the chemical substances in the wood. In addition, the possibility of recycling the materials is an important aspect.

After CCA impregnated wood was banned, theoretically the waste problem from pressure impregnated wood was significantly reduced. Unfortunately it is generally not possible to tell the difference between copper impregnated wood and older types that are hazardous to burn, and in practice there is therefore a great deal of copper impregnated waste (offcuts, demolition wood, and so on) treated as hazardous waste. More recent copper impregnated wood should not be burned in ordinary furnaces, since the copper acts as a catalyst in the formation of chlorinated dioxins and furans. It is therefore important that such wood is burned in furnaces with sufficient flue gas cleaning technology. In addition, heavy metals will be left in the ash. In Finland impregnated wood has to be delivered to a special section at the waste recycling centre or to the wood retailer.[27] After collection, it is treated as hazardous waste and incinerated at a hazardous waste plant. In Denmark, pressure impregnated wood is collected and then currently sent to Germany for incineration. In Sweden and Norway, more recent copper impregnated

[26] Plesser, Thale Sofie Wester et al., Miljøanalyse av trefasader, SINTEF Byggforsk, ISBN 978-82-536-1339-0, 2013
[27] http://www.tukes.fi/en/For-Consumers/Home-and-home-technology/How-to-use-and-dispose-of-impregnated-wood/Waste-management-of-impregnated-and-painted-wood-/

wood must also be collected so that it can be incinerated at an approved incineration plant, but it is not classified as harmful waste in the way that CCA impregnated wood is. It is, however, often recommended that copper impregnated wood is treated as hazardous waste, since it is difficult to differentiate between CCA impregnated and copper impregnated wood (same green colour).[28]

An important benefit of modified wood compared with impregnated wood is that it does not cause problems or require special processing during the waste phase. Incineration tests on durable wood show that the wood acts the same as ordinary untreated wood on incineration. Flue gas surveys also show that emissions of some components are actually less when incinerating furfurylated wood than when incinerating untreated wood.

5 Background for the requirements

This section presents proposals for new and revised requirements, and explains the background to the requirements, the chosen requirement level and any changes since version 1. The appendices that are referred to in the proposed requirements are included in the criteria document "Nordic Ecolabelling of Durable wood – Alternative to conventionally impregnated wood".

5.1 Description of the product

O1 Description of the product

Applicants must provide the following information about the product:

- Trade name/brand
- A description of the product/products and all the materials involved
- A description of production methods/treatment techniques. Suppliers must be described with the name of their business, production site, contact person and the production steps carried out

✉ Detailed description of the points above. Product data sheets can be sent in as part of the documentation. Use a flowchart to describe the production process.

Background

The requirement specifies more points than before to clarify what must be included in the product description. The intention is to give a general, clear picture of which raw materials and production processes that are used. The information is important in obtaining a good overview and ensuring efficient evaluation of applications. A description of any suppliers is also important in achieving a true and complete picture. A description of the chemicals used shall be given in the next requirement, O2.

5.2 Chemical requirements

What do the chemical requirements cover?

The chemical requirements cover all chemicals and chemical products used from the wood is impregnated or modified until the product is ready for sale to the consumer. The requirements apply to the chemicals used by the manufacturer and those used by any supplier.

[28] http://www.byggemiljo.no/article.php?articleID=593&categoryID=298 (23 April 2010)

What is considered to be a constituent substance?
This definition applies for all the chemical requirements:

The term constituent substance refers to all substances in the chemical product, including additives in the ingredients (such as preservatives and stabilisers) but does not include impurities from primary production. Impurities are defined as residual products from the ingredient production that can be found in the final product in concentrations below 100 ppm (0.01% by weight, 100 mg/kg), but not substances added to an ingredient or product deliberately and with a purpose, regardless of amount. Impurities of over 1% concentration in the primary product are, however, regarded as constituent substances. Substances known to be degradation products of the constituent substances are also themselves considered to be constituent substances.

O2 Chemicals used

All chemicals used for impregnation/modification/treatment of the wood are to be stated.

✉ Safety data sheets and formulations for the chemicals used to impregnate, modify or treat the wood.

Background

The requirement remains unchanged from the previous version. The intention of the requirement is to obtain a complete overview of all the chemicals used in order to evaluate these against the chemical requirements in this section. A ban on the use of biocides and other stringent restrictions concerning the properties of the chemicals establish strong limits on the chemicals that may be used.

O3 Biocides

Biocides are not to be used in the impregnation, modification or treatment of wood. In this context, biocides are defined as chemical substances used in the wood to combat vermins, insects, bacteria, fungi and so on, as governed by the Biocidal Products Regulation (EU) No 528/2012.

An exemption is made for the use of biocides in concentrations below 200 g/m^3 wood for impregnation with supercritical CO_2.

✉ Declaration that biocides are not used. If no chemicals are used, this must be stated in the process description (see O1).

Background

The ban on the use of biocides is one of the core requirements of the criteria. A biocide product contains one or more active substances that enable the product to be used to destroy, neutralise or in some other way prevent the effects of harmful organisms. Many biocide products have properties that are harmful to health and the environment, since it is the toxicity of the products that provides the desired effect on the harmful organisms such as fungi, insects or pests[29]. It is estimated that around 25-30% of the heavy metals in impregnated wood leach out into the environment over a period of 25 years. By switching to modified wood without the addition of heavy metals or other biocides, significant environmental gains can be achieved through reduced use and emissions of substances that are harmful to health and the environment. These are the main reasons why Nordic Ecolabelling generally does not permit the use of biocides in Nordic Ecolabelling durable wood.

[29] www.miljodirektoratet.no/no/Tema/Kjemikalier/Kjemikalieregelverk/Biocider/ (March 2014)

The criteria have been drawn up to promote other treatments that achieve the same durability in wood as when impregnating with biocides, but where that durability is due to the wood being modified, without using significant quantities of biocides with toxic properties. In alternative treatments such as chemical or thermal modification, the chemical composition of the cell walls in the wood is changed, and during modification that involves impregnation (without biocides), chemicals are used that polymerise in the wood[30]. All these alternative technologies change the wood so that it does not swell or suffer attacks by insects, fungi, etc., and the wood therefore does not need to contain an active biocide in order to achieve the desired durability.

The requirement has been updated to account for the current European regulations. Biocides were previously governed by EU Directive 98/8/EC. In summer 2012, a new Biocidal Products Regulation was adopted in the EU (528/2012/EU), which now applies in the Nordic countries.

The greatest change to the requirement is the introduction of an exemption for biocides in concentrations below 200 g/m^3 wood in the case of impregnation with supercritical CO_2. Nordic Ecolabelling is aware that this is a relaxation of one of the main requirements in the criteria. As such we would particularly like comments on this during the consultation. The suggested limit value for biocides is low in comparison with the quantities used in conventional wood impregnation. It is also Nordic Ecolabelling's opinion that supercritically impregnated wood has several environmental advantages compared with conventional impregnation:

- The quantity of impregnation agent used is in the order of 30 times less than for example with Wolmanit
- The agent used in supercritical impregnation, SC200, contains fewer active substances (three biocides), while Wolmanit contains copper compounds and boric acid, as well as small quantities of three biocides
- The leaching potential from superimpregnated wood is lower than from conventionally impregnated wood, since much less impregnation agent is used and bound to the cell walls of the wood
- Supercritically impregnated wood may be treated as ordinary combustible waste in contrast to wood impregnated with copper and biocide
- Spruce is used for superimpregnation, despite being a wood that is not usually well suited to impregnation

See Appendix 4 for further justification. Nordic Ecolabelling will make a final decision on this inclusion after considering the comments received during the consultation.

[30] Hill, C.A.S.: "The potential for the use of modified wood products in the build environment", Proceedings of the 11th International Conference on Non-conventional Materials and Technologies (NOCMAT 2009) 6-9 September 2009, Bath, UK. Available from: http://opus.bath.ac.uk/16170/1/papers/Paper%2080.pdf (06 November 2011)

O4 Classification of chemical products

Chemical products used in the impregnation, modification or treatment of wood must not be classified according to the table below.

There is an exemption for products where the classification Carc 2 H351 is due to the presence of furfuryl alcohol (CAS 98-00-0). Such products may be used on condition that the requirements in O9 and O10 are fulfilled. There is also an exemption for the classifications H361, H400, H410 and H411 for biocides in concentrations below 200 g/m^3 wood for impregnation with supercritical CO_2.

Classification under CLP Regulation (EC) No 1272/2008		**Classification under Dangerous Preparations Directive 1999/45/EC 2008**
Hazard class and category	**Hazard phrases**	**Hazard class and risk phrases**
Toxic to aquatic organisms Category acute 1 Category chronic 1-2	H400, H410, H411, H412	N with R50, R50/53, R51/53, R52/53.
Acute toxicity Category 1-3	H300, H310, H330, H301, H311, H331	T+ with R26, R27, R28, R39 T with R23, R24, R25, R39, R48
Specific target organ toxicity (STOT) with single and repeated exposure STOT SE category 1-2 STOT RE category 1-2	H370, H371, H372, H373	T+ with R39 T with R39, R48, Xn with R68
Carcinogenic Carc 1A/1B/2	H350, H350i or H351	T with R45 and/or R49 (Carc 1 or Carc 2) or Xn with R40 (Carc 3)
Mutagenic Mut 1A/B/2	H340, H341	T with R46 (Mut 1 or Mut 2), Xn with R68 (Mut 3)
Toxic for reproduction Repr 1A/1B/2	H360, H361, H362	T with R60, R61, R64, R33 (Repr1 or Repr2), Xn with R62, R63, R64, R33 (Repr3)

✉ Declaration from the manufacturer/supplier of the chemical product, see Appendix 2. In addition, safety data sheet in line with prevailing legislation in the country of application, e.g. Annex II to REACH (Regulation 1907/2006/EC) for all chemical products.

Background

The requirement has been updated in line with official regulations and has also been tightened/expanded to include prohibition of the following classifications:

- Toxic to aquatic organisms, category acute 1 and category chronic 1-2
- Acute toxicity, category 1-3
- Specific target organ toxicity (STOT) with single and repeated exposure, STOT SE category 1-2 and STOT RE category 1-2

The previous requirement set stringent requirements regarding health classification and these continue to form part of the requirement. The aim of these requirements is to ensure that the chemicals used do not entail serious health problems. The requirement has now been expanded to include stringent requirements concerning classification of environmentally harmful effects. In addition, the hazard classes and categories are primarily described in relation to the CLP Regulation (EC) No 1272/2008 (only hazard class and risk phrases are given under the EU Dangerous Substances Directive 67/548/EEC, which expires on 1 June 2015).

Nordic Ecolabelling works to ensure that the health and environmental effects of the chemical products are as few as possible. This is the reason why the requirement has now been expanded to include classification related to environmental harm. It has not been shown that chemical products with this type of classification are necessarily used in durable wood, but it is desirable to exclude them from use to cover any new products that may come onto the market.

The requirement applies to all chemicals used for the impregnation, modification or other treatment of wood, from the wood is modified/treated until the product is ready for sale to the consumer.

Since March 2009, there has been an exemption from the carcinogenic requirement for furfuryl alcohol, which at the time was classified as R40 (may cause cancer) – under the CLP Regulation this equates to the classification Carc 2, H351. The exemption only applies if the requirements concerning workplace limits (O9) and chemical residues in the product (O10) are fulfilled. The starting point in this context is that the use of chemicals classified as "may cause cancer" is undesirable. In the case of chemically modified wood (furfurylation), the furfuryl alcohol is polymerised during hardening after penetrating the wood. Furfurylated wood is therefore generally judged to be a more eco-friendly alternative than ordinary impregnated wood, which uses copper or other biocides that leach out during use. A more in-depth explanation of the exemption is given in the background to version 1.

Version 2 proposes a new exemption for the classifications H361, H400, H410 and H411 for biocides used in concentrations below 200 g/m^3 wood for impregnation with supercritical CO_2. See the explanation in O3 and Appendix 4.

O5 CMR substances

The chemical products used in the impregnation, modification or treatment of wood must not contain chemical substances that are classified as carcinogenic (Carc), mutagenic (Mut) or toxic for reproduction (Rep), according to CLP Regulation (No) 1272/2008 or the Dangerous Preparations Directive 1999/45/EC as amended, see table below. Note that classification under the Dangerous Preparations Directive may only be used until 31 May 2015.

Classification under CLP Regulation (EC) No 1272/2008		**Classification under Dangerous Preparations Directive 1999/45/EC 2008**
Hazard class and category	**Hazard phrases**	**Hazard class and risk phrases**
Carcinogenic* Category Carc 1A/1B/2	H350, H350i or H351	T with R45 or R49. Or Xn with R40
Mutagenic Mut 1A/B/2	H340, H341	T with R46 or Xn with R68
Toxic for reproduction** Repr 1A/1B/2	H360, H361, H362	T with R60 or R61. Or Xn with R62, R63 and/or R64

** There is an exemption for products where the classification Carc 2 H351 is due to the presence of furfuryl alcohol (CAS 98-00-0). The substance may be used on condition that the requirements in O9 and O10 are fulfilled.*
*** An exemption is made for products where the classification H361 is due to biocides used in concentrations below 200 g/m³ wood for impregnation with supercritical CO_2.*

✉ Declaration from the manufacturer/supplier of the chemical product, see Appendix 3. In addition, safety data sheet in line with prevailing legislation in the country of application, e.g. Annex II to REACH (Regulation 1907/2006/EC) for all chemical products.

Background

The requirement is new to the criteria for Durable wood. The requirement is harmonised with equivalent requirements in other criteria for Nordic Ecolabelling, such as those pertaining to Chemical building products.

Alongside requirement O4 – Classification of chemical products, this requirement prohibits chemical substances classified as CMR from being included in any chemical products used. Substances that may cause cancer, change genetic material or interfere with reproduction (known as CMR substances in categories 1A and 1B) are prioritised substances within the EU's chemical legislation due to their inherently dangerous properties. It is therefore of central importance to considerably reduce, and in the long term move away entirely from, the use of CMR substances. It is not permitted to use CMR substances in chemical products that are accessible to consumers[31], but they do occur in other goods. The most common applications at this time are in fuels, soft plastics, rubber tyres, paints and pressure impregnated wood.

An exemption is made for furfuryl alcohol, classified as R40 (may cause cancer) in 2009 – under the CLP Regulation this equates to the classification Carc 2, H351. The exemption only applies if the requirements concerning workplace limits (O9) and chemical residues in the product (O10) are fulfilled. See also the background to O4.

[31] Information from: http://www.regjeringen.no/nb/sub/europaportalen/eos/eos-notatbasen/notatene/2005/okt/begrensningsdirektivet---cmr.html?id=523623

A new exemption has been introduced for the classification H361, where it relates to biocides used in concentrations below 200 g/m^3 wood for impregnation with supercritical CO_2. See the explanation in O4 and Appendix 4.

O6 Substances that must not be present in the products

The following substances must not be present in the chemicals and chemical products used in the production of durable wood.

- Substances on the Candidate List*
- Substances that the EU judges to be PBT (persistent, bioaccumulative and toxic substances) and vPvB substances (very persistent and very bioaccumulative) in accordance with the criteria in Annex XIII of REACH
- Substances considered to be potential endocrine disruptors in category 1 or 2 on the EU's priority list of substances that are to be investigated further for endocrine disruptive effects. See following link: http://ec.europa.eu/environment/chemicals/endocrine/strategy/being_en.htm
- APEO – alkylphenol ethoxylates and alkylphenol derivatives (substances that release alkylphenols on degradation)
- Halogenated organic compounds**
- The following heavy metals or heavy metal compounds must not be present in the products: lead, cadmium, chromium VI, mercury and arsenic

** The Candidate List can be found on the ECHA website: http://echa.europa.eu/sv/candidate-list-table*

*** Paint pigments that meet the EU's requirements concerning colourants in food packaging under point 2.5 of Resolution AP (89) are exempted.*

✉ Declaration from the manufacturer/supplier of the chemical product, see Appendix 3. In addition, safety data sheet in line with prevailing legislation in the country of application, e.g. Annex II to REACH (Regulation 1907/2006/EC) for all chemical products.

Background

The requirement is new to the criteria for Durable wood, but is included in many other Nordic Ecolabelling criteria where relevant. The purpose of the requirement is to contribute to the phasing out of the substances due to their problematic properties as regards health and the environment. They are therefore excluded from use in the Nordic Ecolabelling of durable wood. Appendix 6 describes the environmental aspects associated with the substances excluded from use by the requirement. The requirement covers all chemical products used at the factory/place of manufacture or by any supplier.

O7 Nanoparticles

Nanoparticles (from nanomaterial*) must not occur in chemical products or in the finished product. The following are exempt from the requirement:

- Pigments**
- Naturally occurring inorganic fillers***
- Synthetic amorphous silica****
- Polymer dispersions

** The definition of nanomaterials follows the European Commission's definition from 18 October 2011 (2011/696/EU): "A nanomaterial is a natural, incidental or purposely manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for at least 50% of the particles in the number size distribution, one or more external dimensions is in the size range 1–100 nm."*
*** nano-titanium dioxide is not considered a pigment, and is thus not covered by the requirement.*
**** this applies to fillers covered by Annex V point 7 in REACH.*
***** this applies to traditional synthetic amorphous silica. Chemically modified colloidal silica may occur as long as the silica particles form an aggregate in the end product. For surface treated nanoparticles, the surface treatment must meet the chemical requirements in O4 (Classification of chemical products) and O7 (Substances that must not be present in the products).*

☒ The manufacturer must declare any nanomaterials that occur in the product.

☒ Declaration in line with Appendix 3 from the manufacturer of the durable wood and the manufacturer of each raw material.

Background

The requirement is new to the criteria for Durable wood. The requirement was recently drawn up and introduced in version 4 of the criteria for Windows and exterior doors and version 2 of the criteria for Chemical building products. One part of the documentation requirement is a requirement for information on the nanomaterials present in the product. This has been introduced in order to obtain more knowledge on which nanoparticles appear in different products.

Nanoparticles are increasingly used in a number of consumer products to provide new and improved product properties. However, there remains a great deal of uncertainty about how nanoparticles affect human health and the environment[32]. Nanoparticles may pose an unforeseen risk to health and the environment. The particles can reach parts of the body and the environment that are otherwise protected and their minute size may result in increased reactivity as small structures have a far larger available surface area relative to larger ones. Research into the risk associated with nanomaterials has focused on health impacts and some cases of damage have been recorded. This does not mean that all nanoparticles cause damage, but at present we lack sufficient knowledge of their effects on human health and the environment, and of long-term effects in particular. Based on the precautionary principle, Nordic Ecolabelling wishes to adopt a restrictive stance on the use of nanoparticles, and thus proposes that nanomaterials are restricted in chemical products. The definition of nanomaterials in the requirement follows the European Commission's definition of nanoparticles[33].

[32] European Council, Recommendation 2017 (2013), Provisional version, Nanotechnology: balancing benefits and risks to public health and the environment Available online: http://assembly.coe.int/ASP/Doc/XrefViewPDF.asp?FileID=19730&Language=EN (21 May 2013)
[33] COMMISSION RECOMMENDATION of 18 October 2011 on the definition of nanomaterial (2011/696/EU)

For a full explanation of the requirement, see the justification and requirement O11 in version 2 of the background document for the product group Chemical building products (available on the Nordic Ecolabelling websites).

Consequences of the requirement
The requirement means that nanomaterials produced with the intention of containing nanoparticles must not be used. Examples of such nanoparticles are fullerenes, carbon nanotubes, nanosilver, nanogold and nanocopper. Traditional fillers are, however, permitted. Pigments are exempted from the requirement, such that TiO_2 may be used in pigment form.

It can be difficult to find out the particle size of inorganic fillers from raw material suppliers. Naturally occurring inorganic fillers such as chalk, marble, dolomite and lime are exempted from registration under Annex V, point 7 of REACH, as long as these fillers are only physically processed (ground, sifted and so on) and not chemically modified. They are also exempted from registration in the Danish Environmental Protection Agency's draft Regulation on a register of blends and goods that contain nanomaterial and the duty of producers and importers to update the register[34].

In REACH directive (1907/2006/EC[35]) it is stated in article 2, point 2, point 7b:
"The following shall be exempted from Titles II, V and VI":
(Title II relates to registration of substances, Title V relates to downstream user and Title VI relates to evaluation)
(b) substances covered by Annex V, as registration is deemed inappropriate or unnecessary for these substances and their exemption from these Titles does not prejudice the objectives of this Regulation;"

Annex V Exemptions from the obligation to register in accordance with article 2(7)(b):
"The following substances which occur in nature, if they are not chemically modified. Minerals, ores, ore concentrates, cement clinker, natural gas, liquefied petroleum gas, natural gas condensate, process gases and components thereof, crude oil, coal, coke."

After the public consultation period an exemption has been added for inorganic fillers as long as they are covered by appendix V, point 7 in REACH.

Polymer dispersions are also exempted from the requirement after the public consultation period. The European Commission's report[36] to accompany the second "Regulatory Review on Nanomaterials" from 2012[37] states that solid nanomaterials in the dispersant in a liquid phase (colloid) are to be considered nanomaterials in accordance with the European Commission's recommendation. Nano emulsions are however not covered by the definition. Polymers/monomers may occur in different phases and sizes, and it is therefore chosen to explicitly state that polymers are exempted from the definition.

---

[34] Link to the Danish Environmental Protection Agency hearing: http://hoeringsportalen.dk/Hearing/Details/16910 (visited 20 January 2014)
[35] Link to the REACH Regulation: http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l_396/l_39620061230en00010849.pdf
[36] European Commission, COMMISSION STAFF WORKING PAPER, Types and uses of nanomaterials, including safety aspects, Accompanying the [..] second regulatory review of nanomaterials, SWD(2012) 288 final
[37] Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee, Second Regulatory Review on Nanomaterials, COM(2012) 572 final
Website of DaNa: http://nanopartikel.info/cms

O8 Volatile organic compounds (VOC)

The chemicals used for the impregnation, modification or other treatment of wood must contain no more than 5% by weight volatile organic compounds (VOC).

Volatile organic compounds (VOC) are defined as any organic compound having an initial boiling point less than or equal to 250°C measured at a standard pressure of 101.3 kPa (1 atm).

The aromatic content of the solvent must be no more than 5% by weight

Any solvents that polymerise in the wood may be used if the degree of polymerisation is at least 95%.

✉ Overview of the organic solvents included in the chemicals, stating the boiling point and aromatic content.

If there is any polymerisation of solvent in the wood, submit a report documenting that the degree of polymerisation is at least 95%.

Background

The requirement has been amended and updated to include definitions and wording that reflect similar requirements in other product groups for Nordic Ecolabelling. One of the reasons for setting requirements concerning volatile organic compounds (VOC) is Nordic Ecolabelling's goal of reducing ground level ozone formation. Some organic solvents also contribute to the greenhouse effect and some to the breakdown of the ozone layer[38]. The capacity for solvents to dissolve other substances and their volatility make then extremely useful, but they can also be highly harmful to health and can create a health issue in the workplace. Solvents that evaporate pollute the air that is inhaled and are then carried onward from the lungs and the blood. They can cause dizziness, headaches and lasting damage to the nervous system.

O9 Threshold limit value for chemical products classified as Carc 2 H351

During the production of Nordic Ecolabelled durable wood, air pollution in the production premises must not exceed a limit value of 1 ppm for furfuryl alcohol (CAS 98-00-0).

The limit value of 1 ppm states the highest acceptable limit value over an eight hour shift, and may be exceeded by a maximum of 200% for periods of 15 minutes.

The classification applies with the Dangerous Preparations Directive 1999/45/EC with subsequent amendments and adaptations.

Sampling and analysis methods must comply with the instructions given for national measurements in the administrative standards issued by the authorities. The analysis laboratory/test institute must fulfil the general requirements for analysis laboratories, see Appendix 1.

✉ Test results from measurements showing compliance with the limit value.

Background

Furfuryl alcohol is a chemical extracted from vegetable by-products such as bagasse from sugar cane production. Furfuryl alcohol is included in moulding sand for making cast iron and in anti-corrosion products and paint removers, plus it reduces the viscosity of

[38] Miljøvejledninger Ordbog, 2009: Section on organic solvents in the glossary at Miljøvejledninger.dk, which can be found at http://www.miljoevejledninger.dk/ordbog/uddybendeforklaringer/o/organiskeoploslashsningsmidler.

epoxy resin[39]. Furfuryl alcohol is also used as a flavouring in food, and WHO has set an acceptable daily intake level of 0.5 mg/kg body weight per day[40].

The requirement was first introduced in version 1.3 of the criteria and remains unchanged. Furfuryl alcohol, classified as Carc 2 H351, may be used on condition that the production fulfils this requirement (O9) concerning workplace limits and the requirement on chemical residues in the product (see O10 below). The workplace limit is set at 1 ppm in the workplace atmosphere during the production of Nordic Ecolabelled durable wood. This is half the limit value in Finland, which is the strictest in the Nordic region. The limit value states the highest acceptable limit value over an eight hour shift, and may be exceeded by a maximum of 200% for periods of 15 minutes. The odour limit for furfuryl alcohol is 8 ppm.

For furfuryl alcohol, the authorities in Sweden, Denmark and Norway have set an official limit for pollution in the workplace atmosphere of 5 ppm. In Finland the official limit is 2 ppm. This means that the highest acceptable average concentration of air pollutants over an eight hour shift is 2 ppm in Finland and 5 ppm in the other countries. The limit standard may be exceeded for a short time if the concentration is otherwise kept so low that the average concentration for the whole eight hour period falls below the official limit. The scale and duration of the acceptable exceedances must be judged in relation to the other environmental factors in the workplace (noise, heat and so on). The Norwegian Labour Inspection Authority gives the following rule of thumb for the scale of acceptable exceedances over periods of up to 15 minutes. (This is on condition that the average concentration for the eight hour shift is kept below the official limit):

- 200% of the limit for limits of less than or equal to 1 ppm
- 100% of the limit for limits of 1 to 10 ppm
- 50% of the limit for limits of 11 to 100 ppm
- 25% of the limit for limits of 101 to 1000 ppm

Nordic Ecolabelling has chosen to use the Norwegian authority's rule of thumb, allowing the limit value to be exceeded by 200% (i.e. 2 ppm) for periods of 15 minutes.

The requirement remains unchanged, since the level has proven to be strict but appropriate. Occupational hygiene measurements have shown that the requirement can be achieved, but the industry will have to implement measures to come in below the requirement level. The requirement has therefore not been tightened during this revision.

O10 Chemical residues in the product

The product can contain a maximum of 0.2% by weight of furfuryl alcohol (CAS 98-00-0). The amount is to be calculated in relation to wood is pre-dried.

The analysis laboratory/test institute must fulfil the general requirements for analysis laboratories, see Appendix 1.

✉ Test report showing that the average values fulfil the requirement.

[39] International Furan Chemicals. A marketing organisation in the field of furfural and furfuryl alcohol worldwide, based in the Netherlands. Available from: http://www.furan.com/furfuryl_alcohol_applications.html (25 January 2009)

[40] Evaluation of Certain Food Additives and Contaminates. WHO Technical Report Series, 901, 2001. Available from: http://whqlibdoc.who.int/trs/WHO_TRS_901.pdf (25 January 2009)

Background

This is the second requirement that must be fulfilled in order for furfuryl alcohol to be exempted from the ban on CMR substances. Under the requirement, the finished modified wood may contain a maximum of 0.2% furfuryl alcohol by weight. The amount is to be calculated in relation to wood that has been pre-dried. The intention of the requirement is that residues of a substance classified as Carc 2 H351 will not leach out during use of the modified wood, or that they will leach out in such small quantities that they do not constitute a risk to health or the environment. A previous leaching test has shown that moisture from brand new furfurylated wood is more toxic to algae and crustaceans than untreated wood, but that moisture from wood that was furfurylated 1 year earlier showed no difference compared with untreated wood. It could not be ruled out that the toxicity was due to the low pH of the moisture that leached out.

Furfuryl alcohol is readily soluble in water, and according to the industry organisation's data sheet, it is assumed to be readily degradable in water, and not bioaccumulative[41]. Bioaccumulative potential is measured as log(oil/water) = 0.28. The degradation products are less toxic than the furfuryl alcohol itself.

Test results have shown that the requirement can be achieved, but the industry will have to implement measures to come in below the requirement level. The requirement has therefore not been tightened during this revision.

5.3 Sustainable forestry

O11 Origin and traceability of the wood

The requirement applies to both certified and uncertified wood. The licensee must:

1. Demonstrate traceability for all wood raw material. State the name (in Latin and in a Nordic language) and geographic origin (country/state and region/province) of the types of wood used.
2. Have a written procedure for sustainable wood raw material supply. The wood raw material may not be sourced from:
   - Protected areas or areas in the process of being awarded protected status
   - Areas where ownership or usage rights are unclear
   - Genetically modified trees or plants

Furthermore, forestry operations must not damage:

- Standing natural timber, biodiversity, special ecosystems or important ecological functions
- Social and/or cultural preservation values

Nordic Ecolabelling may require further documentation if there is any uncertainty surrounding the origin of the raw material.

✉ Name (in Latin and one Nordic language) and geographic origin (country/state and region/province) of the kinds of wood used. Appendix 4a can be used.

✉ The manufacturer of the durable wood must have a written procedure for sustainable wood raw material supply. The procedure shall include up-to-date lists of all suppliers of wood raw material.

[41] ATP to the CLP Regulation (the EU's new regulation on the classification of chemicals). Amendment to EU Directive 67/548/EEC of 15 January 2009 (2009/2/EC). Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:011:0006:0082:EN:PDF (25 January 2009)

O12 Biocides

After harvesting, the wood must not be treated with biocides classified by WHO as type 1A and type 1B.

This requirement applies to the treatment of logs after felling.

WHO classification: An overview is available at: http://www.who.int/ipcs/publications/pesticides_hazard/en/, "The WHO recommended classification of pesticides by hazard and guidelines to classification 2009" or by contacting one of the secretariats.

✉ Report from the suppliers of the wood stating which biocides were used and a declaration in line with Appendix 4a for each individual product.

O13 Wood from certified forestry

On an annual basis, at least 70% of the wood raw material content shall be derived from areas where forestry operations are certified according to a forestry standard and certification system that meet the criteria stated in Appendix 4c.

Nordic Ecolabelling may request the submission of further documentation to enable it to assess whether the requirements concerning the standard and certification system and certified proportion have been fulfilled. Such documentation may comprise copies of the certification body's final report, a copy of the forestry standard, including the name, address and phone number of the organisation that established the standard, as well as references to individuals representing parties and interest groups who have been involved in the development of the standard.

✉ A statement showing the quantity of all constituent wood and the percentage of certified wood used in the applicant's Nordic Ecolabelled production on an annual basis. Appendix 4b can be used.

✉ Copy of relevant forestry certificate(s) that meet the criteria for forestry certification, as stated in Appendix 4c.

Background (O11-O13)

The requirements have been updated according to the latest version of Nordic Ecolabelling's forestry requirements. The requirement level remains unchanged.

Origin and traceability of the wood (O11)

Version 1 of the criteria contained a requirement that the wood raw material should not come from forestry environments with a great need for protection for biological and/or social reasons. This requirement remains relevant, since wood from tropical regions and from many parts of the world does appear on the Nordic market. The requirement applies to all wood raw material, regardless of geographic origin, even if the problem of illegal felling is greater in the tropical regions overall.

The new EU Timber Regulation (995/201/EU) came into force in April 2013 and affects timber felled and wood products manufactured both within and outside the EU. The purpose of the regulation is to tackle the global problem of illegal felling and prevent the inflow and trade of illegally felled wood and wood products in the EU. The Timber Regulation's requirements of businesses do somewhat facilitate fulfilment of the Nordic Ecolabel's requirements with regard to wood raw material origin and traceability. However, it does not completely replace the Nordic Ecolabel's requirements, even though it can help to document the origin of the wood raw material and its ecological functions. The Nordic Ecolabel's requirements, stating that wood raw material must not be sourced from natural forests, areas with a high level of biodiversity, unique ecosystems or important ecological functions, nor compromise important social or cultural values, are not covered by the Timber Regulation. The Timber Regulation applies to illegal

felling and is consistent with the legislation of the country in question. It therefore fails to provide sufficient guarantees that the wood raw material has been sourced from sustainable forestry operations.

Wood from certified forestry (O13)
Version 1 of the criteria contained a requirement calling for at least 70% of the constituent wood to be sourced from certified sustainable forests. The recommendation is to leave the requirement unchanged but with the formulation updated so that it corresponds to Nordic Ecolabelling's most recent formulation and to the introduction of the EU Timber Regulation.

The section below explains the benefits of certification systems for wood.

Sustainable forest management
There is no unified global standard for sustainable forestry. The understanding of what is sustainable depends on social and cultural values and as such can vary from country to country, and over time. There is, however, some international consensus on the overarching principles and criteria.

The Statement of Forest Principles from the United Nations Conference on Environment and Development in Rio de Janeiro 1992 established that "forest resources and forest lands should be sustainably managed to meet the social, economic, ecological, cultural and spiritual needs of present and future generations." The document also sets out a number of other principles for sustainable forestry, including a nation's right to utilise, manage and develop its own forests (www.un.org). As a result of this, various organisations have been formed with the aim of drawing up internationally recognised principles, rules and standards for ensuring socially and environmentally appropriate forestry. The objectives have since been expanded to also include certification of wood products, in order to enable manufacturers to show that their products are ecofriendly and socially sustainable, and to provide consumers with an easily understandable tool for assessing the consequences of their purchases.

Forestry and traceability certification
The aim of forest management certification, based on sustainability principles, is to establish rules on how forests should be managed in order to meet social, economic, ecological and cultural needs. Today's certification systems all include management related aspects and environmental and social requirements.
The leading certification bodies have developed regulations, policies and standards that more clearly define various specific requirements.

Below are some of the basic requirements that occur in various forestry certification systems. They may seem obvious, but in many parts of the world not even these basic requirements are fulfilled. It is in these areas that forest management can have the greatest positive impact:

- Ban on converting forest or other natural biotopes for other purposes
- Compliance with international labour law
- Ban on the use of harmful chemicals
- Compliance with the Universal Declaration of Human Rights, with a specific focus on indigenous peoples
- No corruption – compliance with all prevailing legislation

- Identification and appropriate management of areas that require special protection (e.g. cultural and sacred sites, and habitats for endangered animals or plants)

Treatment of wood after harvesting (O12)
The requirements concerning the wood have been expanded with the addition of O14, which relates to the treatment of logs after harvesting. The aim of the requirement is to ensure that the most harmful biocides, classified by WHO as type 1A "extremely hazardous" and type 1B "highly hazardous", are not used. The requirement has been harmonised with other relevant Nordic Ecolabelling criteria.

5.4 Biological durability

O14 Biological durability

The wood must as a minimum fulfil the test methods for one of the areas of use given in the table below.

Area of use	Test methods
Wood used in marine environment*	- Fungi test EN 113. The wood must be aged with relevant method, i.e. EN 73 or EN 84. - Soft rot test in accordance with ENV 807, part 2. - Marine test EN 275 over at least 5 years in a Nordic test field
Wood used in contact with soil*	- Fungi test in accordance with EN113. The wood must be aged with relevant method, i.e. EN 73 or EN 84. - Soft rot test in accordance with ENV 807. - Field test in accordance with EN 252, over at least 5 years in 2 fields, one of them in a Nordic country.
Wood used above soil*	- Fungi test in accordance with EN113. The wood must be aged with relevant method, i.e. EN 73 or EN 84. - Field test in accordance with CEN/TS 12037 (ENV 12037) or EN 330. The tests must be carried out in accordance with EN 599.

** Wood classified in class M, A or AB in accordance with the Nordic Wood Preservation Council (NTR) system fulfils the respective durability requirement with regard to use in marine environment, soil contact or above soil (exposed to the elements). NTR classes M, A and AB in the table are comparable with the following classes in EN 350-1: 1, 2 and 3.*

Alternative test methods may be used if an independent and competent test institution judges the methods to be equivalent in terms of quality.

✉ Analysis report showing test results or certificate showing approved usage class. There must be a clear declaration of which methods were used, who conducted the analyses and the independence of the test institution (see Appendix 1).

Background

The requirement level remains unchanged, but the requirement has been reformulated. A study has been conducted to see whether any relevant new tests for durability have been created that could be included in the requirement, but few relevant newly established test methods have been found. A new fungal test method that can be used to test ThermoWood is, however, described in US standard AWPA 10 (soil-block test). The test is conducted under optimum conditions for degradation by basidiomycete fungi (white and brown rot fungi). The evaporation procedure equates to the procedure in EN84, and the calculation of natural durability follows EN 350-1. This test may be used if an independent and competent test institution judges the method to be equivalent to the methods named in the requirement in terms of quality.

One of the greatest challenges in developing alternative products to conventionally impregnated wood has been achieving sufficient durability. This issue now appears to

have been resolved and some of the alternative products have biological durability in line with pressure impregnated wood. Pressure impregnated wood is assessed in the Nordic Wood Preservation Council (NTR) system of 4 classes: M, A, AB and B. The classes state the degree of protection and durability. The system has been harmonised with the standards EN 351 and EN 599, and states requirements concerning penetration and absorption of different impregnation agents for each class. EN 599 contains a description of the various test methods for durability.

The more environmentally aware alternatives to impregnated wood are not based on the penetration of active substances, but on the modification of the wood itself. The NTR test methods are not specifically adapted to these methods. Alternative tests that will be able to be used for such methods are currently under development. Until these become available, a modified version of the EN standards and the NTR system is used. Established EN tests are taken as the starting point, and the requirement level corresponds to the NTR system for classes AB, A and M.

Class B "not durable" is not included in the requirement, since it is not a relevant alternative. Wood in usage class AB accounts for the largest volume in the current market, and it is in this segment that the greatest environmental gains can be made by switching from traditionally impregnated wood to more environmentally aware wood. One of the most important properties of the newly developed alternatives is that they have a similar biological durability to traditionally impregnated wood.

Chemically modified wood can be used in contact with the ground and in freshwater, as well as above ground. Thermally modified wood is generally used above ground.

Table 2: Equivalence across different standards

Area of use	NTR	EN 350-1	EN 335-1
Wood for use in permanent contact with saltwater (quay structures, jetties, posts)	M	1 (very durable)	5
Wood for use in permanent contact with ground or freshwater (terraces, lampposts, fences, bridges)	A	2 (durable)	4
Wood that is exposed to the elements, but not in permanent contact with ground or water (windows, doors, cladding)	AB	3 (moderately durable)	3
Wood for use above ground that is not directly exposed to the elements, but that may be exposed to short-term dampness (roof trusses, ceilings)	B (normally no need for impreg-nated wood)	4 (not very durable)	2
Wood for use indoors	B	5 (not durable)	1

NS-EN 350-2 states durability against rot attack for untreated wood, and not for impregnated or modified wood. The classification gives an indication of the performance of the wood in contact with the ground. According to NS-EN 350-2, the durability classes for some relevant wood species are as follows:

- Spruce: 4
- Pine heartwood: 3-4
- European larch heartwood: 3-4
- Oak heartwood: 2
- Western red cedar: 2 (grown in North America)
- Western red cedar: 3 (grown in the UK)

Applying the same classes as in NS 350-1, one obtains the following durability classes for impregnated and modified wood:

- Impregnated wood (in line with NTR): 1
- Thermally modified wood: 1-5 (depending on wood type and process)
- Acetylated radiata pine: 1-2
- Furfurylated pine: 1-2[42]

5.5 Climate impact

O15 Monitoring energy consumption

The following information is to be documented by the licensee. If the data is not available at the time, it must be submitted no later than one year after the Nordic Ecolabel licence is issued.

Raw material phase:

a) Drying of the wood: The drying method must be described. Total energy consumption and energy consumption per energy source* is to be reported on an annual basis. Energy consumption is to be expressed as MJ/m3 dried wood. If the drying takes place somewhere other than at the premises of the durable wood manufacturer, the information must be sourced from the supplier/sawmill.

Production phase:

a) The manufacturer of the durable wood must report, on an annual basis, which energy sources that have been used and the amount of energy used in the manufacturer's production. Energy consumption is to be expressed as MJ/m3 wood.

b) The manufacturer must have an energy efficiency plan that is not less than three years old.

** In this context, energy source means electricity, district heating (supplier is to be stated) and fuels (e.g. wood waste, wood chips, biogas, straw, peat, pellets, natural gas, heating oil).*

Annual follow-up:

The manufacturer of durable wood must have an environmental management system that ensures the annual collection of energy data as described above.

✉ Documentation regarding the points in the raw material phase and production phase above. Appendix 5 can be used. The calculations must be per cubic metre of wood, and may be stated for the Nordic Ecolabelled production or the total production.

Energy efficiency plan.

Procedures in environmental management system that ensure annual collection of energy data.

Background

This requirement is new. The MECO analysis and the various life cycle analyses of durable wood show that energy consumption in the raw material and production phases often accounts for a substantial amount of the product's environmental impact. One goal in this revision was therefore to draw up energy/climate requirements with a focus on

[42] Information from http://www.trefokus.no/fullstory.aspx?m=1748&amid=18250 (April 2014)

energy efficiency. In gathering the data and considering possible requirement levels, it became clear that the data is associated with a great deal of uncertainty. It was also judged that the manufacturers have low steerability when it comes to affecting energy consumption for drying, since this is often carried out by a supplier, and it would often require major investments for the manufacturers to switch energy sources. See also the RPS analysis in section 4. These circumstances make it difficult to set requirement levels for permitted energy consumption.

The requirement has therefore instead been formulated as an information/follow-up requirement in this version, with the objective of obtaining good data so that level requirements can be set for energy consumption in the next revision. There is also a requirement that the manufacturers must have an energy efficiency plan in place at their production facilities. The intention behind setting requirements concerning energy efficiency is to encourage manufacturers to identify any potential for improvement at their facility, and come up with cost-effective measures that can be realistically implemented.

Appendix 5 summarises the energy data that has been studied for the raw material phase and outlines how level requirements for energy consumption may be set in the next revision.

O16 Transport emissions

The manufacturer must state the transport distance from the forest (geographic origin stated in O11-O13) to the production facility. The means of transport used (ship, train or truck) must also be stated. The transport distances are to be stated in kilometres on an annual basis per m^3 timber.

If the manufacturer reports CO_2 emissions from transport, please state which emission factor and methods/standards that were used (CO_{2eq}/m^3).

✉ Overview of transport distances and transport means per m^3 wood on an annual basis. Appendix 6 can be used. The information may be stated for the Nordic Ecolabelled production or the total production.

Background

This requirement is new. The MECO analysis and the various life cycle analyses of durable wood show that transport of wood over long distances can account for a large part of the product's greenhouse gas emissions. It is therefore relevant and important to place a focus on transport and highlight the differences in greenhouse gas emissions between wood that travels short distances and long distances. In some cases, the manufacturers have low steerability when it comes to influencing transport distances, if they are dependent on a particular type of wood in order to achieve good quality in the end product. Nordic Ecolabelling is beginning with a monitoring requirement in this version, with the objective of obtaining good data so that level requirements can be set for greenhouse gas emissions from transport of the raw material in the next revision.

5.6 Wood during use and disposal

O17 Product specification/instructions for use

The product specification/instructions for use shall, as a minimum, contain information and recommendations related to the following topics:

- Biological durability
- Areas of use
- Instructions for optimum installation
- Recommended maintenance during the use phase.
- Waste management. It must be specifically stated that the durable wood does not need to be treated as hazardous waste.

✉ Product specification/instructions for use containing the points above.

Background

The requirement has been adjusted somewhat and expanded to require instructions for optimum installation and information regarding waste disposal. Information is to be given on correct waste management, since there is a danger that durable wood may unnecessarily be treated as hazardous waste by the recycling centres. Furthermore, the requirement shall ensure that consumers receive adequate information for the intended use and optimal maintenance so that the product shall remain of high quality and have a long service life.

O18 Waste management

Durable wood should not need to be treated as hazardous waste in any of the Nordic countries.

✉ Declaration from the country's authorities about appropriate waste management.

Background

The requirement is new and is aimed at ensuring that none of the methods used for the modification of wood can lead to the wood having to be treated as hazardous waste at the end of its life. With the exception of this requirement on waste, there is no requirement on waste management in the criteria, since this is dealt with indirectly in the chemical requirements, where substances harmful to health and the environment are strictly limited.

5.7 Quality and regulatory requirements

The following requirements, O19 to O26, are general requirements that are always included in Nordic Ecolabelling's criteria for products. The purpose of these requirements is to ensure compliance with environmental legislation and fundamental requirements for quality management. Requirements O19 to O26 are new compared with version 1 of the criteria and replace previous requirements R13 and R14 in version 1 of the criteria.

O19 Nordic Ecolabel licence person

The company shall appoint a person responsible for ensuring the fulfilment of Nordic Ecolabel requirements, and a contact person for communications with Nordic Ecolabelling.

✉ A chart of the company's organizational structure detailing who is responsible for the above.

O20 Documentation

The licensee must be able to present a copy of the application and factual and calculation data supporting the documents submitted with the application (including test reports, documents from suppliers and suchlike).

🔑 Checked on site

O21 Quality of durable wood

The licensee must guarantee that the quality of the production of the Nordic Ecolabelled durable wood is maintained throughout the validity period of the licence.

✉ Procedures for collating and, where necessary, dealing with claims and complaints regarding the quality of the Nordic Ecolabelled durable wood.

O22 Planned changes

Written notice must be given to Nordic Ecolabelling of planned changes in products and markets that have a bearing on Nordic Ecolabel requirements.

✉ Procedures detailing how planned changes in products and markets are handled

O23 Unforeseen non-conformities

Unforeseen non-conformities that affect Nordic Ecolabel requirements must be reported to Nordic Ecolabelling in writing and logged.

✉ Procedures detailing how unforeseen non-conformities are handled.

O24 Traceability

The licensee must have a traceability system for the production of the Nordic Ecolabelled durable wood.

✉ Description of/procedures for fulfilment of the requirement.

O25 Take-back system

Relevant national regulations, legislation and/or agreements within the sector regarding the recycling systems for products and packaging shall be met in the Nordic countries in which the Nordic Ecolabelled products are marketed.

✉ Declaration from the applicant regarding adherence to existing recycling/take-back agreements.

O26 Laws and regulations

The licensee must ensure compliance with the applicable legislation on health and safety, environmental legislation and installation-specific terms/permits at all the production sites for the Nordic Ecolabelled product.

Documentation is not required. However, Nordic Ecolabelling may revoke the licence if the requirement is not fulfilled.

Background

The above procedures must be implemented to ensure that Nordic Ecolabelling's requirements are fulfilled. It is necessary for Nordic Ecolabelling to know, at all times, who the licensee's contact person is for the Nordic Ecolabel. The applicant must therefore appoint a person who is responsible for ensuring constant compliance with the requirements applicable to the Nordic Ecolabelled products. The contact person is also responsible for communication with Nordic Ecolabelling.

If the company has an environmental management system that is certified to ISO 14 001 or EMAS and the following procedures are applied, it is sufficient if the accredited auditor certifies compliance with the requirements.

The requirements ensure that the holder of the Nordic Ecolabelling licence is responsible for health and safety, environmental legislation and installation-specific terms/permits at the production facility for the Nordic Ecolabelled product.

Changes to the ecolabelled production process may have repercussions for the Nordic Ecolabel licence. A written report of all changes that may relate to the requirements set for the ecolabelled product must therefore be submitted to Nordic Ecolabelling. This will enable Nordic Ecolabelling to provide information on what needs to be done to ensure that the change does not impact on the licence.

In the event of unforeseen non-conformities, Nordic Ecolabelling can assess the consequences of the non-conformity and provide advice on what action the licensee should take.

5.8 Marketing

O27 Marketing

Marketing of Nordic Ecolabelled durable wood must comply with the "Regulations for the Nordic Ecolabelling of Products".

✉ Duly completed Appendix 6.

Background

The requirement ensures that the marketing of Nordic Ecolabelled products complies with the "Regulations for the Nordic Ecolabelling of Products". The regulations describe how the Nordic Ecolabel must be presented and give instructions on the right placement of the label. They also describe how the licensee may use the Nordic Ecolabel in the other Nordic countries and what documentation is required for registration.

6 Changes compared to previous version

Comparison of requirements for durable wood in criteria version 1 and draft version 2.

Req. version 1	Proposed requirements version 2	Comments
R1	O1	The requirement has been clarified and more points added
R2	O2	The requirement remains unchanged
R3	O3	The requirement has been amended to allow for the use of biocides in concentrations below 200 g/m^3 wood in wood impregnation with supercritical CO_2
R4	O4	The requirement has been updated in line with official regulations and expanded to include a prohibition of more classifications
-	O5	New requirement on CMR substances
-	O6	New requirement on chemical substances that are excluded from use
-	O7	New requirement on nanoparticles
R5	O9	The requirement remains unchanged
R6	O8	The requirement text has been amended/updated, but the requirement limit remains unchanged
R7	-	The requirement concerning surface treatment has been removed and the product definition states that surface treated wood cannot carry the Nordic Ecolabel.
R8	O10	The requirement remains unchanged
R9	O11	The text has been amended/updated
-	O12	New requirement on biocides for newly harvested wood
R10	O13	The requirement text has been amended/updated, but the requirement limit remains unchanged
R11	O14	The text has been amended
-	O15	New requirement on monitoring of energy consumption in production
-	O16	New requirement on reporting transport distances
R12	O17	The requirement has been clarified and new points have been added on instructions for optimal installation, plus the point about surface treatment has been made more specific
-	O18	New requirement on waste management for durable wood
R13 and R14	O19	New standard requirements for Nordic Ecolabelling products that replace previous requirements R13 and R14 in version 1
	O20	
	O21	
	O22	
	O23	
	O24	
	O25	
	O26	
R15	O27	The text has been amended/updated

Appendix 1 Different treatment methods for durable wood

This appendix gives a summary of the different treatment methods for durable wood. The following is described: modified wood (thermally and chemically modified), traditional pressure impregnated wood and new types of impregnated wood. Finally, there is a brief description of wood with naturally long durability.

Thermally modified wood

This process uses high temperatures and steam, with no chemicals involved. The wood is heated to around 130°C and is kept there for a certain period of time, before being further heated to around 185-225°C. This final part of the process requires an inert atmosphere. There are several patented processes for this. The inert atmosphere may be water vapour, nitrogen or oil. The product is then conditioned, with the final treatment taking about 8 hours. In all, production takes approximately 36 hours. One of the patented processes is called ThermoWood and is owned by the Finnish ThermoWood Association[43].

Together, spruce and pine account for over 90% of the production of thermally modified wood. The wood takes on a brown colour and its properties change slightly, in that it becomes more brittle and has lower flexural strength. On the other hand, the product has improved dimensional stability and lower density. Over time, the wood turns grey on exposure to the elements. Results of durability tests have so far concluded that the wood is not recommended for use in contact with the ground or in marine applications.

The method can be adapted and used for all types of wood. The wood is divided into different classes after treatment: Thermo-S (S=stability) and Thermo D (D=durability). Thermo D meets biological durability class 2 in line with the standards EN 113, EN 807 and EN 350-2. The areas of use are as follows:

- Softwood (conifers):
  Thermo-S: structural elements, interior fittings, furniture, outdoor furniture, components for doors and windows, sauna fittings
- Thermo-D: Fittings for exterior walls, exterior doors, window frames, structural elements, sauna and bathroom fittings, flooring, outdoor furniture
- Hardwood:
  Thermo-S, Thermo-D: interior fittings, furniture, outdoor furniture, flooring, sauna fittings

Since no chemicals are used in the process, the wood waste can be incinerated or handled the same way as untreated wood. Energy demand for drying accounts for 80% of the total demand. Energy/heat demand during the production of ThermoWood is about 25% higher than for traditional drying.

[43] http://www.thermowood.fi/ (11 April 2014)

Thermally modified wood with linseed oil

In Denmark, the company Royal Træ produces thermally modified wood that is then treated with linseed oil. The manufacturer describes the product and process as follows[44]:

Description of Royal Termo Træ and the process:

1) Royal Termo Træ is a green, durable product based on nature's own resources
2) Wood protection by removing nutrients in the wood and linseed oil

Core components: Wood - heat - linseed oil

The first step is thermal treatment, where the wood is heated and the glucose-containing cellulose is caramelised, with the resin hardening and changing structure. Thermal treatment reduces the movement in the wood by between 80 and 90%, and absorption of moisture is reduced by around 50%. Following thermal treatment, the wood remains vulnerable and needs to undergo further treatment – which involves a supplementary Royal process. The Royal oil is a science in itself. Linseed oil, which is the main ingredient in the Royal oil, contains proteins, stearin and paraffin. Proteins are nutrients for bacteria and fungi. Stearin and paraffin make the Royal oil unstable (liquid) when temperatures are high and the sun shines. In our Royal oil, we have removed the proteins, stearin and paraffin. The actual Royal process takes place in a modern autoclave. The thermally modified wood undergoes a process where the wood absorbs up to 5 times as much Royal oil as when wood is normally painted or treated with wood preservative.

There is also the option of leaving the wood entirely untreated. It will still last an incredibly long while, but will turn grey and begin to split over time.

Chemically modified wood

There are three main variants of chemically modified durable wood:

Furfurylation/Kebonisation

In 1996, the company Wood Polymer Technology (WPT) developed a non-toxic technology for modifying wood that gives similar durability results to pressure impregnated wood. The durability arises from chemical modification/polymerisation using furfuryl alcohol, which "saturates" the timber to make it harder and more resistant. Furfuryl alcohol is derived from biological waste from sugar cane production. Norwegian company Kebony is responsible for manufacturing furfuryl modified wood in the Nordic region.

The technology is called furfurylation or Kebonisation, and has many features in common with the technology used in traditional impregnation systems. The wood is treated/"impregnated" in an autoclave. The difference lies in the post-treatment. The products are hardened in a heat chamber after pressure treatment. During the hardening process, the chemicals react with the components of the cell walls in the wood and polymerise. Once the hardening is complete, the wood is transferred to the warehouse. Kebony describes the process as follows on its website[45]:

[44] E-mail correspondence with Lars H. Kristensen, Royal Træ, March 2014
[45] http://www.kebony.com

Kebonisation is a time-consuming process that upgrades the properties of wood, making it more stable and harder, while also extending its service life. The liquid used is derived from biomass.

The steps in the process:
1. The input substances are blended to a patented recipe
2. The liquid is added under pressure
3. Drying and hardening of the wood by heating to over 100°C
4. Packaging

The closed-loop production process includes recycling of the input liquid. The furfuryl alcohol used is derived from biological waste from sugar cane production.

Kebony's patented modification methods were developed over several years of research and development in Norway, Sweden and Canada. There were also additional collaborations with universities and institutes in Germany, the Netherlands, the USA and South Africa. These included the Norwegian Institute of Wood Technology, the Norwegian Forest and Landscape Institute, SP Trätek in Sweden, SHR in the Netherlands and the University of New Brunswick and Woodtech, both in Canada.

The product is just as flexible in its applications as traditionally impregnated wood. It has improved dimensional stability, which means that it moves less than other wood when subject to climatic changes. The wood has a golden brown colour after treatment, and turns grey over time when exposed to sun and wind. Beyond normal cleaning, Kebony products require no form of maintenance.

Kebony does not contain chemicals that could leach out into the environment. The polymer is permanently bound into the wood, and the process cannot be reversed. In the waste phase, Kebony can be handled in the same way as ordinary untreated wood.

Acetylation
Another method of chemical modification is the acetylation of wood. The process basically involves acetic anhydride reacting with hydroxyl groups in lignin and hemicellulose at 120-130°C. Acetylation causes the chemical modification of the cell walls in the wood, providing increased biological durability, hardness and dimensional stability[46]. In Europe, acetylated wood is manufactured in the Netherlands under the trade name of Accoya[47].

OrganoWood
A relatively recently developed supplementary wood preservative (Sioo), which is a commercialised research project (silicate-like silicon particles, can be particles on a nanoscale before application). The Swedish company OrganoWood AB, which was founded in 2010, manufactures and sells this type of modified wood. On its website, OrganoWood describes the technology as follows[48]:

OrganoWood's technology is based on modifying the wood to provide effective protection against rot, fire or water and moisture. The fibres are changed at a molecular level, using non-toxic silicon compounds, in stark contrast to traditionally pressure impregnated wood, where biocides and heavy metals are forced into the wood.

The molecular change to the fibres is caused by the silicon compounds. The natural fossilisation process is accelerated using catalysts to encourage the silicon compounds to bond with the wood fibres. A physical barrier is created that prevents fungi from eating the wood fibres.

[46] SINTEF, Miljøanalyse av trefasader, 2013
[47] http://www.accoya.com/
[48] www.organowood.com

Impregnated wood

Conventionally impregnated wood(not included in the Nordic Ecolabelling product group)

There are essentially three different production processes: pressure impregnation, vacuum impregnation and dip impregnation.

Pressure impregnation is used for wooden structures subject to a substantial risk of biological degradation. These may be wooden structures in direct contact with the ground or load-bearing elements of structures exposed to the weather, such as terraces, steps, balconies and so on. Pressure impregnation is the dominant industrial process. The technique involves impregnation agents being forced into the wood under pressure. There are three main types of pressure impregnation agent, 1) water-borne substances such as salts, 2) creosote and 3) oil-borne substances (Skogstad, 2009)[49]. The most common agent used in pressure impregnation comprises heavy metals suspended in water. Copper, chromium and arsenic (CCA impregnation) were the dominant heavy metals up until 2002, when they were banned for use in impregnation in the Nordic region. Copper is now the most common impregnation agent, together with one or more organic fungicides, as a replacement for chromium and arsenic. Other active substances are boric acid and/or organic biocides/fungicides.

There are also tight restrictions on creosote impregnation, which has been banned in Denmark since 1989. Some creosote treated wood is still manufactured in Finland, Norway and Sweden, but volumes have fallen considerably since a ban on private use came into force in 2003. Creosote impregnated wood is only permitted in an industrial context, and largely relates to telegraph poles, jetty posts and glulam bridges[50].

Vacuum impregnation is usually based on organic solvents. The agent used comprises around 90% organic solvent, often turpentine, and 10% active ingredient/fungicide. The most common fungicides are Propiconazole and/or Tebuconazole (see further description in section below). Vacuum impregnation is used for wood where there is a risk of attack from wood-decaying fungi, but not for wood in contact with the ground or permanently in water. Several approaches require follow-up surface treatment and ongoing maintenance throughout the lifetime of the product. Vacuum impregnation is used almost exclusively for the impregnation of window frames and doors.

After CCA impregnated wood was banned, theoretically the waste problem from pressure impregnated wood was significantly reduced. Unfortunately it is generally not possible to tell the difference between copper impregnated wood and older types that are hazardous to burn, and in practice there is therefore a great deal of copper impregnated waste treated as hazardous waste. More recent copper impregnated wood should not be burned in ordinary furnaces, since the copper acts as a catalyst in the formation of chlorinated dioxins and furans. It is therefore important that such wood is burned in furnaces with sufficient flue gas cleaning technology. In addition, heavy metals will be left in the ash. In Finland impregnated wood has to be delivered to a special section at the waste recycling centre or to the wood retailer. After collection, it is treated as hazardous waste and incinerated at a hazardous waste plant. In Denmark, pressure impregnated

[49] SINTEF, Miljøanalyse av trefasader, 2013
[50] Evans, Fred (Trefokus og Treteknisk), Fokus på tre issue 21, Trykkimpregnering, 2008

wood is collected and then currently sent to Germany for incineration. In Sweden and Norway, more recent copper impregnated wood must also be collected so that it can be incinerated at an approved incineration plant, but it is not classified as harmful waste in the way that CCA impregnated wood is.

More recent types of impregnated wood

Royal impregnation (not included in the Nordic Ecolabelling product group)

Royal impregnation is a combination of salt impregnated wood (usually copper salts) followed by boiling in linseed oil.

On its website Norwegian manufacturer Talgø, which produces the product MøreRoyal®, describes the process of impregnation as follows[51]:

In the process of manufacturing MøreRoyal®, the wood undergoes two treatments. It is first impregnated with a copper-based impregnation agent. Then it is boiled in oil for 6 to 8 hours in a vacuum – a full litre of oil per m^2 is boiled into the wood in this way.

According to descriptions from other producers, it appears that the length of time the wood is boiled in linseed oil varies.

Wood treated with supercritical CO_2 and small quantities of biocides

A relatively new impregnation method uses supercritical carbon dioxide as the carrier for small quantities of biocides with which the wood is impregnated. Hampen Træforarbejdning A/S in Jutland, Denmark, has one of the world's first facilities for impregnating spruce in this way, known as Superimpregnation/Superwood, on a reasonably large scale[52]. The product is marketed as an ecofriendly alternative to conventionally impregnated wood and received the EU's environmental award for clean technology in 2002.

The wood is impregnated with SC200. The impregnation takes place in a closed-loop process where the carbon dioxide acts as a carrier and under high pressure (supercritical level) forces the impregnation agent fully into the wood. At the end of the process, the carbon dioxide and impregnation agent are pumped back round and re-used.

The active components in SC200 are the following biocides: propiconazole (8-9% in the product), tebuconazole (8-9% in the product) and IPBC (3-iodo-2-propynyl butyl carbamate, 3-5% in the product). The first two are both classified as category II biocides (moderately harmful) in line with WHO's recommended classification of biocides (2009). The biocides are not in conflict with the Biocide Directive and the impregnation agent is approved by the Danish Environmental Protection Agency. Tebuconozole has the classifications Rep. 2, H361d toxic for reproduction (formerly R63) and very toxic to aquatic organisms, H411 (formerly R51/53). Propiconazole has the classification very toxic to aquatic organisms H400 and H410 (formerly N; R50/53). IPBC has the classification very toxic to aquatic organisms H400 (R-50) and very toxic to aquatic organisms with long lasting effects H410. Generally, very little biocide remains in the product (< 0.015% for each biocide, totalling an estimated 0.06-0.09% biocide by weight in the wood).

Superwood has a durability/wood protection effect that fulfils DS/EN 335 with a use/risk class of 3 (outdoors above ground). The Danish Technological Institute tests the

[51] http://hoved.talgo.no/byggevare/trelast/om-moereroyal/
[52] www.superwood.dk

products every 6 months. The product has also been tested in Malaysia and the test results indicate that the product may have a service life of 30 years even in a temperate climate. Tests in Denmark indicate no decay (above ground) after 8 years of horizontal exposure.

The product will (according to the product description) fade over time and may, like other untreated wood products/pressure impregnated wood, suffer splitting and splintering. The product can be surface treated and worked on like normal wood. The product is described as being best suited to horizontal surfaces (for example as facade cladding) and to a lesser extent for exterior decking. The product is not suitable for a marine environment.

Wood with natural durability (untreated wood)

There are woods with natural durability that may be used for certain applications as an alternative to impregnated wood. Natural durability refers to the wood's capacity to resist fungal and insect attack[53]. Good examples are the heartwood of pine, oak, and larch. The availability of pine heartwood, for example, is limited however, particularly due to the methods employed by the sawmills.

[53] Evans and Flæte (Trefokus og Treteknisk), Fokus på tre issue 2, Treslag og holdbarhet, 2009

Appendix 2 MECO analysis – durable wood

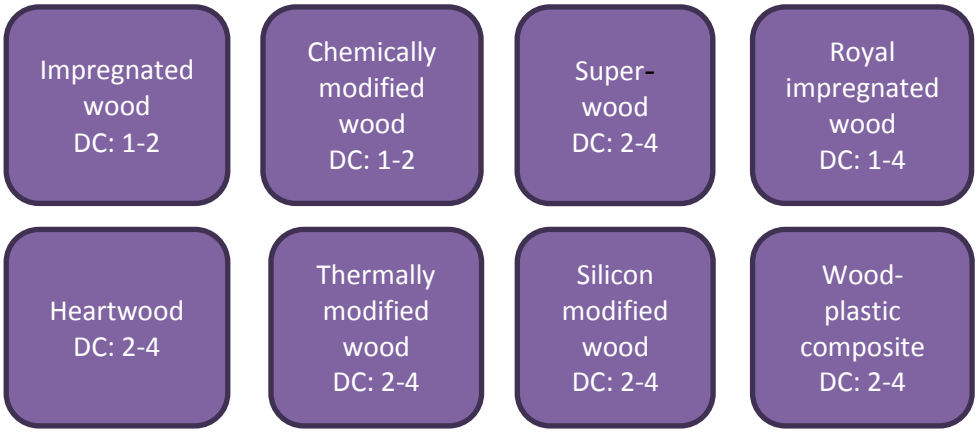
A qualitative MECO analysis (an assessment of Materials, Energy, Chemicals and Other) is presented in the table and text below. The purpose of the analysis is to show where in the life cycle the environmental impact occurs for different types of durable wood and wood-plastic composites, and to assess whether there is any potential to reduce that environmental impact. The analysis is general, and shows some of the most common materials and processes used. The analysis covers products inside and outside the product group as defined in the criteria for the Nordic Ecolabelling of Durable wood.

Unfortunately, there is a general lack of good LCA studies within this product group (particularly for the newest treatment methods), but there are a few LCA studies with a focus on climate impact and these have been used. There are also certain EPDs, but these are often based on different assumptions, which make it difficult to obtain exactly comparable data. Specific production data has also been collected for some of the production processes. The data presented in the MECO analysis therefore entails a great deal of uncertainty and must be interpreted with care. A practical study that has been used is "Miljøanalyse av trefasader" (Environmental analysis of wood facades) conducted in Norway as a collaboration between SINTEF Byggforsk, the Norwegian Institute of Wood Technology and the Norwegian Forest and Landscape Institute[54]. The study focuses specifically on building facades, which is one of many areas of use for durable wood. The facade materials were assessed with regard to potential global warming, human and ecological toxicology.

The text below provides a summary of the environmental impact in the different phases of the products' life cycle. For underlying data and qualitative assessments, also see the MECO table at the end of the appendix.

General information about products, materials and durability

There are a wide range of products on the market with different degrees of durability. The durability of different products is an important factor in any life cycle analysis and is therefore a requirement in the Nordic Ecolabelling criteria. In the criteria, durability is divided into three classes in line with the NTR system: M (marine environment), A (in contact with the ground) and AB (above ground). These equate to the classes M=1, A=2, AB=3-4 as set out in EN-350-1. The figure below gives some products and their typical associated durability classes (DC). Some of these products are excluded from Nordic Ecolabelling's product definition for durable wood.



[54] Plesser, Thale Sofie Wester et al., Miljøanalyse av trefasader, SINTEF Byggforsk, ISBN 978-82-536-1339-0, 2013

When assessing the environmental impact of durable wood, area of use and durability are important factors, since they are linked to the lifetime of the products. The environmental factors should be seen against this background. The products with the highest durability are chemically modified wood and impregnated wood. For this reason, these products will also have the broadest possible areas of use, since they are suitable for use in contact with water and the ground, as well as use above ground. Heartwood and thermally modified wood have different degrees of durability, depending on the type of wood, and the type of thermal treatment (see background to requirement O16).

Raw material phase
In the raw material phase, the environmental impact relates primarily to: forestry (sustainable or not), harvesting and processing the wood, extraction and processing of the plastic for composites (new or recycled) and raw material extraction for chemicals. In addition to this, there is the issue of transport for all materials.

Materials based on solid wood generally have a lower environmental impact, on condition that the forest is managed in a sustainable way. The raw material phase for wood includes the harvesting of roundwood, debarking, transport and processing at the sawmill (including drying). Drying sawn timber entails the greatest energy consumption, and in the Nordic region it accounts for around 90% of the environmental impact from processing. In the raw material phase, the drying process in the Nordic region makes up around 90% of an energy consumption that stands at around 1700 MJ/m^3. The climate impact tends to be low, however, since the energy source in the Nordic region is based chiefly on renewable materials such as bark and wood chips. Extraction and transport usually account for around 10% of the energy consumption involved before finishing in the Nordic region. The environmental impact from transport can vary considerably depending on transport distance, while the climate impact may range from 1% to approx. 20% of the total climate impact over the life cycle (see MECO table).

Impregnated wood and chemically modified wood generally have around the same energy/climate impact in the raw material phase, but transport can be a significant factor in increasing the environmental impact.

The plastic used in wood-plastic composites has a high environmental impact compared with wood, because plastic is an oil-based raw material. There is a substantial climate impact in the raw material phase if virgin plastic is used. Using recycled plastic can considerably reduce the environmental impact, depending on the degree of recycling. For composite products, the climate impact in the raw material phase for virgin plastic, such as PP, accounts for over 50% of the total climate impact over the lifetime of the product (this is described in more detail in Appendix 4).

Raw material extraction for the chemicals used in impregnation or modification may increase the environmental impact through increased energy consumption (10-20% cradle to gate) and higher greenhouse gas emissions (10-50% cradle to gate).

Production phase
The greatest environmental impact during the production phase is associated with the chemicals used to treat the wood (potential emissions to the outdoor environment and working environment), and with the energy used during production.

The production phase can differ greatly for different products and the environmental impact varies significantly in this part of the life cycle. Unsurprisingly, solid wood

products with natural durability (such as heartwood) generally fare best, since no chemicals are added and the products do not undergo any form of thermal or pressure treatment. If a surface treatment, in the form of a stain or paint, is applied to the finished sales product, this will, however, increase the environmental impact considerably in the production phase. Generally speaking, impregnated wood (Cu impregnation) will also have a low climate and energy impact in the production phase, since this technology does not usually use heat in production. Various EPDs suggest a very low energy consumption of 30-40 MJ/m^3 (large production volumes, figure uncertain) but there is data for less efficient processes, where the energy consumption may be ten times greater (figure uncertain). In the production phase, thermally modified wood usually has a somewhat higher energy consumption than impregnated wood due to the nature of the process (figures uncertain). Chemical modification using known technology such as furfurylation or acetylation has a much higher energy consumption compared with impregnated wood and thermally modified wood. Energy consumption can be 4-5 times as high (figures uncertain, little data) compared with thermally modified wood. Wood-plastic composites have even higher energy consumption in the production phase, with data suggesting up to twice the energy consumption of chemically modified wood where virgin plastic is used (figure is uncertain, little data).

When it comes to the carbon footprint of durable wood in the production phase, this is, as in the raw material phase, primarily determined by the kind of energy source used. In general terms, manufacturers in the Nordic region mainly use electricity in combination with propane or natural gas in the production phase. This often leads to a high carbon footprint where fossil energy sources are used in production. There is considerable potential here for a reduction in greenhouse gas emissions by switching to bio-based energy sources (bark, wood chips, pellets, etc).

Use phase

In the use phase, leaching of impregnation agents from the wood and the need for maintenance, particularly surface treatment, account for the greatest environmental impact. The fact that durable wood lasts a long time is extremely important (as described above) since the material does not have to be replaced as often.

For pressure impregnated wood, around 30% of the substances will leach out over the course of a service life of 20–30 years[55]. Leaching is not a problem for thermally modified wood, since it does not use chemicals. It is also not a problem for furfurylated or acetylated wood, where the polymer is permanently bound into the wood.

The environmental impact of surface treatment over the life cycle of wood is documented in the report from SINTEF Byggforsk et al, as mentioned above. The study shows the significance of surface treatment on untreated wood, compared with impregnated wood and a range of other durable facade products. The types of chemicals and the frequency of the treatment are decisive factors in the environmental impact of different claddings. In the majority of cases, untreated wood and impregnated wood will be given a large number of surface treatments over the course of the use phase. This has a crucial effect on the climate impact over the life cycle, and durable alternatives will fare better if they are not surface treated in the use phase. There will always be a likelihood that the end user will surface treat the durable, modified alternatives, but not with the same frequency as untreated, or pressure impregnated wood. The report also clearly shows the significance of emissions to soil, air and water in the form of ecotoxicity and

[55] www.miljodirektoratet.no

human toxicity. It is here, in particular, that many of the environmental gains offered by durable wood become apparent. There has generally been little focus on this aspect of environmental impact in the form of studies.

One benefit that should be mentioned for wood-plastic composites in the use phase is that they do not require surface treatment.

Disposal/waste phase
The environmental aspects of the waste phase are primarily associated with the treatment of end-of-life wood due to the chemical substances in the wood. In addition, the possibility of recycling the materials is an important aspect.

Creosote and CCA impregnated wood must be processed as hazardous waste in the Nordic countries. Impregnated wood that only contains copper salts (since 2002) is no longer defined by the Swedish or Norwegian authorities as hazardous waste, but has to be taken to a recycling centre[56] for incineration in furnaces with sufficient flue gas cleaning technology. Copper can act as a catalyst in the formation of dioxins and furans during incineration. It is therefore important that the plant which will be destroying the wood has optimised the process to prevent this happening. Ash with metal content must also be processed correctly. After CCA impregnated wood was banned, theoretically the waste problem from pressure impregnated wood was reduced. Unfortunately it is often not possible to tell the difference between Cu impregnated wood and other types that are hazardous waste, and therefore all types of pressure impregnated waste are generally treated as hazardous waste. In Finland, copper impregnated wood is still treated as hazardous waste, and in Denmark it is collected and sent for incineration in Germany (it was previously sent to landfill).

The durable wood alternatives (thermally modified and chemically modified) have the advantage that they can be processed in the same way as ordinary untreated wood and can be recycled into new products or sent for energy recovery.

When it comes to wood-plastic composites (WPC), the scope for material recovery is more limited than for pure wood products. The mix of wood, plastic and various additives causes the plastic to degrade, and plastic from used composite cannot be separated out and used in other types of product. End-of-life composite can be ground down and used in the production of new composite products, but there is no system in place for this in the Nordic region.

[56] Norwegian Environment Agency: www.miljodirektoratet.no (March 2014)

Table 3: Qualitative MECO analysis of durable wood and WPC

Type of durable wood (DW)*	Raw material extraction	Production	Use	Waste	LCA (total)
*CM = Chemically Modified with furfuryl alcohol (FA), acetylation, silicon treatment and linseed impregnation (Royal Træ), TW = ThermoWood, Thermally modified wood, WPC = Wood-Plastic Composite, IW = Impregnated Wood (copper impregnation), SW=supercritical CO_2 impregnation with biocides.					
Materials	CM, TW, SW and IW = pine/spruce/maple WPC = wood chips, PP(virgin)/PP(recycled) Felling, debarking, sawing, drying, processing.	Modified recycling PP, recycling paper fibre/recycling TW	Surface treatment in use phase can have major impact. Fuel for transport of wood from forest to sawmill and then to manufacturer.	End-of-life DW can be incinerated or have material recovered. In practice, most DW sent to the recycling centres is incinerated.	Materials based on solid wood have a low footprint, while materials such as polypropylene (PP) have a high footprint. See point on climate.
Energy MJ/m³** **The figures are generally highly uncertain, and many factors cause a major bias. The choice of energy mix in the electricity supply, for example, will be a decisive factor for CO_2 emissions.	Raw material extraction – solid wood[57,65] (transport +): approx. 200 MJ/m³ Drying of solid wood[58],[59],[60],[61],[62]: approx. 1500 MJ/m³ CM, WPC, SW, IW: Raw material extraction – chemicals: FA[63],[64]= 661 MJ/m³	CM: FA = approx. 2400-3300 MJ/m³ depending on wood type[65], gas (propane) accounts for almost 90% and electricity just over 10%. TW[66] = approx. 2400 MJ/m³ for all production and transport. Gas (LPG) accounts for 80% and electricity 20% in production. It is assumed that drying is included in the figure, and that energy for drying	Indications are that for solid wood products use and waste may account for just over 10% of the life cycle. Surface treatment and other maintenance is not normally included in the LCA, and may be significant over the lifetime of the product, depending on the quantity	Energy from incineration or energy saved in production through recycling. In general, conventional wood and durable wood can be recycled, and this has a positive effect on the life cycle, but in practice durable wood is often processed as	For solid wood products, energy use relates mainly to drying and processing the wood. Energy consumption is approx. 2000 MJ/m³ over the life cycle. For Norwegian exterior cladding surface treated with water-based paint, energy consumption over the life cycle is approx. 6000 MJ/m³.

[57] http://www.klimatre.no/uploads/KlimaTre/Presentasjoner/101111%20Fagdag%20biprodukter/101111%20Henning%20Horn.pdf
[58] Silje Wærp et al., Livsløpsanalyser av norske treprodukter, MIKADO, SINTEF Byggforsk, 2009. Norway.
[59] Jungmeier, G. et al, Allocation in Multi Product Systems – Recommendations for LCA of Wood-based Products
[60] Andersson, B-I, (1996) Environmental declaration for sawn timber, Trätek.
[61] Jarnehammar, A. (2000): LCA for multi-layer parquet flooring in Life Sys Wood. Trätek.
[62] Adebahr, 1995, Energy consumption for roof building related to 1 m³ structural timber
[63] Christian Rostock, Nicole Lambert. Carbon footprints of Ipê vs. Kebony Southern yellowpine – A comparative study. Published: Oslo, NORWAY /September 2010. Bergfald Miljørådgivere, Kongens gate 3 NO-0153 Oslo.

Type of durable wood (DW)*	Raw material extraction	Production	Use	Waste	LCA (total)
*CM = Chemically Modified with furfuryl alcohol (FA), acetylation, silicon treatment and linseed impregnation (Royal Træ), TW = ThermoWood, Thermally modified wood, WPC = Wood-Plastic Composite, IW = Impregnated Wood (copper impregnation), SW=supercritical CO_2 impregnation with biocides.					
	IV = 255-400 MJ/m^3 [60] Raw material extraction – PP: High compared with wood as it is an oil-based material. Reduced when recycled plastic is used.	amounts to approx. 1500 MJ/m^3 of the total. WPC = high, estimated to > 6000 MJ/m^3 SW = approx. 823 MJ/m^3 [67] IV = approx. 30-40 MJ/m^3 [60]. Figures uncertain. Thermally modified wood with linseed oil = approx. 500 MJ/m^3 [68] Royal impregnated wood = approx. 2200 MJ/m^3 [69]	of the chemical product and frequency of use. Must be assessed separately. The MIKADO study indicates that where water-based paints are applied to exterior cladding, the use phase may account for 67% of energy consumption.	specialist waste. According to the manufacturers, WPC can be recycled into new composite, but this has not been documented.	Chemical modification has relatively high energy consumption. Wood-plastic composite has high energy consumption, but if hollow boards are used, the impact will be almost halved if the functional unit for energy is set per kg of product.
Climate** **The figures are generally highly uncertain, and many factors cause a major bias. The choice of energy mix in the	CM: Transport of wood (0.06) + chemicals FA (0.07) + production of FA and auxiliary chemicals (0.22) = Total 0.36 kg CO_{2eq}/ kg	The energy sources in production account for the vast majority of the climate impact. It is still common in the Nordic region to use propane/natural gas alongside electricity. There	Surface treatment and other maintenance is not normally included in the LCA, and may be significant over the lifetime of the product,	In general, conventional wood and durable wood can be recycled, and this has a positive effect on the life cycle, but in practice durable wood is	CM (FA)[67]= 0.5-0.7 kg CO_{2eq}/kg CM (Ac)[70] = 0.4-1.1 kg CO_{2eq}/kg

[64] Christian Rostock, Nicole Lambert. Carbon footprints of Burmese teak versus Kebony Maple – A comparative study Published: Oslo, NORWAY/April 2010. Bergfald & Co as, Kongens gate 3 0153 Oslo, NORWAY.
[65] Correspondence with manufacturer. March 2014.
[66] Executive summary – ThermoWood: Life cycle assessment (LCA) of Finnish thermally modified wood cladding, Finnish ThermoWood Association, Publishing House Koivuniemi Ltd., Finland. 2008.
[67] Correspondence with manufacturer. April 2014.
[68] Correspondence with manufacturer. April 2014.
[69] Correspondence with manufacturer. April 2014.

Type of durable wood (DW)*	Raw material extraction	Production	Use	Waste	LCA (total)
*CM = Chemically Modified with furfuryl alcohol (FA), acetylation, silicon treatment and linseed impregnation (Royal Træ), TW = ThermoWood, Thermally modified wood, WPC = Wood-Plastic Composite, IW = Impregnated Wood (copper impregnation), SW=supercritical CO_2 impregnation with biocides.					
electricity supply, for example, will be a decisive factor for CO_2 emissions.	WPC: PP production accounts for up to 65% of total climate impact. Additives account for 7-11%, transport < 5%. See also Appendix 4.	is potential to switch to bio-based energy sources.	depending on the quantity of the chemical product and frequency of use. Must be assessed separately. Surface treatment with a stain, decking stain or paint increases the climate impact by a factor of 10, 5 and 4 respectively (see figure 4, section 4).	often processed as specialist waste. According to the manufacturers, WPC can be recycled, but in practice this has not been documented.	WPC = 0.7-0.9 kg CO_{2eq}/kg IV = ± 0.05 kg CO_{2eq}/kg
Chemicals and emissions	Chemical raw material extraction and associated emissions. See climate impact in row above.	Biocide, furfuryl, acetylation, silicon treatment and other additives.	Leaching of chemicals from impregnated wood in particular. Stain and paint in the use phase. Emissions of greenhouse gases and particulates.	Leaching of chemicals.	
Other	Sustainable forestry, biodiversity.	Working environment. Closed-loop process.	Ease of cleaning has impact on quality.		

[70] Vogtländer, J.G. Life Cycle Assessment of Accoya, Final 21 March 2010.

Appendix 3 Properties of active substances related to pressure impregnation

This appendix summarises the properties of common active substances currently used in the impregnation of wood.

CCA impregnation of wood (with chromium, copper and arsenic) was banned in the Nordic region in 2002, but still poses a pollution problem. This is because buildings and structures still have CCA impregnated wood in them that contains these substances, and they are gradually leaching out, plus during demolition such wood must be handled as hazardous waste. The properties of arsenic and chromium are described in Appendix 6.

Copper
Copper (Cu) has largely taken over from the previous system of copper, chromium and arsenic (CCA) impregnation. The copper content has increased considerably to compensate for the absence of chromium and arsenic in order to achieve the same level of protection. Copper compounds can be toxic if taken in through the mouth, lungs, skin and mucous membranes. At the same time, copper is a vital trace element that has an effect on the formation and functions of important biological structures such as genes, proteins and cell membranes. Aquatic organisms are generally more sensitive to copper than other organisms.

Copper acts as a catalyst in the formation of chlorinated dioxins and furans in incineration processes. Uncontrolled incineration can thus be a major contributor to emissions of chlorinated dioxins and furans. As such, incineration of impregnated wood that contains copper can have much more harmful consequences for health and environment than the metal alone would have[71].

Both Australia and New Zealand have studied leaching of copper from impregnated wood in the case of different impregnation agents. The results were presented at the 39th conference of the International Research Group on Wood Protection (IRG) in May 2008. The tests were carried out using a different approach to the one usually used by the Norwegian Institute of Wood Technology. The results showed that both above and in the ground, copper azole agents leached out more than CCA. It is not known how the copper bonds to the tested wood type radiata pine compared with Norwegian pine sapwood[72].

Organotin compounds
Tributyltin compounds (TBT) are very toxic to organisms in both soil and water. TBT accumulates in fish and in this way may be transferred to humans. Some organotin compounds bioaccumulate in humans. TBT has been proven to have endocrine disruptive effects on aquatic organisms.

[71] Toxnet, Hazardous Substance Data Base. Physician Consensus Statement, Physicians For Social Responsibility and Health Care Without Harm, March 1998.
[72] Results from studies of copper leaching from impregnated wood in Australia and New Zealand. The study was presented at the 39th conference of the International Research Group on Wood Protection (IRG) in May 2008, and is described in a report from the conference by Fred Evans of the Norwegian Institute of Wood Technology. Available at: http://www.treteknisk.no/fullstory.aspx?m=193&amid=8749 (25 January 2009)

Boric acid
In animal tests, boric acid has been proven to have reproductive toxicity properties, and to cause foetal damage in several animal species. The toxicity is, however, lower than for many of the alternative impregnation substances.

Creosote (only permitted in restricted circumstances/products)
Creosote is the oldest impregnation agent we know. Creosote comprises polycyclic aromatic hydrocarbons (PAH), of which benzo(a)pyrene, for example, is carcinogenic. Several of the hydrocarbons are classed as toxic and genotoxic. The level of degradability varies, but some PAHs are not readily degradable in soil, sediments and landfill sites. The substances bioaccumulate, and many of them are classed as toxic to aquatic organisms. It has also been shown that PAH affects the fertility of fish.

Triazoles
Triazoles are a class of fungicides that are commonly used in wood impregnation. They act as growth inhibitors, resulting in the reduced spread of rot and fungal mycelia. Some triazoles have been proven to be carcinogenic. Some triazoles have been proven to cause hypothyroidism.[73]

Carbamates
Carbamates are a class of biocides that are particularly effective against pests. Carbamates inhibit an enzyme that is necessary for the function of the nervous system and are therefore acutely toxic. Certain carbamates are carcinogenic. The carbamates are usually water-soluble and this has caused pollution of groundwater in some places. However, carbamates are generally readily degradable.[74]

[73] Organotin compounds, note from the Danish Environmental Protection Agency.
[74] Hazardous Substances Database, Herbicide Profile Cornell University 03 January 2001, EPA Special Review 10/92.

Appendix 4 Product group definition – assessment of new product types

One of the aims of the revision was to review the product group definition and consider adding new products. The products under consideration for inclusion in the criteria for durable wood were wood impregnated with supercritical CO_2 and small quantities of biocides, and wood-plastic composites (WPC). The conclusion was to put out for consultation the possibility of including supercritical impregnation but not WPC. The reasons for this are given below. The possibility of adding WPC will be re-examined as part of the next revision. There will be a particular focus on investigating whether manufacturers would use more recycled plastic or bioplastic and a greater proportion of post-consumer waste as a consequence.

1 Wood-plastic composites (WPC)

The use of wood-plastic composites (WPC) has grown sharply in recent years. This growth has occurred primarily in North America, but over the past few years we have also seen a clear increase in Europe. The market was expected to reach 270 000 tonnes in Europe and 1.7 million tones in North America in 2010[75]. The main areas of use are exterior applications such as decking, terraces, walkways, railings, furniture, cladding and fences. The products are sold primarily to B2B customers for public environments such as schools, parks, hotels, and so on, but also to private individuals. Some composite manufactures have shown interest in Nordic Ecolabelling.

Production and content

WPC is made by mixing wood chips/wood particles and melted plastic/polymer. The plastic acts as a binder. WPC may be manufactured from virgin plastic or recycled thermoplastic, usually polypropylene (PP), polyethylene (PE) or polyethylene terephthalate (PET). When WPC first came onto the market, it tended to comprise 50% wood and 50% plastic. Now it is usually made up of 70-80% wood raw material, but the ratio can vary. In addition to the main ingredients of wood chips and plastic, WPC often contains small quantities of additives such as colourings, binders, UV stabilisers, blowing agents and so on, in order to give the product its desired properties. WPC is manufactured both as solid and hollow profiles. [76]

Since WPC can be used in thermoplastic processes, it is excellent for extruding and casting. Quality is important, particularly for consumer products such as exterior decking, where WPC is clearly comparable with ordinary decking in terms of known properties and expected service life. Wood-plastic composite can be manufactured from recycled plastic bottle caps mixed in with wood chips, which are themselves a by-product of the wood processing industry. Test runs of WPC have been made using bio-PP, but there is currently no commercial production.

[75] Wood Plastic Composites made from Modified Wood, Kristoffer Segerholm, Licentiate Thesis, KTH 2007.
[76] Wikipedia

The development of WPC is taking place in various areas, which are summarised below (in no particular order):

- Increased proportion of recycled plastic raw material
- Increased proportion of post-consumer raw material
- Shift from fossil polymers to biopolymers
- Improved quality (splitting, swelling, etc.) and service life



Figure 1: Terrace decked with WPC



Figure 2: A carport built from WPC boards

In this review, products from four producers have been examined in more detail: LunaComp and The Biofore Company, both based in Finland, Polyfiber from Norway and Megawood, which is a German manufacturer. Only one of these manufacturers uses recycled plastic in its production. The main reason for this is that there have been problems achieving sufficient quality when using recycled plastic. There are, however, manufacturers outside the Nordic region that use a high proportion of recycled material (including plastic). One example is the world's biggest manufacturer of WPC, Trex in the USA, which uses 95% recycled material (plastic bags and by-products from projects involving wood and wood chips)[77].

None of the products examined contain PVC. No manufacturers use bio-polymers.

Waste phase

One aspect of composites in the waste phase is that the opportunities for material recovery are more limited than for pure durable wood. The blending of wood, plastic and various additives causes degradation of the plastic and the wood. Plastic and wood from end-of-life composite cannot be separated and used in other types of product.

All the manufacturers state that the products are recyclable at the end of their service life, or can be incinerated as ordinary household waste. Conversations with Polyfiber and LunaComp indicate, however, that in practice the limit of material recovery is that end-of-life composite can be ground up and used in the production of new composite products. It is uncertain what proportion of post-consumed composite they can use in the production of new composite products. The manufacturers currently have no established take-back system for collecting old products.

What do the life cycle analyses say?

We have not found any LCA studies that directly compare WPC with modified wood. There has, however, been a general comparison of LCA climate data for Kebony (chemically modified wood), ThermoWood (thermally modified wood) and the wood-

[77] http://www.trex.com/why-trex/how-to-choose-a-deck/eco-friendly-decking/ (April 2014)

plastic composites LunaComp and UPM ProFi. There is a great deal of uncertainty associated with the data (see Appendix 2, MECO analysis). Nevertheless, one distinct difference between the composites and pure wood products made from durable wood is that composite has a considerably higher environmental impact over its lifetime (raw material phase), due to the use of virgin plastic. This impact is naturally lower if recycled plastic is used, but only one of the three composite types examined currently uses recycled plastic.

Polymer production is thus responsible for the largest contribution of CO_2 emissions in the life cycle. The carbon footprint[78] calculated for the WPC product UPM ProFi, manufactured in Lahti, Finland, shows the following distribution:

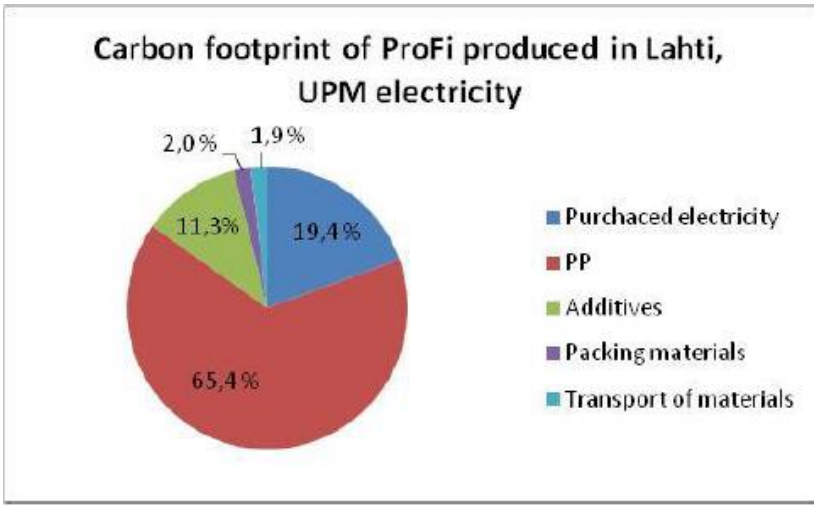


Figure 3: Carbon footprint WPC product UPM ProFi (source: VTT Research Report VTT-R -02591-11.2011[80])

UPM ProFi is made from production waste arising from the manufacture of self-adhesive labels, plus virgin polypropylene (PP). The ratio varies, but the proportion of recycled plastic raw material is never less than 50%. It is unclear what type of electricity the calculation is based on. The diagram should not be studied in detail, but provides an indication of the ratios involved. The phases after manufacture and packaging of the product are also not included in the carbon footprint calculation.

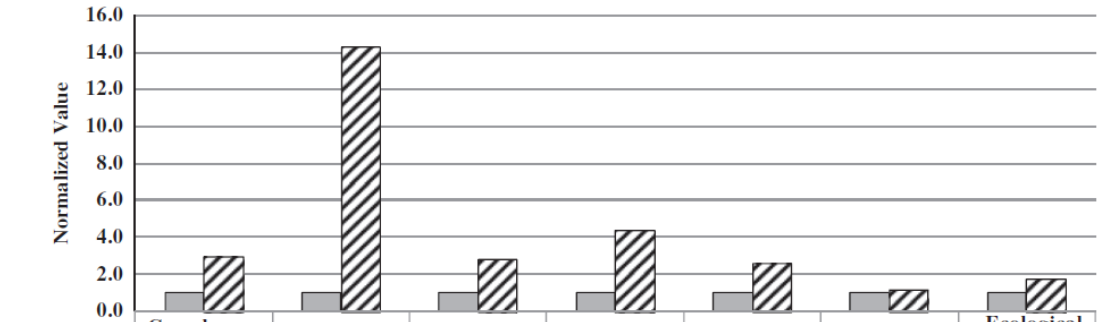
There are also three LCA studies that compare WPC with other materials. A summary of these can be found in Table 1:

[78] Carbon Footprint of UPM ProFi, VTT Research Report VTT-R -02591-11, 2011

Table 1. Summary of LCA studies. WPC versus other materials

Materials compared (LCA study conducted by)	Material facts	Summary
Untreated, naturally resistant cedar wood versus WPC decking (Bowyer, J. 2010)[79]	- Untreated cedar wood compared with - WPC using virgin PE - WPC using 100% recycled PE	For each environmental aspect (GWP, acidification, particulates, eutrophication, etc.), WPC using virgin PE shows the highest values (greatest impact). For each environmental aspect, natural wood shows the lowest impact. If recycled PE is used in WPC, the environmental impact is significantly lower compared with virgin PE, but in all cases the impact is higher for WPC than for ordinary decking.
Pressure impregnated wood decking versus WPC (Bolin, C.A and Smith, S. 2011) [80]. See figure 4 below.	- Wood impregnated with water-based impregnation agent for wood above ground using copper (oxide) and ammonium compounds (ACQ) compared with - WPC using 50% recycled wood raw material, 25% post-consumer HDPE and 25% virgin HDPE	The analysis shows that WPC decking has a higher environmental impact for indicators, see figure 4 below. The analysis also shows that if surface treatment is assumed to be carried out every three years, the environmental impact for ACQ wood increases for all indicators, except "ecological impact". However, the impact is still higher for WPC. It is assumed in the analysis that the WPC does not have a hollow cavity. If it is a hollow structure, all the indicators for WPC decking fall in line with the percentage of hollow cavity. If 100% recycled HDPE is used instead of 50%, the fossil fuel indicator falls from 14 times to 4 times more than for ACQ wood. Total energy consumption falls from 8.5 times more energy to 2.8 times more than ACQ wood.
WPC decking in spruce and exotic African woods (Kuntzstoff Zentrum, SKZ, Germany)	- Spruce and exotic African woods compared with - WPC using 70% wood fibre and 30% virgin polyethylene	The study concludes that: - The production phase dominates - Maintenance is not relevant in this context - The waste phase is less important, except for GWP, but recycling is a possibility for WPC - Spruce is the most ecofriendly choice for all categories - If the service life is increased from the normal assumption of 15 years to 30 years for WPC, hollow WPC is environmentally comparable with spruce for all parameters except GWP

[79] Wood-Plastic Composite Lumber vs. Wood Decking – A Comparison of Performance Characteristics and Environmental Attributes, Dr. Jim Bowyer, Dovetail Partners Inc, 2010.
[80] Life-cycle assessment of ACQ-treated lumber with comparison to wood plastic composite decking, Journal of Cleaner Production, Bolin, C.A and Smith, S, 2011.



	Greenhouse Gases	Fossil Fuel Use	Water Use	Acid Rain	Smog	Eutrophication	Ecological Impact
ACQ Lumber	1.0	1.0	1.0	1.0	1.0	1.0	1.0
WPC Decking	2.9	14	2.8	4.3	2.6	1.1	1.7

Figure 4: Cradle to grave comparison of a number of indicators for the average sized wooden deck (for an American family). Source: (Bolin, C.A and Smith, S. 2011)[82]

The three LCA studies show that the use of plastic accounts for a large part of the total environmental impact, and that WPC has a higher environmental impact than the other materials with which WPC was compared. However, the analyses also indicate that the environmental impact can be changed by making different choices in terms of materials (including the proportion of recycled plastic), hollow cavities and production techniques.

Relevance, Potential and Steerability (RPS)

Relevance

The objective of the criteria for durable wood is to find alternatives that are environmentally better than conventionally impregnated wood. It would be a positive thing to be able to expand the product group to include more alternatives, if they are environmentally better than conventionally impregnated wood. LCA studies show that there is an environmental impact associated with the production of WPC, and there is therefore high relevance in setting environmental requirements for such products in order to promote more environmentally aware products.

Potential

The LCA data and assessments that have been conducted show a considerable difference in the environmental impact of different composite materials, and there is therefore high potential for improving such products.

Steerability

Can Nordic Ecolabelling do anything about the environmental issues? Nordic Ecolabelling can set relevant requirements for composites and can steer the products towards a lower environmental impact. There currently appears to be little steerability in the Nordic region, however, regarding the use of virgin plastic, which constitutes the greatest environmental impact, since many of the manufacturers have stopped using recycled plastic due to quality issues. There are also limited opportunities for material recovery from composites at the end of their service life. There is therefore low steerability for these two aspects, which are important in the life cycle of the composite.

Conclusion wood-plastic composite

Nordic Ecolabelling will not be expanding the criteria to include composite materials in this revision because:

- Studies have shown that composite has higher energy consumption and CO_2 emissions than impregnated wood and modified wood due to the plastic used (use of recycled plastic reduces the CO_2 emissions). Research into the use of biopolymers is under way, but there is no commercial production as yet.
- Only one of the manufacturers examined uses recycled plastic today, and that is primarily only pre-consumer material. Since the plastic is what makes the environmental impact of WPC higher from an LCA perspective than products made from 100% wood, there is not a sufficient environmental argument in the current circumstances for expanding the product group to include WPC.
- There is low steerability over the proportion of recycled plastic in composites, due to quality issues (this may improve in the future through product development).
- The opportunities for material recovery are more limited for composite than for durable wood. The mix of wood, plastic and various additives causes the plastic to degrade, and plastic from end-of-life composite cannot be separated out and used in other types of product.
- There is no established take-back system for collecting and recycling end-of-life WPC in new composite products.

2 Wood impregnated with supercritical CO_2 and small quantities of biocides

In the Nordic region today, there is one Danish supplier of wood treated with supercritical CO_2 and small quantities of biocides. The impregnation agent comprises three organic biocides (fungicides) approved by the Danish Environmental Protection Agency and the EU. The impregnation agent is suspended in supercritical carbon dioxide, which carries it into the core of the wood. The wood preservatives remain in the wood, while the carbon dioxide is drawn out and re-used. The impregnation is carried out in a closed-loop system that recycles all auxiliary substances. See Appendix 1 for further information about the process.

The Danish product (Superwood) is approved for "use above ground". Superwood showed good results in a ten-year field study looking at the durability of pine treated in different ways[81]. The applications are most closely comparable with thermally treated wood approved for the same areas of use. Chemically modified wood and pressure impregnated wood have greater durability, can also be used in contact with the ground and freshwater, and have less need for surface treatment.

A comparison has been made between wood treated with supercritical CO_2 and small quantities of biocides, and wood impregnated with Cu salts and biocides. In terms of

[81] Schabacher, A. et al. System treatments of Pinus sylvestris – influence on moisture, decay and discoloration. June 2013.

chemical use and leaching, superimpregnated wood shows itself to be a much better environmental alternative. The greatest advantages of superimpregnated wood are:

- The quantity of impregnation agent used is in the order of 30 times less than Wolmanit. According to data in a Norwegian EPD from 2010 for "Copper-impregnated wood" (Nordic class AB, preservation Wolmanit CX-8), 5.5 kg impregnation agent is used per m^3 wood[82]. Ecoinvent gives figures down around 3.5 kg/m^3. In comparison, 120-160 g/m^3 impregnation agent is used for supercritical impregnation.
- The agent used in supercritical impregnation, SC200, contains fewer active substances (three biocides), while Wolmanit contains copper compounds and boric acid, as well as small quantities of three biocides.
- The leaching potential from superimpregnated wood is lower than from conventionally impregnated wood, since much less impregnation agent is used and bound to the cell walls of the wood. The Danish Technological Institute has conducted experiments on this[83].
- Supercritically impregnated wood can be processed as ordinary combustible waste, in contrast to wood impregnated with copper and biocides (which in Denmark is collected and sent for incineration in Germany, and in Finland is treated as hazardous waste. In Norway and Sweden, it can be incinerated in special furnaces if it is known that the wood is not CCA impregnated).
- Spruce is used for superimpregnation, despite being a wood that is not usually well suited to impregnation.

With the above advantages in mind, Nordic Ecolabelling wishes to put out for consultation the question of whether the criteria should allow small quantities of biocides associated with impregnation using supercritical CO_2. The consequences of this would be that an exemption would be made for the use of biocides in concentrations below 200 g/m^3 in requirement O3, and that an exemption would be made for the classifications H361, H400, H410 and H411 in O4.

3 Fire resistant wood

There has also been interest in Nordic Ecolabelling wood treated with fire retardants. The product uses no chemicals that require hazard classification, but no durability tests have been conducted. Traditionally, fire retardants have been products that use a wide range of undesirable chemicals, but the same effect is now possible without toxic chemicals. Nordic Ecolabelling has, however, not assessed products with this function when drawing up the criteria, and therefore has no underlying data for comparing this product with the traditional alternatives from an environmental perspective.

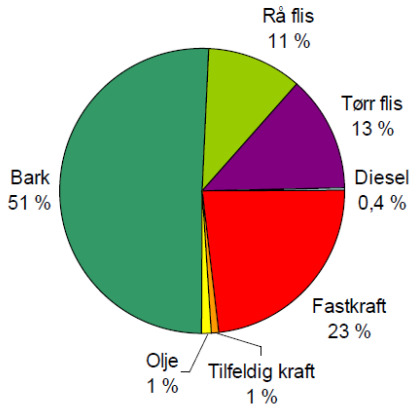
[82] EPD no. 087E "Copper impregnated wood": http://www.epd-norge.no/getfile.php/PDF/EPD/Byggevarer/NEPD087E_Wolmanit_vugge_til_port_en.pdf
[83] Venås and Morsing, The performance of supercritical impregnated wood, February 2014

Appendix 5 Background to energy requirements in raw material phase

Energy use – drying sawn timber
According to a Norwegian study by ENØK into drying kilns in the sawn timber industry (Horn 2008) the average energy use in production at 16 sample companies is 1529 MJ/m^3. The data, from 2000-2003, is based on the Nordic electricity mix. There are major variations between the companies in certain areas, and it has not been possible to explain these differences entirely, although the type of drying process used is a critical factor.

There are two main types of drying plant used in the commercial production of sawn timber in Norway: the batch kiln and the progressive kiln. In a batch kiln, batches of sawn timber are placed inside, the doors are closed and the heating begins, with moisture also added to the air. Gradually during the process, the air humidity is changed to create a drier climate. In a progressive kiln, sawn timber is conveyed continuously through different climate zones. The climate is kept constant in each zone, with the wood moving through the different zones over the course of the drying time. Since the progressive kilns have a constant climate, they are ideal for the installation of heat exchangers, and will thus consume less energy. Since this is a continuous process, it also avoids the energy hungry warm-up period that is required in a batch kiln. As a rule, progressive kilns are used for large quantities of single species wood, while batch kilns are often used for specially adapted wood.

The study also shows that the drying process accounts for around 80% of energy consumption, with 20% going towards the heating needs in the production premises and other buildings. Potential energy efficiencies in the Norwegian companies amount to around 6.5% savings in the form of optimising the drying process (approx. half of the saving) and insulation of the drying system and connecting pipes (approx. half of the saving).



Kilde: Bransjenettverket 2001

Figure 1 to the left is taken from a presentation by Henning Horn[84] and shows the distribution of energy sources in Norwegian energy consumption. The energy source is primarily biomass used in biofuel incineration plants. There are good grounds to believe that the proportion of biomass is also very high in the rest of the Nordic region.

84 http://www.klimatre.no/uploads/KlimaTre/Presentasjoner/101111%20Fagdag%20biprodukter/101111%20Henning%20Horn.pdf

Another, more recent, Norwegian study[85] (Silje Wærp et al., 2009) shows that energy consumption for 1 m^3 Norwegian timber up to the sawmill (cradle to gate) is approx. 193 MJ. If one includes production at the sawmill, where drying (1516 MJ/m^3) is a significant component, the average energy consumption is around 1709 MJ/m^3 up until the finishing of the wood. Timber "extraction" thus accounts for just over 10 percent of energy consumption up until the finishing stage. The figures are closely aligned with the ENØK study described above, and are likely to derive from the same source. Figure 2 below shows the system limits for these figures.

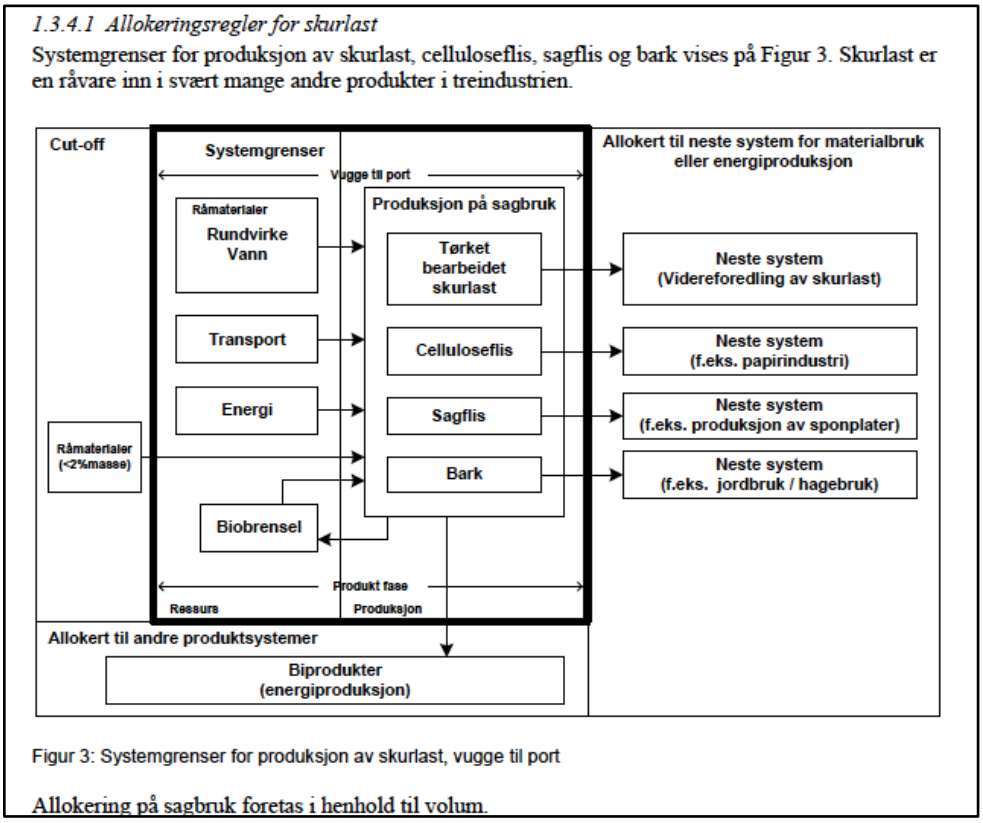


Figure 2. System limits for production of sawn timber, cradle to gate (source: SINTEF Byggforsk[90])

Figure 3 below[86], taken from Jungmeier et al., shows different ways of calculating energy consumption used for the production of construction timber, according to how energy consumption is allocated to the different products from the sawmill. In the allocation to the left, the sawmill is divided into different separate processes, where all the steps are considered as co-products, with the intention of preventing individual allocations. In the right-hand section of the figure, all environmental impact is allocated to the sawn timber, with the various processes at the sawmill gathered into one process. The functional unit is MJ/m^3.

[85] Silje Wærp et al., Livsløpsanalyser av norske treprodukter, MIKADO, SINTEF Byggforsk, 2009. Norway.
[86] Jungmeier, G. et al, Allocation in Multi Product Systems – Recommendations for LCA of Wood-based Products

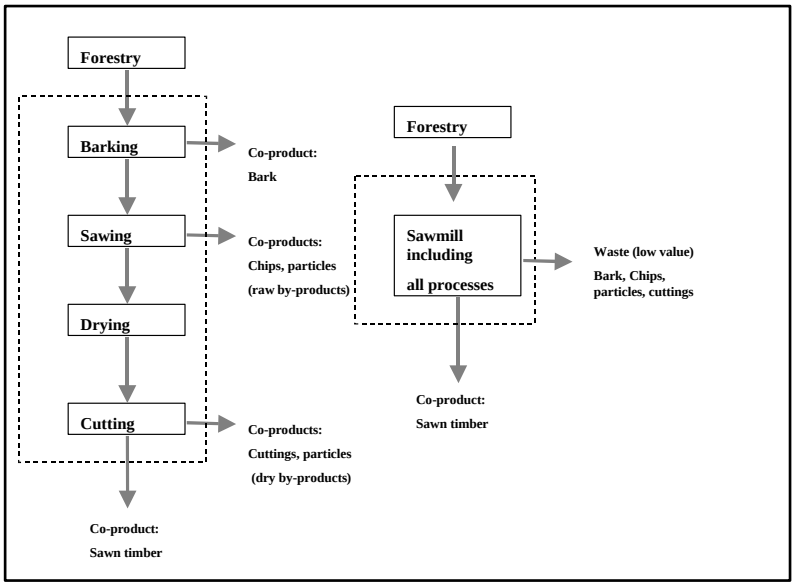


Figure 3. Different allocation of energy consumption to different products from sawmill (source: Jungmeier et al. [78])

If one takes the energy consumption allocated to one product, sawn timber, the total energy consumption at the sawmill is 1580 MJ/m^3 timber. The data is taken from Anderson[87] (1996) and Jarnehammar (2000)[88]. In addition to this, there is the energy for forestry and transport, plus the inherent energy (calorific value) in the actual wood. Adebahr, 1995 puts forestry at around 165 MJ/m^3 and transport at around 270 MJ/m^3.[89]

Outline of future energy requirements

The next revision of the criteria should set level requirements for maximum permitted energy consumption for the drying and production of the wood. The requirement should be set in MJ/m^3 on an annual basis. A requirement should also be set for the maximum permitted proportion of fossil energy sources used.

[87] Andersson, B-I, (1996) Environmental declaration for sawn timber, Trätek.
[88] Jarnehammar, A. LCA for "multi-layer parquet flooring in Life Sys Wood. Trätek. (2000).
[89] Adebahr, 1995, Energy consumption for roof building related to 1 m³ structural timber

Appendix 6 Background to requirements on undesirable substances in chemical products

Requirement O6 which lists undesirable substances has been introduced. Below is a brief background to the ban for each of the substances:

Substances of Very High Concern and the Candidate List

Substances of Very High Concern (SVHCs) are, as the name suggests, substances that require great caution due to their inherent properties. They meet the criteria in Article 57 of the REACH Regulation: Substances that are CMR (category 1 and 2 under the Dangerous Substances Directive 67/548/EEC or category 1A and 1B under the CLP Regulation), PBT substances, vPvB substances (see section below) and substances that have endocrine disruptive properties or are 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 Authorisation List, which means that the substance becomes regulated (ban, phasing out or other form of restriction). Since these substances face being phased out or banned, it is logical for Nordic Ecolabelling not to permit this type of substance in ecolabelled products.

A substance may meet the criteria for SVHC without being included on the Candidate List, so there is no direct equivalence between SVHC and the Candidate List.

To avoid cross-references between PBT, vPvB, CMR and endocrine disruptors, instead of excluding SVHC (which does cover some CMR, PBT, vPvB, etc.) Nordic Ecolabelling chooses to exclude from use the substances on the Candidate List and to separately exclude PBT, vPvB and endocrine disruptors. This should still cover all SVHC substances.

"Persistent, bio accumulative and toxic (PBT) organic substances" and "Very persistent and very bio accumulative (vPvB) organic substances" are substances whose inherent properties are not desirable in Nordic Ecolabelled building products. PBT- and vPvB-substances are defined in Annex XIII of REACH (Regulation 1907/2006/EC). Materials that meet or substances that form substances that meet the PBT or vPvB criteria can be found at: http://esis.jrc.ec.europa.eu/

Substances "deferred" or substances "under evaluation" are assumed not to have PBT or vPvB properties.

Potential endocrine disruptors are substances that may affect the hormone balance in humans and animals. Hormones control a number of vital processes in the body and are particularly important for development and growth in humans, animals and plants. Changes in the hormone balance can have unwanted effects and here there is an extra focus on hormones that affect sexual development and reproduction. Several studies have shown effects on animals that have been traced to changes in hormone balance. Emissions to the aquatic environment are one of the most significant routes for the spread of endocrine disruptors[90]. Nordic Ecolabelling bans the use of substances that are

[90] Miljøstatus i Norge, 2008

considered to be potential endocrine disruptors, category 1 (there is evidence of a change in endocrine activity in at least one animal species) or category 2 (there is evidence of biological activity related to changes in hormone balance, in line with the EU's original report on "Endocrine disruptors" or later studies[91], see http://ec.europa.eu/environment/endocrine/documents/final_report_2007.pdf.

This entails a ban on substances such as bisphenol A, several phthalates and certain alkylphenols.

APEO[92,93,94]

Alkylphenol ethoxylates and alkylphenol derivatives, i.e. substances that release alkylphenols on degradation, must not be used in ecolabelled chemical building products. APEOs can occur in binders, dispersants, thickeners, siccatives, anti-foaming agents, pigments, waxes, etc. APEOs have a host of properties that are problematic and harmful to health and environment. They are not readily degradable according to standardised tests for ready degradability, they tend to bioaccumulate and they have been found in high concentrations in waste sludge. Degradation products of APEOs, alkylphenols and APEOs with one or two ethoxy groups are very toxic to aquatic organisms and certain alkylphenols are suspected of being endocrine disruptors. Alkylphenols and bisphenol A are among the more potent chemicals with oestrogen effects that may occur in wastewater.

Halogenated organic substances

Organic substances that contain halogenated substances such as chlorine, bromine, fluorine or iodine must not appear in chemical products. Halogenated organic substances include many substances that are harmful to health and the environment, in that they are very toxic to aquatic organisms, carcinogenic or harmful to health in some other way. Halogenated organic substances persist in the environment, which means they pose a risk of having harmful effects. This means that brominated flame retardants, chlorinated paraffins, perfluoralkyl compounds (PFOA and PFOS) and certain plasticisers are not permitted in chemical products for Nordic Ecolabelled durable wood.

Heavy metals

Heavy metals or compounds thereof: cadmium, lead, chromium VI, mercury and arsenic must not be present. It is acceptable for ingoing substances to contain traces of these substances, deriving from impurities. The trace quantities of the individual heavy metal must not exceed 100 ppm (0.1 mg/kg, 0.01 weight %) in the raw material.

Chromium

Chromium (III) and chromium (VI) are used, inter alia, in chrome plating, dyes and pigments. Chromium (III) is essential, i.e. living organisms need chromium. The effects of the various forms of chromium differ. All chromium compounds are toxic. However, the most harmful effects are associated with chromium (VI) in particular, this being a carcinogen and an allergen. A number of chrome compounds are on the Danish EPA's

[91] http://ec.europa.eu/environment/endocrine/documents/final_report_2007.pdf
http://ec.europa.eu/environment/endocrine/documents/bkh_report.pdf#page=1
http://ec.europa.eu/environment/endocrine/documents/wrc_report
http://ec.europa.eu/environment/docum/pdf/bkh_main.pdf
[92] Substitution af alkylphenolethoxylater (APE) i maling, træbeskyttelse, lime og fugemasser, Arbejdsrapport fra Miljøstyrelsen Nr. 46, 2003
[93] Nonylphenol og nonylphenolethoxylater i spildevand og slam, Miljøprojekt nr. 704, 2002
[94] Feminisation of fish, Environmental Project no. 729, Miljøstyrelsen, 2002

list of undesirable substances. Accordingly, it continues to be relevant to prohibit chromium in the criteria.

Arsenic
The risk associated with the disposal arises primarily when private households incinerate wood waste treated with arsenic. An unacceptable risk was also ascertained in connection with impact on organisms living in aquatic environments in certain seawater areas. Based on this risk assessment, the Commission's Directive 2003/2/ EC of January 6th 2003 relating to restrictions on the marketing and use of arsenic, prohibited the use of arsenic-treated wood for consumer purposes (e.g. for fences and as construction timber).

Lead
Lead is a toxic heavy metal with both acute and chronic health and environmental effects. Lead is acutely toxic for aquatic organisms and mammals. Lead gives chronic toxic effects in many organisms, even in small concentrations. Chronic lead poisoning may have neurotoxic and immunological effects and cause damage to the blood-forming system in warm-blooded animals. Lead compounds can cause fetal damage and possible risk of reduced reproductive capacity. There has also been conducted much research on children's exposure to lead in low concentrations. It is suspected that exposure to lead can affect children's intellectual development.

Cadmium
Cadmium and cadmium compounds are both acutely and chronically toxic to humans and animals. Most cadmium compounds are carcinogenic. Cadmium can accumulate and be stored in fish and animals. When cadmium has entered the body, it takes a very long time before it is excreted from the body. Small amounts can damage the liver, lungs, kidneys and bones. Cadmium can also damage the ability to have children and cause damage to the fetus[95].

Mercury
Mercury can accumulate in animals and humans. It can damage the nervous system and kidneys. High levels in maternal blood, can cause birth defects. Mercury can also provide a contact allergy. The organic mercury compounds are most toxic. Mercury poisoning can also occur if you inhale mercury vapours[95].

[95] Nettstedet Er det farlig: http://www.erdetfarlig.no