About Nordic Swan Ecolabelled

Windows and Exterior doors

Version 4.16

Background to ecolabelling
20 February 2024

Nordic Ecolabelling

Content

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This document is a translation of an original in Swedish. 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 Swan Ecolabel. These organisations/companies operate the Nordic ecolabelling system on behalf of their own country's government. For more information, see the websites:

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1 Summary

Nordic Ecolabelling established a set of criteria for the ecolabelling of windows in 1997, which was extended to include exterior doors in 2001. The product group includes facade windows, roof windows and exterior doors covered by the product standard EN 14351-1. Exterior doors between indoor and outdoor climates can carry the Nordic Swan Ecolabel. This background document presents the results of the criteria revision performed in autumn 2012–2013 that has resulted in version 4.0 of the criteria. The revision focuses on the following areas:

- Tightening energy requirements.
- An overview of the way in which the energy rating of windows should be presented based on national systems for energy balance/energy gain calculations.
- An overview of requirements applicable to constituent materials based on a MECO[1] analysis.
- Examination of wood preservation methods as a basis for requirement revision.
- An assessment as to whether the product group should be expanded to include windows and doors used in commercial properties.

Energy rating
Several LCAs shows that the single most important contributing factor to the overall energy impact of the product is the window's energy consumption when in use. Nearly 5,000 MJ may be lost over the course of the usage phase, which is assumed to be 30 years. That is more than double the energy consumed when manufacturing the same window, see Table 2 (page 16). This is based on PVC windows and the ratio differs for other types of materials. It also varies according to the heat transfer coefficient (U-value). Wooden windows have lower energy consumption at the production phase, meaning that the usage phase is even more significant in comparison. Heat loss in the usage phase can account for 90 to 95% of total energy consumption for purely wooden windows or windows in wood with external aluminium cladding for weatherproofing.

The second most important contributing factor is the emission of greenhouse gases, which in turn is affected by the energy consumption. Having the option of using sunlight as a passive contribution in order to lessen the building's heating needs is important, but cooling requirements must not arise/increase as a result. From an LCA perspective, other environmental impact factors include the production phase and raw material extraction. LCA analyses of exterior doors produce similar results. The main difference is that an exterior door does not normally contribute to lessening the building's heating requirements in the same way, which is why only the door's ability to insulate against heat loss is considered relevant.

Broad approach to energy consumption
On this basis, it is understandable that Nordic Ecolabelling enforces a strict requirement with regard to a window's heat transfer coefficient (its U_W-value) while also requiring that a satisfactory level of solar energy transmittance (g-value) is achieved. A requirement model on three levels has been drawn up, following consultation. The requirement model links requirements concerning the U-value with materials, in order to differentiate energy

[1] Nordic Ecolabelling's tool for analysing the energy, material, chemicals and other environmental aspects.

performance related to materials and to environmental impact (VOC emissions) from wood treatment.

The requirement model drawn up after the consultation period entails three levels of requirements for highest permitted U-value. For windows with wood as the main material in the frame and casement and where water-based wood preservation techniques or other techniques are used with no VOC emissions, it is proposed that the maximum U_W-value should be 0.91 W/m^{2}K.

If, however, vacuum impregnation with solvent and thus VOC emissions is used, the maximum U_W-value will be 0.82 W/m^{2}K.

For windows made in materials other than mainly wood (non-renewable materials), there is a requirement that the U_W-value is a maximum of 0.74 W/m^{2}K.

The background to the differentiated requirements for the heat transfer coefficient is that there are large differences in energy consumption when manufacturing windows in different materials. Manufacturing "entirely" wooden windows uses the least energy, while a window made entirely in aluminium uses considerably more energy and there are other options in between. By establishing differentiated U-value requirements, we create a holistic view of a window's energy performance, seen over its entire life cycle. We also allow for the possibility of "new" materials such as composite windows. Composite has the benefit of enabling slim profiles, while retaining the same strength.

We have also chosen to differentiate the energy requirement for different wood preservation techniques for wooden windows. We have done this to clearly *encourage* an environmentally aware wood preservation technique, while at the same time:

- Trying to take account of the Nordic countries' varying views on wood preservation techniques and what it takes for wood to be fully protected against rot.
- Tightening the limit value for VOC emissions from 11 to max. 9 kg/m^3 treated wood, so that only plants with the best emission treatment technology systems will be able to meet the requirement.

One important reason for not excluding vacuum impregnation is that wood preservation and surface treatment is one environmental aspect among many that Nordic Swan Ecolabelled windows need to meet. From a life cycle perspective, the most important issue is the window's energy efficiency.

The g-value measured on the windowpane is the same as in version 3 of the criteria, i.e., it must be at least 48%, while the g-value of the entire window must be 34% or more. The ± 2% margin has been removed and the value adjusted downward by a corresponding value instead.

During the revision, Nordic Ecolabelling also examined the possibility of imposing requirements based on the energy balance concept (E_{ref}) that has been introduced in Denmark. The E_{ref} value indicates the entire system's energy balance during the heating season. Here, the window is fitted into a context (a reference building). A positive E_{ref} value means that the window contributes positively to the building's heating requirements. However, imposing requirements for a certain E_{ref} value entails a risk of windows with varying energy performance being awarded the ecolabel. In other words, a Nordic Swan Ecolabelled window in one Nordic country could have a poorer U-value than one in another Nordic country. This is unsustainable within Nordic Ecolabelling and this is

the most important argument against basing energy requirements on energy balance calculations. A U-value requirement also provides better steerability, since the energy balance depends on the location of the window in the building. Another key reason is that Nordic Ecolabelling's requirements must function for and cover all climate zones relevant to the Nordic region.

A requirement for differential climate testing to ensure door air permeability, even when the difference between indoor and outdoor temperature is significant, has been added to the requirement relating to exterior door air permeability.

Raw materials, materials and manufacture

During the revision, two new materials – (plastic) composite and steel – have been investigated and added. There is good reason for imposing requirements on the various materials. However, steerability is low when it comes to requirements for extraction and manufacture of e.g. aluminium and composite. In summary, Nordic Swan Ecolabelled windows or exterior doors manufactured using non-renewable materials such as aluminium or PVC must consist of at least 30% recycled raw material in the non-renewable material components.

Window profiles manufactured using plastic composite (often a mixture of glass fibre and polymers) are a relatively new but growing product area. Composite is a hardened plastic and there is no scope to use recycled materials, which is why Nordic Ecolabelling is unable to set requirements concerning recycled material. Steel is not uncommon in exterior doors and a requirement has been set at 20% recycled material.

The requirement concerning content of lead and cadmium in recycled plastic (usually PVC) remains unchanged from version 3 of the criteria, at 100 ppm for lead and for cadmium. The principle of high and equivalent requirements concerning content of harmful substances in newly produced and recycled materials is important to Nordic Ecolabelling.

The chemical requirements remain essentially unchanged but have been made clearer in the sense that they now apply regardless of whether production takes places at the licensee's own premises or with a supplier.

Other

The requirement that a Nordic Swan Ecolabelled window/exterior door must also meet the requirements in established product quality labelling/product certification systems in the country of sale has been reformulated. The requirement is now for compliance with one of the quality labelling/certification systems, whichever the licensee chooses. The requirement for a take-back/recycling system for end-of-life windows and doors has been removed. However, the requirement that it must be possible to separate out the various components of the window remains intact. The purpose of this is to enable material recovery. The manufacturer's responsibility to inform the customer of the importance of sun screening solutions has been added to the criteria.

The other requirements of the criteria document have been adapted to the present situation and any uncertainties have been corrected. However, the requirements have not changed in terms of scope or requirement level. Appendix 1 to this report contains an overview of all requirements. With this revision, Nordic Ecolabelling hopes to ensure that the requirements for Nordic Swan Ecolabelled windows and exterior doors are well conceived from an LCA perspective and so stringent that only the very best manufacturers in the industry are able to meet them.

2 Basic facts about the criteria

2.1 What are windows and exterior doors?

Facade windows and roof windows (skylights) have the following primary characteristics:

- they provide a barrier against the outside climate, i.e. precipitation and wind
- they keep the cold out and the heat in during the heating season
- they allow daylight into the building
- they allow a view of the surroundings from the building

Furthermore, various secondary functions are also associated with windows; for example, that they can be opened to allow fresh air in, they are air-tight to avoid draughts, or that they are fitted with coated glass with a specific function. The window design may also be important in terms of the value that it adds to the building.

For low-energy buildings, work is under way to give windows an added function, namely the contribution of solar energy to the building during the heating season. However, this function has to be qualified, as there is a risk that it might cause overheating in the summer period unless measures such as sun screening are put in place to limit sunlight entry outside of the heating season.

The overarching function of an exterior door is to be an integral part of the building envelope that allows entrance and exit to and from the building. The exterior door must also have insulating properties to avoid heat loss and be equipped with a lock. In addition, the exterior door may be required to let sunlight through, making it an external glass door, e.g. a patio door.

The frame, casement and door leaf are normally made from one or more of the following:

- wood
- metal, often aluminium or steel
- composite material (e.g. glass fibre-reinforced polyester or glass fibre-reinforced polyurethane)
- plastic (often PVC)
- a combination of these materials, e.g. wooden windows with aluminium cladding
- insulation materials

2.2 Version and validity of the criteria

The window criteria were first established in 1997. Version 2 was created in December 2001 and has since been extended to include exterior door requirements.

At the end of 2008, version 3 of the Criteria for Windows and Exterior Doors was finalised. Compared with the previous version, the U-value had been tightened, taking it down from 1.3 to 1.0 W/m^2K.[2] Requirements for non-renewable materials in frames, casements and door leaves were introduced. These included requirements for the use of

[2] Calculation based on the entire window including the frame for the dimensions 1200 x 1200 mm.

recycled materials and a requirement stating that wood raw material be sourced from certified, sustainable forestry. The chemical products requirements were updated and tightened.

The most recent evaluation of the criteria and their function was performed in 2011. The evaluation showed that the criteria were in need of revision and this document is the result, see Chapter 3 for further details.

2.3 The Nordic Market

The text below is an extract from the evaluation performed in 2011.

Table 1: Overview of window market share

Type of window	Denmark[3]	Finland[4]	Sweden[5]	Norway[6]
Wood	30		40	76
Wood/aluminium	50	90	50	10
Plastic (PVC)	12		6 (2010)	12
Other (metal, composite, tropical wood)	8		4 (2010)	2

Finland

According to the Confederation of Finnish Construction Industries RT, there were around 200 window manufacturers and 50 exterior door manufacturers in Finland in 2011. The Finnish window market turns over between EUR 600 million and 700 million (1.6 million windows delivered) each year. The exterior door market turns over EUR 300 million. The scale of imports and exports is very small. The market is relatively stable, and no major changes are expected in the near future. The main manufacturers include Fenestra, Pihlavan ikkuna, Tiivituote, Skaala, Domus and Eskopuu, in descending size order.

Wood/aluminium accounts for 90% of the market and is thus very dominant. Wooden windows are mainly found in wooden houses and cabins while aluminium is primarily used in office buildings. According to the industrial organisation, double-glazed windows are all but "illegal" in Finland. These can be used in cabins that are not heated. Double-glazed windows account for about 5% of the total production annually. The majority of windows are triple, or quadruple glazed. According to Motiva Oy, discussions are being held to assess the development potential of windows with five panes. However, this might prove unprofitable due to the weight of such windows. The majority of the windows sold have a U-value of between 0.8 and 1.0. It is possible to achieve a U-value of 0.7 using four glass panes with a gas layer between the panes. According to Motiva OY, the best windows have a U-value of 0.52. The g-value varies more.

Sweden

There are around 60 window manufacturers in Sweden. The Swedish window market turns over around SEK 5 billion annually (2010). Sweden imports just under 6% and the export share is just under 4%. Norway accounts for half of exports, the UK a quarter and

[3] Johny H. Jensen of the Danish Windows Industry, 21.05.2013.
[4] Confederation of Finnish Construction Industries RT, 2011.
[5] Lars-Göran Johansson of the Swedish Federation of Wood and Furniture Industry (TMF), 02.09.2011.
[6] Tore Gran of the National Organisation of Norwegian Wood Product Factories (NTL), 06.09.2011.

Denmark and Japan just under 10% each. The Swedish window market grew by 6% between 2009 and 2010.

Diana Avasoo of WSP Environmental works as project manager for Frivillig energimärkning av fönster (Voluntary window energy-labelling), a project initiated by the Swedish Energy Agency in 2005. At the moment, this project is being run by the organisation EQ Fönster, www.energifonster.nu. According to Avasoo, windows with a U-value of 1.0 or less account for less than 5% of the market in Sweden. There has been a shift toward lower U-values, but most windows sold in Sweden have a U-value of between 1.2 and 1.4. Many buy windows with a higher U-value from Eastern Europe/the Baltic states due to the low cost.

There is demand for windows with low U-values, particularly from the low-energy housing/passive house segment, but the market share is nevertheless small. Avasoo also stated that companies that energy label their windows rarely have a U-value lower than 0.9. In order to achieve low U-values they have chosen glass with extremely low U-values, in the region of 0.5-0.6 W/m^2K, which increases the risk of external condensation. The Finnish window manufacturer Skaala has solved this problem by introducing a new glass solution that does not cause any external condensation, even at very low U-values. It is as yet unknown whether this glass could be used in other manufacturers' windows, but it could potentially solve the problem of external condensation and pave the way for lower glass and window U-values.

Denmark

Denmark has 70 window manufacturers and the industry turns over around DKK 5 billion. 15-20% of Danish windows manufactured are exported, two thirds of which are destined for the UK and Ireland. One third of exports relate to Sweden, Norway and Germany. The Danish window industry employs 5000 people.

In 2010, Denmark introduced a new classification/energy labelling system (A-G) for windows. The classification relates to the building regulations, with a window labelled C meeting the requirements for windows in newbuilds and renovations. Windows labelled B meet the requirements in coming building regulations (2015) and a window labelled A meets the requirement level for 2020 (which harmonises with the EU Directive on nearly zero-energy buildings).

The energy classification (A-G) is determined using a reference window (standard size 1230 mm x 1480 mm) and is based on the energy calculation E_{ref} where E_{ref} is a function of the U-value and g-value for the window. More information can be found in Appendix 3.

Norway

In Norway there is no industry organisation especially for manufacturers of windows and exterior doors. However, many manufacturers are members of Norske trevarefabrikkers landsforbund (NTL – The National Organisation of Norwegian Wood Product Factories), www.trevare.no. According to data from NTL[7], there are roughly 90 companies manufacturing windows in Norway. The manufacturers tend to be small and total industry turnover is around NOK 3.5 billion. Import accounts for 8% of the market and there are various countries of origin, the most important being Poland and Sweden.

[7] Telephone interview with Tore Gran, 6 September 2011.

2.4 Nordic Swan Ecolabel licences

Licences are currently held by four companies in the Nordic region: NorDan, Gilje, Elitfönster and Svenska Fönster, which is licensee for the brands SP Fönster, Traryd Fönster and Mockfjärds Fönster. Unfortunately, there is no licensee for exterior doors even though a couple of manufacturers have shown interest in becoming labelled.

2.5 Other labels

Other ecolabelling systems

In addition to Nordic Swan Ecolabel, US ecolabel Green Seal, the Chinese Ecolabel, the Korean Ecolabel and the Hong Kong Green Label scheme all have criteria for windows. Green Seal's criteria date back to 1995 and include requirements for U-values and solar energy transmittance above the g-value (solar energy transmittance/g-value > 1). In addition, the requirements include a ban on lead, cadmium, arsenic, mercury and hexavalent chromium in window frames/casements and a requirement stating that 25% of packaging materials should consist of recycled material[8].

The German ecolabel Blaue Engel and Canadian Ecologo do not impose requirements for windows.

Green Public Procurement (GPP)

GPP criteria have been developed for windows and exterior doors. These date back to 2010 and are now being revised. The revision work can be accessed here: http://susproc.jrc.ec.europa.eu/windoors/whatsnew.html

Following the working group's latest meeting in June 2012, the European Commission has decided to halt the continued revision of the GPP criteria. The reasons given relate to the technical and legal challenges, and to the fact that the scope of the task does not match the environmental benefit that can be achieved.

Energy labelling

While the EU has been working to develop a shared energy labelling system for windows, Denmark, Sweden and Finland developed their own systems some years ago. The purpose is to develop a voluntary system for presenting window energy rating. Sweden, Denmark and Finland have different energy labelling systems. However, there are some similarities. The label itself and the classification system using A, B etc. are relatively similar. Fundamental window properties and performance, such as insulating properties and the share of surrounding sunlight that permeates as heat, are used as a basis for the labelling. For a more detailed description, see Appendix 3.

Environmental product declarations (EPD)

Environmental product declarations (EPDs) do not impose requirements on the products. Instead they serve to document the products' environmental impact through production, use and disposal[9]. EPDs are based on the principles of the international standard for type III environmental declarations, ISO 14025, and on LCAs performed on the products. In order to be able to create an EPD a set of Product Category Rules, or PCRs, need to be in place or created for the product category. As previously mentioned, the EPDs do not contain limit requirements and it is difficult to compare different EPDs

[8] GS-13, Green Seal standard for windows, sec. ed., 21 March 21, 1995.
[9] http://www.sintef.no/Projectweb/Miljodeklarasjoner/Hva-er-miljodeklarasjoner-EPD/

as there are no standardised methods for calculating the environmental impact of, for example, energy consumption. A new standard for creating PCRs has been introduced for construction materials (incl. windows and doors) in Europe (EN 150804) but no PCRs have been developed for windows based on this standard yet.

PCRs have been developed for windows in Denmark and Norway. There used to be PCRs for windows in Sweden, but these have expired.

- Denmark: (PCR for windows 12 January 2010)
- Norway (Windows and doors NPCR 014, Rev1, 22.03.2013):
- Sweden: (PCR for preparing an environmental product declaration (EPD) for WINDOW Frames, transparent surfaces, shutters. PCR 2008:03 - EXPIRED)

The EU Construction Products Directive & harmonised product standard

As of 1 July 2013, all construction products covered by a harmonised standard or European technical assessment (ETA) must have a performance declaration and be CE marked in order to be sold in Sweden and other EU countries. This is regulated by the EU Construction Products Directive (305/2011/EU), abbreviated CPR, which also applies in Norway, Switzerland, Iceland, Turkey and Lichtenstein. The purpose of the CPR is to facilitate trade between the member states. The appendix to the EU Construction Products Directive contains a steered template for performance declaration. It should be completed by the manufacturer, after which the product may be CE marked.

Windows and exterior doors are regulated by a harmonised product standard: EN 14351-1: - Windows and doors - Product standard, performance characteristics - Part 1: Windows and external pedestrian doorsets without resistance to fire and/or smoke leakage characteristics.

Product certification of insulating glass units

The Danish glass industry applies a product certification for insulating glass units which is based on "EN 1279-5 - Glass in building - Insulating glass units - Part 5: Evaluation of conformity" to create a basis for CE marking of insulating glass units in accordance with the Construction Products Directive.

The aim of the product certification is:

- to help ensure the quality of insulating glass units
- to ensure that the closure mechanisms meet the requirements outlined in EN 1279-5 and EN 1279-6
- to ensure that the manufacture of insulating glass units takes into account the internal and external environment
- to create a documented and accurate basis for assessing the energy properties of insulating glass units[10].

[10] http://www.glasfakta.dk/?page_id=23 visited 8.11.2012

3 About the criteria revision

3.1 Purpose of the criteria revision

The aim of the project was to revise the criteria for the product group Windows and Exterior Doors and has had the following focus areas:

- Tightening energy requirements.
- An overview of the way in which the energy rating of windows should be presented based on national systems for energy balance/energy gain calculations.
- An overview of requirements applicable to components based on a MECO analysis.
- Examination of wood preservation methods as a basis for requirement revision.
- An assessment as to whether the product group should be expanded to include windows and doors used in commercial properties.

3.2 About this criteria revision

The project was started in 2012 and continued into the first half of 2013. Heidi Bugge, product group manager at Ecolabelling Denmark, was project manager up until the year end 2012/2013. Sara Bergman of Ecolabelling Sweden stepped into the project manager role in January 2013. Ingvild Kvien and Elisabeth Magnus also worked on the project. Karen Dahl Jensen holds the position of Nordic product development manager and commissioned the revision.

In October 2012, Nordic Ecolabelling held a full-day seminar for invited industry stakeholders. A large number of representatives from the industry, industry organisations, suppliers, quality and control labelling organisations etc. participated in the event.

Telephone meetings have been held with stakeholders and many contacts have been established in order to gather information as part of this work.

4 The environmental impact of windows and exterior doors

Several LCA studies[11] indicate that heat loss during the usage phase is the most important environmental impact of windows over the course of their life cycle. The thermal surface properties of windows are important in order to ensure energy efficient buildings. Typically, windows account for around 30-50% of the total transmittance losses from the building envelope, even though their surface area share of the building envelope is much smaller than this. The reason for this can be found by comparing the windows' heat transfer coefficient (U-value) with U-values for other construction elements (walls, roofs and floor structures). In well insulated buildings, the U-value of construction elements such as walls, roofs and floors tend to be between 0.1 and 0.2 W/m^2K. The best windows have U-values of around 0.7-1.0. In low-energy windows the frame's design and the materials used are often of great importance as the frame's

[11] E.g. "Miljøvurdering av vinduer", By och Byg Documentation 046, Danish Building Research Institute 2003 and the report "Life Cycle Assessment of PVC and of principal competing materials", commissioned by the European Commission, July 2004.

performance tends to limit the reduction of the window's overall U-value further. For low-energy glass, the U-value is between 0.3 and 0.5, while the frame itself has a higher U-value based on materials and construction, meaning that the U-value of the window overall is between 0.7 and 1.0 W/m^2K for the windows with the best energy rating[12].

The Nordic Swan Ecolabel is a type I ecolabel pursuant to standard ISO 14024 and must thus ensure that various relevant environmental impacts over the window's service life are considered that could help window manufacturers reduce overall environmental impact. It is therefore important to assess all relevant environmental impacts over the window's long service life and not just energy rating. A purely qualitative MECO (Materials, Energy, Chemicals and Other) analysis has therefore been included in Appendix 2 to highlight the different environmental impacts over the window's life cycle. The analysis is based on windows, but the product group also includes exterior doors and it is assumed that many of the environmental parameters can also be applied to these.

The MECO analysis shows that it is relevant to impose requirements at all phases of the life cycle: raw material extraction, production, use, disposal/end-of-life and transport. However, the steerability and potential for ecolabelling to make a difference varies.

As energy consumption is at its highest when the product is in use, rather than during production, Nordic Ecolabelling focuses on requirements relating to the window's or the door's U-value, g-value and air permeability. Nordic Ecolabelling believes that it is not relevant to impose direct energy requirements on the production. We do, however, impose indirect energy requirements by calling for a certain share of renewable materials to be used. We also set indirect energy requirements via a differentiated U-value requirement for products made from renewable materials compared with non-renewables. The production of virgin aluminium requires far more energy than if the raw material is recycled aluminium, for example.

Unfortunately, Nordic Ecolabelling assesses the steerability of imposing requirements with regard to transport as low.

It is also relevant to impose environmental requirements on the various materials used to manufacture a window or door as a means of influencing the environmental impact of extraction and production. There are requirements relating to hazardous substance content, as well as to the chemical products used in production. PVC is deemed to have steerability and potential for imposing requirements on the production process.

Filler gas requirements have significant potential due largely to the marked difference in energy consumption during the manufacture of the noble gases in question, something that is not recouped during the window's usage phase. Steerability is extremely good since the window manufacturer is free to choose the filler gas composition.

It is still relevant to impose criteria on wood raw material. Wood can be sustainably grown and can be sourced from areas where forestry is certified to a national forest certification system. Steerability is good through requirements for certification and traceability along the processing chain. Fibreboard manufactured entirely from waste generated from sawn timber production is exempt from the requirements as it is not relevant when the raw material is waste. Wood preservation and surface treatment have a

[12] Gustavsen, A., Key Elements of and Material Performance Targets for Highly Insulating Window Frames, 2011

clear environmental relevance and the steerability is good, which is why Nordic Ecolabelling still imposes requirements in this area.

5 Justification of the requirements

This chapter outlines proposed requirement revisions and provides a background to why the requirement is applied, and the requirement level chosen. The appendices referred to are those that appear in the Criteria for Nordic Ecolabelling of Windows and Exterior Doors. The chapter begins with section 5.1, which gives an account of the product group definition and any changes compared with version 3 of the criteria.

5.1 Product group definition

Nordic Ecolabelling's experience of licensing and other customer contact indicates that the product group definition has not represented an obstacle to products achieving labelling. The 2011 evaluation highlighted the issue of whether windows for commercial buildings (offices, stores and similar) were excluded from labelling. The revision has shown that this is not the case. Windows for commercial properties that meet the criteria requirements are not excluded from ecolabelling under the Nordic Swan Ecolabel. However, this type of window is more often a specially tailored solution and the lack of standard products may obstruct labelling. In this context, it should be borne in mind that the primary target group for Nordic Ecolabelling is the private individual as end customer/consumer.

Another focus area for this revision has been the review of constituent material requirements. The revised criteria are now deemed to contain well adapted requirements for windows manufactured using a composite outer component. The composite material makes it possible to combine strength with slim profiles. Our hope is that this will make it easier for larger windows and also result in windows for commercial properties becoming subject to Nordic Swan Ecolabelling.

The changes made are as follows:

- For the product group definition and thus what can carry the Nordic Swan Ecolabel, reference is made to the product standard EN 14351-1, which defines windows and exterior doors and their functional qualities.
- Clarification of the product group definition, making it clear that curtain walling as defined in product standard EN 13830 and lantern lights as defined in EN 1873 are not covered by the criteria for Nordic Ecolabelling.

As before, a licence can be given that covers several types/models of window within the same family or series. This is possible because the U-value and g-value are given for the reference size of the window, and thus apply to all sizes of the same window in the series/family. There are often different types of window within the same series/family, such as side-hinged windows, top-hinged windows, opening windows, side swing and so on. The U-values are only applicable to windows with the same construction as the example used in the calculation. For each type of window to be covered by the Nordic Swan Ecolabel within the same family/series of windows, the U-value is to be calculated according to current methods.

The criteria open, before the first requirement, with definitions of key terms as follows:

Product series and product family

A Nordic Swan Ecolabel licence can be given that covers several types/models of window within the same family or series. This is possible because the U-value and g-value are given for the reference size of the window, and thus apply to all sizes of the same window in the series/family. The percentage by weight for each material under requirement O1 is also given for the reference size of the window.

Materials in the profiles, glazing bars, glass combinations and other components that affect the U-value must be the same in the same series/family, to ensure that the impact from these factors is taken into account.

There are often different **types** of window within the same series/family, such as side-hinged windows, top-hinged windows, opening windows, side swing and so on. The U-values are only applicable to windows with the same construction as the example used in the calculation. For each type of window with a different construction in the same family/series of windows, the U-value is to be calculated according to current methods.

External cladding

External cladding refers to wooden windows, where the external components of the window, i.e. the wooden frame and/or casement, are clad usually in aluminium. The purpose is to provide weatherproofing, increase durability and reduce the need for regular maintenance of exposed wooden components.

If the whole of the external window profile is made entirely in a material other than wood, this is not considered external cladding. Instead, the window is considered to be manufactured in non-renewable material, see below.

Other materials, such as plastic composite and PVC, may also be used in window profiles. However, external cladding using other metals such as zinc and copper is not permitted.

Requirement O5 contains an exception for external cladding of wooden windows. This means that the external cladding can be made from virgin material without the requirement for recycled raw material. The material used for external cladding must, however, meet all other relevant material requirements.

Non-renewable materials

Common non-renewable materials in windows and external doors are PVC, aluminium, steel and (plastic) composite. Nordic Ecolabelling accepts these window profiles and door leaves, but sets requirements concerning recycled material, for example (see O5).

5.2 What can carry the Nordic Swan Ecolabel?

Nordic Ecolabelling's Criteria for Windows and Exterior Doors, version 4.0, covers products pursuant to standard EN 14351-1: 2006. This means that the following products may carry the Nordic Swan Ecolabel:

- fixed and opening facade and roof windows (manual or electrically operated)
- window doors (e.g. balcony and patio doors)
- external doors

Windows and exterior doors not covered by standard EN 14351-1:2006 cannot be labelled. This applies, for example, to lantern lights[13] regulated by product standard EN 1873, and windows and exterior doors that are resistant to fire under standard EN 16034.

Nordic Swan Ecolabelled products are windows and exterior doors between open and enclosed, constantly heated spaces, i.e. between an outdoor climate and an indoor climate. There are various other types of exterior doors that can be subject to various function requirements. Examples of such doors include hallway doors, loft space doors, warm store doors, cold store doors and various gates. These doors are not covered by the product group definition as they are not subject to the same requirements with regard to insulation capacity.

Interior doors cannot be Nordic Swan Ecolabelled under these criteria but can be labelled under the Nordic Ecolabelling criteria for the product group Furniture and Fitments.

The frame, casement and leaf in Nordic Swan Ecolabelled windows and exterior doors may be made from:

- wood
- metal, often aluminium or steel
- composite material (e.g. glass fibre-reinforced polyester or glass fibre-reinforced polyurethane)
- plastic (often PVC)
- a combination of these materials, e.g. wooden windows with aluminium cladding
- insulation materials

Normally, the internal profiles of a window are still wood. If these are also in aluminium, steel or (plastic) composite, the window cannot carry the Nordic Swan Ecolabel. The internal profiles of a PVC window may, however, be in PVC.

Windows and exterior doors manufactured from materials other than those listed above must be assessed by Nordic Ecolabelling before they can be considered for labelling.

5.3 Product description

O1 Overview of product and manufacture

Describe the design of the window/exterior door and the manufacturing process for the model(s) intended for Nordic Swan Ecolabelling.

Specify the materials/components and chemical products from which the window/exterior door is made. State the percentage by weight of each material and component in relation to the standard/reference size. It is not necessary to specify the percentage by weight for chemical products.

☒ An overall product and manufacturing description per model.

☒ Written details, or a drawing, of all materials and components used in manufacturing the window or exterior door, with details of the percentage weights per product series/family.

[13] Lantern lights are installed on flat or almost flat roofs but fulfil many of the functions of a "normal" window.

Background to product description requirements

In version 3 of the criteria, this requirement was split across two (R1 and R2).

Windows do not come in just one version, there are a multitude of different window configurations with differing frames, panes, glazing options, etc. This means that it can be difficult to gain an overview of the products when processing the licence application. The requirement is therefore very important when it comes to establishing order with regard to which products the manufacturer is seeking to label.

The requirement concerning the material overview is important when it comes to quality assuring the processing of the licence application. As a clarification of the requirement, the percentage by weight must be stated for the reference/standard size for the product(s) intended for ecolabelling. Otherwise, there are no changes. Standardised sizes for windows, window doors and external doors are stated in requirement O2.

5.4 Energy requirements

O2 U-value, heat transfer coefficient

To take account of:

- the different energy consumption between wooden windows and windows in non-renewable materials, plus
- the environmental impact of emissions of volatile organic compounds from solvent-based impregnation, the requirement concerning highest permissible U-value for windows, window doors and external doors is as follows:

Requirement concerning highest permissible U-value for windows, window doors and external doors:

Product	Maximum U-value (W/m²K)
Wooden windows where wood preservation/impregnation and surface treatment are water-based*. The window may come with or without external cladding**:	
facade window window door roof window	0.91 1.0 1.1
Wooden windows where wood preservation/impregnation and surface treatment are solvent based (vacuum impregnation). The window may come with or without external cladding*:	
facade window window door roof window	0.82 0.91 1.0
Window where the frame and/or casement are fully or partially made from non-renewable material:	
facade window window door roof window	0.74 0.82 0.91
External door, irrespective of material and any wood preservation:	1.0

** Other wood preservation/impregnation free from solvents is also accepted. One example is impregnation with supercritical carbon dioxide.*

*** see section "Terms and definitions"*

The U-value shall be set for a model/family of windows or external doors according to the product standard EN 14351-1. Presented U-values shall be determined by or reviewed by a notified or an accredited party or by a corresponding independent body. See also Appendix 1.

The U-value is to be measured for the whole window/door, including frame, according to the sizes in the product standard EN 14351-1.

The U-value is to be given to two significant figures in line with ISO 10077.

✉ The calculation or testing result of the U_W-value and a report on how the calculation/ testing were performed.

O3 The solar energy transmittance and daylight transmittance of windows

The solar energy transmittance of window glass (g_g-value) must be 0.48 (48%) or higher. At the same time, the solar energy transmittance of window glass (g_W-value) must be 0.34 (34%) or higher. These values are applicable to both facade windows and roof windows.

The daylight transmittance must be 0.63 (63%) or higher.

The window's g_W-value is calculated using the formula:

$g_W = g_g$ x (Ag/Aw). Where Ag represents the glass area and Aw is the window area.

The g-value and daylight transmittance are to be determined and presented based on the methods stated in product standard EN 14351-1. Presented values shall be determined by or reviewed by a notified or an accredited party or by a corresponding independent body. See also Appendix 1.

The g-value for the window (g_W) is to be stated for the same window size used in O2 in accordance with EN 14351-1.

✉ The result from calculation or testing of the g_g-value and daylight transmittance. Report on how the calculation/testing were performed.

O4 Window or exterior door air permeability

The window or exterior door must fulfil at least Class 4 according to EN 12207 for air permeability under negative and positive pressure.

The exterior door must also undergo differential climate testing pursuant to standard EN 1121 (climates A and D or climates C and D).

Air permeability and differential climate testing are to be measured through tests or calculations based on the methods stated in product standard EN 14351-1. Presented values shall be determined by or reviewed by a notified or an accredited party or by a corresponding independent body. See also Appendix 1.

Unless otherwise stated, a door of normal size is to be tested.

✉ Result of air permeability test and details of how air permeability was tested.

✉ In addition, for exterior doors, results from differential climate testing and details of how the test was performed. The time of the climate testing and air permeability testing is to be stated.

Background to energy requirements

Windows and exterior doors play an important part in the energy consumption of buildings during their usage phase. In addition, windows can cause problems such as overheating (resulting in a need for air conditioning/cooling), cold draughts and condensation. Studies conducted on a PVC window show that twice as much energy is consumed during the usage phase as during manufacture of the window. The draft Background to the EU's guidelines for Green Public Procurement (GPP)[14] shows the breakdown of total energy consumption (Table 2). The ratio may be entirely different for other materials and can also vary according to the U-value. Wooden windows have lower or significantly lower energy consumption during manufacture, making the usage phase consumption all the more important. Studies show that the usage phase may account for as much as 90-95% of the total energy consumption for wooden windows[15,16].

[14] Developing an Evidence Base for Windows and External Doors. Base Case Assessment, JRC, itps and AES, Draft Report, April 2012.
[15] EPD for VELFAC 200i window system in line with LCA principles (UMIP method) http://www.velfac.no/velfac-no/data.nsf/webDocsByID/CHGR-6WEC99
[16] EPD windows, Cormo, update data: 10.04.2013, http://www.environdec.com/Detail/?Epd=6119#.Ul-m1RCTq6M

Table 2: Allocation of total energy consumption, UPVC double-glazed window[17].

	Manufacture	Transport	Use	End-of-life
Share of total energy consumption (%)	29	4	62	5

The same report concludes that the energy consumption during the usage phase is even more important for exterior doors compared with energy consumption during manufacture, transport and end-of-life, see Table 3.

Table 3: Breakdown of total energy consumption for UPVC and wood exterior doors.

	Manufacture	Transport	Use	End-of-life
Share of total energy consumption (%)				
UPVC door	9	1	88	2
Wooden door	2	1	94	2

In addition to this significant environmental relevance, window energy performance requirements also have strong potential and high steerability, see Appendix 2. The energy rating of windows and exterior doors is primarily described using the parameters U-value and g-value. Below is a brief description of these and the concept of air permeability.

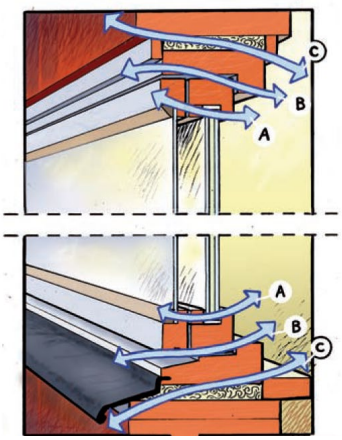


Figure 1: Heat and cold enter and escape through windows in three ways: between the glass and the frame (A), between the frame and the casement (B) and between the casement and the wall (C). Heat also escapes through the glass itself.
Source: Swedish Energy Agency brochure "Windows, 2007".

Heat transfer coefficient, U-value

Heat and cold enter and escape through windows in several ways, see figure 1. The U-value of windows and doors is a measurement of how well the window or exterior door insulates against heat losses. Heat loss through windows should be minimised by optimising:

1. Window size and orientation
2. Glass type, number of glass panes and glass film
3. Frame/casement material and composition

Note that Nordic Ecolabelling can only steer points 2 and 3.

Different building regulations apply in the different Nordic countries. All countries impose requirements on newbuilds with regard to the building's specific energy use (calculated and/or measured). Some countries also impose requirements with regard to the U-value of various building elements and some impose requirements with regard to the U-value of the whole building envelope. The international and national classification systems that exist for buildings impose requirements with regard to the specific building's energy balance, not the U-values of individual windows.

In version 3 of the ecolabelling criteria the U-value requirement was set at **0.95 W/m^{2}K** for the entire window including casement measuring 1480 x 1230 mm[18]. When the proposal for the revised criteria was sent out consultation, it was suggested that the U-value should be tightened to 0.9 W/m^{2}K. As it is the entire glass, frame and casement construction that gives the window's U_W-value, 0.9 W/m^{2}K is considered a well-balanced level. The proposed U-value for roof windows was 1.0 W/m^{2}K. Roof windows score

[17] UPVC or uPVC stands for unplasticised polyvinyl chloride, i.e. unsoftened or rigid PVC.
[18] In the past the reference dimensions were 1200 x 1200 mm, which corresponded to a U-value of 1.0 W/m^{2}K.

lower in U-value measurements due to the incline at which they are tested. If exactly the same (roof) window was to be used as a facade window, the U-value would improve. The international Passive House standard contains different recommendations depending on whether it is a roof window (1.0 W/m^2K) or a facade window (0.8 W/m^2K). This difference between window types was not taken into account in the current criteria, an issue that has now been rectified. There are roof windows with a U-value of 0.9, but they are an extremely expensive solution, making the recouping period far longer than the expected lifetime of the product. The windows are also very heavy and difficult to handle during installation. Nordic Ecolabelling adopts the same relationship between the roof and facade windows as can be found in the Passive House criteria.

During the consultation period, a large number of submissions came in, showing the major national differences in the areas of energy, wood preservation and materials used, particularly in windows, but also to some extent in exterior doors. Wood preservation and materials are described later in this background document, see section 5.5 (materials) and O18 (wood preservation). A number of submissions expressed a view that the requirement level for the U-value was too low seen over the full validity period of the criteria. This has resulted in a new requirement model that takes a holistic approach. The most significant environmental impact in a window's life cycle is linked to its ability to insulate and thus save energy in the building in which the window is installed. Windows are complex and built up of many different material types, with some having a greater environmental impact than others. The new requirement model aims to balance these against each other, such that materials with a greater environmental impact can be used as long as they help improve the window's energy performance, seen over its entire life cycle.

The energy requirement (U-value) and materials are linked together in order to differentiate energy performance related to materials and environmental impact from wood preservation/impregnation. This means that three levels will be set out for the requirement concerning maximum permitted U-value. The background to the differentiated requirements for the heat transfer coefficient is that there are large differences in energy consumption when manufacturing windows in different materials. Manufacturing entirely wooden windows uses the least energy, while a window made entirely in aluminium uses considerably more energy and there are other options in between, such as composite. By establishing differentiated U-value requirements, we create a holistic view of a window's energy performance, seen over its entire life cycle. Window profiles manufactured using plastic composite (often a mixture of glass fibre and polymers) enable narrow profiles while retaining the same strength. They are ideal for buildings with a modern design and show good thermal insulation properties.

The requirement model with energy differentiation also enables us to handle the challenge of wood preservation, in particular VOC emissions during impregnation, about which there were many conflicting comments during the consultation. VOC emissions have a relatively limited environmental impact when the usage phase is taken into account. However, with the differentiated energy requirement, we clearly promote environmentally aware wood preservation techniques. Wooden windows that use water-based wood preservation (no VOC emissions) have to meet a certain U-value, while wooden windows impregnated with solvent (VOC emissions) have to achieve a better U-value. To summarise, the requirement model drawn up on the basis of the consultation is as follows:

a) For windows with wood as the main material in the frame and casement and where water-based wood preservation techniques or other techniques are used with no VOC emissions, the maximum U_W-value is 0.91 W/m^{2}K.
b) If, however, vacuum impregnation with solvent and thus VOC emissions is used, the maximum U_W-value is 0.82 W/m^{2}K.
c) For windows made in materials other than mainly wood (non-renewable materials), the U_W-value is maximum 0.74 W/m^{2}K.

Corresponding stepped requirements for U-values apply for roof windows and window doors.

Solar energy transmittance, g-value
Solar energy transmittance is a measurement of how much solar energy, in the form of heat, enters through the window. A high g-value means that the window allows a high level of heat radiation into the building. It is important to utilise passive solar energy, above all in passive/low-energy buildings where the use of solar energy is an integrated part of the design and construction based on:

- Cost effective low-energy building:[19]
- Reducing heat losses (and need for cooling)
- Reducing electricity consumption
- Utilising solar energy including daylight
- Controlling and displaying energy use
- Supplying the rest of the energy demand with renewable sources

In autumn and spring in particular, passive solar energy gains via windows can provide a significant contribution to heating in the Nordic countries. In winter the gains are small at our latitudes as there is so little solar energy available.

It has been proven that many windows are manufactured with aims for low U-values while the glass g-value is not considered to the same extent. How large a free heating contribution the window creates depends on its positioning (the direction in which the window is facing, the height at which it is fitted, external vegetation and nearby buildings, blinds and other sun screening, among other things). Another determining factor is how much of solar energy can be stored as heat, depending on the building's heating needs and control and regulation systems.

Windows that allow the entry of high levels of solar energy risk causing an increased need for cooling on warm, sunny days. Buildings with large, south and west-facing glass surfaces may benefit from low solar energy transmittance coefficients in order to limit the solar energy entering the building. Solar energy transmittance (g-value) can effectively be reduced in two main ways: either through a solar protective film on the glass or through an external sunscreen (awning or similar). A film will limit light and energy transmittance throughout the year, while an external sunscreen, particularly an automatic one, only limits transmittance when used/extended.

In order to achieve gold-level classification in established environmental classification systems (BREEAM, LEED, etc.) offices and commercial buildings are often planned with g-values as low as max. 25%. However, this is rarely the case for residential

[19] Bülow-Hübe, H., Blomsterberg, Å, 2011, Important design aspects of very low energy buildings, NorthPass.

properties, where mobile sun screening is the most important tool. Mobile sunscreens enable the management of solar energy to avoid high indoor temperatures in spring, autumn and particularly in summer.

In version 3 of the criteria the g-value was set at **at least 50 ± 2%** measured on the windowpane. The reason for this was that there was a common g-value and one that creates an addition of energy to the building. The requirement level was considered reasonable in order to achieve a proactive and well-conceived choice of window construction. This g_g-value equates to **34-38%** depending on the width of the casement, converted to give the g-value of the entire window (g_W).

It is suggested that the g-value requirement for the windowpane be kept unchanged with regard to requirement level, but reformulated as g_g = 48% or higher, with no margin. In order to achieve as true a picture a possible of a window's solar energy transmittance, a combination has been proposed whereby both the window glass g-value and the g-value for the entire window must be met. This avoids the risk of windows being manufactured with too wide a frame in relation to the surface of the windowpane. The proposed g-value of 34% for the window is to be stated for the reference size of the window in question.

The solar energy transmittance requirement must be met by both windows and window doors, but not by exterior doors which have significantly less window glass (or none at all).

Energy gain calculation
In connection with the 2008 revision of the criteria Nordic Ecolabelling, together with the Faculty of Engineering at Lund University, assessed the possibility of imposing requirements on the window's energy properties using a so-called energy gain calculation. This means that the window's energy gain is calculated as a function of the g- and U-values to help determine how much energy permeates the window, i.e. solar energy in minus heat out.

Since the criteria were adopted, a method for calculating energy gain (or energy loss) from windows and for a fictional building, the so-called energy balance, has been developed and established in Denmark. See Appendix 3 for further information. The Finnish voluntary energy labelling system for windows also estimates a corresponding annual energy consumption for a fictional building.

The present revision examined the possibility of imposing requirements for U- and g-values, including requirements for a specific E_{ref} (nil or positive, ideally). There are several reasons why this is deemed to be impossible. Since E_{ref} is a function of two variables, it is not possible to determine all three. Either the U- or the g-value can be fixed at a certain value. Such a requirement formulation would result in requirements differing between Denmark and the rest of the Nordic region. A window could thus have a higher U-value in Denmark, but still receive the Nordic Swan Ecolabel.

The model used to calculate energy gain has also met with criticism in Denmark. One criticism has been that the heating season has been assumed to be too long, i.e. that the number of degree hours in the equation is too high. This means that there is too much confidence in the g-value. Analogous reasoning can be applied to newly built low-energy buildings as these have very limited heating needs. The heating season is even shorter for low-energy buildings. There are thus fewer days that the building would benefit from

incoming solar energy (a high g-value). The risk that a need for cooling will increases. Other arguments against using this method of calculating the building's energy gain include the fact that the reference building is fictional. The real building would look entirely different and would thus have an entirely different energy balance. Furthermore, Nordic Ecolabelling is unable to steer in what building or where in a building individual windows are fitted.

Since Finland too has its own method for energy calculation, this method should also be taken into account. Another important argument is that the energy balance is based on one single climate zone. As windows are "moveable products" a Nordic Swan Ecolabel would need to take into account all the climate zones relevant to the Nordic region.

Reasoning behind the proposed energy requirements
A total of 14 manufacturers have chosen to join the Swedish voluntary energy labelling scheme for windows. Not all manufacturers have chosen to rate their windows, but the majority are represented. Of the total of 201 rated windows, 30 are wooden windows that have a U_W-value that equates to level a) as described previously. This corresponds to 15% of all rated windows. Another six wooden windows have a U_W-value of max 0.8 W/m^{2}K. There are also five windows with a U-value of 0.7 W/m^{2}K or lower.

A total of 21 manufacturers have joined the Danish energy labelling scheme and 135 window models have been rated. Of these, 26 (19%) meet the energy requirements proposed by Nordic Ecolabelling. At least 17 window models (just over 62%) also meet the U-value requirement of 0.8 W/m^{2}K.

A review of the rated Finnish windows found that about 123 out of a total of 893 windows, i.e. about 14%, would meet the Nordic Ecolabelling requirements. The 12 Finnish window manufacturers who joined have very low U_W-values for a large number of windows, but the g-values are often too low. A number of windows also have a U-value of 0.8 or better.

Norway has no equivalent energy labelling and it is difficult to give an overview. The big Norwegian producer, NorDan, markets its best wooden windows as having a U-value of 0.7 W/m^{2}K, which is considered very low in the industry.

Overall, Nordic Ecolabelling judges that the requirement for windows to have a U-value in line with level a) i.e. maximum 0.90 W/m^2 K for facade windows and 1.0 W/m^2 K for roof windows, is a reasonable requirement level, considering that:

- It represents so-called high-end products for window manufacturers.
- A Nordic Swan Ecolabelled window should be a good choice for a newbuild as well as for window replacement/renovation.
- The U-value should be met, and the g-value requirement fulfilled at the same time.
- The labelling is for the Nordic region and should suit the entire Nordic market, taking into account that the Nordic countries have different focuses with regard to low U-values.

The tighter requirements for a U-value in line with level b) that apply to vacuum impregnated wooden windows are also judged to be reasonable. The best window and door models on the market from several major manufacturers are already at this level.

The requirement level c) that applies to windows made from non-renewable materials has been consciously tightened. On the Nordic market, there are currently only a few windows with this excellent energy performance that are made from one of the non-renewable materials. Nordic Ecolabelling believes, however, that these relatively new window materials will develop such that the U-value can be lowered further, and more products can meet the requirement level. Targets and European and national legislation in the area of a building's energy performance will drive the development forward.

Daylight transmittance
Daylight transmittance is a measurement of the amount of daylight that enters a building through a window. The main function of a window is to let light into the building. In version 3 the requirement was at least 63 ± 2% daylight transmittance measured on the windowpane. The requirement was the same in version 2 of the criteria. It has been suggested that the requirement be kept unchanged but that the margin be removed.

Air permeability
Wood is a flexible material that moves in different ways at different temperatures and humidity levels. Seals have to accommodate that movement and ensure that the window closes tightly. In order to ensure a satisfactory seal in the Nordic Swan Ecolabelled product, there is a requirement for testing pursuant to EN 12 207 (standard for measuring and rating the air permeability of windows and doors). Windows shall meet at least Class 4, which is in line with NDVK's[20] and SFDK's[21] air permeability requirements. Neither the DVV[22] nor P-labelling impose any requirements with regard to air permeability. It is suggested that the requirement relating to window and exterior door air permeability be left unchanged in version 4.0.

Energy requirements for exterior doors
Lowering the U-value by 0.1 W/m^{2}K results in a saving of about 25 kWh per year and door, which is very little considering the total energy consumption of a building. Viewed against this background, it is not relevant to impose any further tightening of the present requirements. There are some doors marketed in the Nordic region with U-values as low as 0.7 W/m^{2}K. In order to achieve such a low heat transfer coefficient, the doors have been made so thick that practicality and aesthetic values are compromised. In addition, the more the manufacturer lowers the door's U-value, the greater the risk of tension differences in the door material and the harder it becomes to ensure good air permeability under different climatic conditions, i.e. the type of climate that a door needs to be able to withstand in winter[23].

Nordic Ecolabelling focuses on imposing requirements in areas with the best potential for environmental improvement, which for exterior doors means ensuring good air tightness even in different climates. An exterior door that has been tested for air permeability, i.e. that meets Class 4 pursuant to EN 12207, may lose its air permeability properties in a real operating environment. Doors will warp in different climates and the air permeability will be compromised unless the manufacturer has taken this into account. If the door is not airtight, up to 800 kWh/year may be lost each year once the door has been fitted. There is a European standard for climate testing, EN 1121 – Doors. Behaviour between two different climates. The procedure for the Nordic

[20] Norwegian Window and Door Control (NVDK). A voluntary system for quality labelling windows and doors in Norway.
[21] Swedish Window and Door Control (SFDK); the Swedish equivalent.
[22] Danish Window Verifikation (DVV) is the Danish equivalent.
[23] Source: personal communication with Daloc.

countries is to test climate A (or climate C) first, followed by climate D. The air permeability is then measured.

Climate A corresponds to 23°C and 30% Rh[24], and 18°C and 50% Rh respectively.

Climate C corresponds to 23°C and 30% Rh, and 3°C respectively.

Climate D corresponds to 23°C and 30% Rh, and -15°C respectively.

In order to ensure that the door will not leak energy in a real setting, a requirement stating that the exterior door shall undergo a climate test pursuant to standard EN 1121, followed by an air permeability test, has been added to requirement O4. In order to make sure that the door does not revert to its original shape, tests shall be performed in immediate succession. This requirement can be met by following the test standard (EN 1121) referred to in the harmonised product standard. Both tests are normally performed using the same test rig in which the door was fitted. If it becomes necessary to move the door from the climate rig in order to test air permeability using a different rig, the standard clearly states that the warping resulting from the climate test should be mechanically replicated in this second rig.

Verification of energy requirements
Only the methods listed in the harmonised European product standard EN 14351-1 are accepted as testing and calculation methods for the energy-related parameters. For example, according to the standard, the U-value is to be verified using one of the following alternatives:

- EN ISO 10077-1 (simplified calculation)
- EN ISO 10077-1 and EN ISO 10077-2 (detailed calculation)
- EN ISO 12567-1 or EN ISO 12567-2 (Hot Box testing)

In Appendix 1 in the criteria document, the relevant calculation, testing and classification standards accepted by/comprised of EN 14351-1 are listed.

The U-value shall be given to two significant figures in line with ISO 10077. This means stating the U-value to two decimal places if less than 1.0 and to one decimal place if it exceeds 1.0. Rounding is to follow current mathematical calculation rules which means the figure five shall be rounded up or down to the nearest even number.

If we take windows as an example, the U-value is to be reported for the reference size 1.43 x 1.23 m or 1.48 x 2.8 m dependent on type of window according to EN 14351-1, for each *window series or family of windows*. Materials in the frame and casement, glazing bars and other components that affect the U-value are the same in the same series/family, which means that the impact from these factors is taken into account. For exterior doors, reference sizes specified in the standard are 1.23 x 2.18 m and 2.00 x 2.18 m.

At this current time, energy losses are normally lower through the glass component than through the frame/casement, which is why a window that is much smaller than the reference size can have a poorer U-value than the one reported. The most important function of the U-value is, however, to provide comparability between different

[24] Relative humidity.

windows/window models, which is why this anomaly is to be accepted. Anything else would also conflict with the harmonised product standard and CE marking.

In summary, a Nordic Swan Ecolabel licence may be given to a series/family of windows or exterior doors because:

- the U-value is given for the reference size and is considered to apply to all sizes.
- the g-value for the glass is unrelated to dimensions and is linked to the particular glass combinations in the model series/family.
- the g-value for the window is given for the same reference size as the U-value.
- materials (see next section) in the frame/casement and in the particular glass combination are the same and the percentage by weight under requirement O1 is given for the reference size.

This was, in principle, also the case in the previous version of the criteria. However, there was a material requirement that external cladding, e.g. aluminium, had to be stated as a percentage by weight for all window sizes. This requirement has been reformulated to simplify licence applications, see next section.

Adjustment after the Nordic Criteria Management Group decision in June 2015
The U-value is a measurement of how well the window or exterior door insulates against heat losses. The U-value is an important feature when choosing a window and exterior door and a central requirement of the product group. The lower U-value the better insulation properties.

In requirement O2 the highest acceptable U-value is listed as limit value for different type of products, depending on wood preservation techniques and material in frames and casements. The problem is that the limit values are presented with only one significant figure despite our purpose to present them with two significant figures, harmonizing with the European product standard for windows and exterior doors EN 14351-1-. The limit value for wooden windows is in O2 set to 0.9 W/m^2 K, though it should have been written 0.90 W/m^2 K. The text in Italics below the requirement is written that the U-value is to be given to two significant figures ad that rounding is to follow current calculation rules.

In the ongoing renewal this typing error has been revealed. The error needs to be corrected because otherwise it can be interpreted in two different ways:

- Either that product having U-values up to 0.94 W/m^2, K actually can be accepted which is violating the Nordic Ecolabelling's intentions only to accept products having a U-value of 0.90 or lower.
- Or that the text in italics is valid also for the limit value and that the limit value therefore should be interpreted as 0.90 W/m^2, K.

The Nordic Ecolabelling Criteria Group recognize this unfortunate typing error and are aware that the stakeholders can have interpreted the requirement less strict than intended. NKG has therefore decided to correct the error in the best way possible and to take responsibility for the confusion it has caused. Therefore, a minor alleviation of 0.01 units are made for all the limit values compared to the intended U-value. This means that

the U-values in requirement O2 for windows are changed to 0.91; 0.81 and 0.71 respectively.

5.5 Material requirements

O5 Recycled proportion in "non-renewable" materials

Windows and doors made from non-renewable materials* must use a certain proportion of recycled** material as follows:

- At least 40% of the aluminium in profiles or door leaves must be recycled metal.
- At least 30% of the PVC in profiles or door leaves must be recycled PVC.
- At least 20 % of the steel in profiles or door leaves must be recycled steel***.

The requirement for recycled material does not apply to:

- external cladding* of outer wood components for the purpose of weatherproofing
- (plastic) composite
- materials that account for less than 3% by weight of the window, window door or exterior door's total weight in line with the calculation in O1
- hinges, handles, fittings, stabiliser plates and kick plates
- window and exterior door insulation
- non-renewable components in glass/insulation panes

* *See section "Terms and definitions".*

** *Recycled material is defined as recycled material both from the pre-consumer phase and the post-consumer phase, in accordance with ISO 14021:*

Material in the pre-consumer phase: Material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it. Nordic Ecolabelling defines rework, regrind or scrap, that cannot be recycled directly in the same process, but requires a reprocessing (eg sorting, reclamation and granulation) before it can be recycled, to be pre-consumer material. This is whether it is produced in-house or externally.

Material in post-consumer phase: Material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose. This includes returns of material from the distribution chain.

Windows and exterior doors manufactured from materials other than those listed above must be assessed by Nordic Ecolabelling before they can be considered for labelling.

*** *Stainless steel is not permitted in window profiles or door leaves.*

✉ Specification of the material used according to Appendix 2a.

✉ Declaration from the supplier of raw material of the proportion of recycled material on an annual basis according to Appendix 12a.

✉ For recycled PVC, in addition test results or similar that proves that the requirement on lead and cadmium is fulfilled.

Background to the requirement on proportion of recycled material

Introduction

Wood and wood/aluminium is the most common frame materials used for residential buildings in the Nordic market. PVC (with steel plate) and pure aluminium are also used in frames/casements. Plastic composite window profiles are a new type of window that appeared on the Danish market, among others, quite recently. Plastic composite windows are windows manufactured using glass fibre-reinforced plastic, not just windows made up

of various different materials (sandwich construction). In addition to the main materials, other materials may also be used in frames to insulate, prevent thermal breaks or to stiffen the material.

Of the large number of LCA studies on windows, the majority are based on windows with different U-values, meaning that the studies do not rate the window materials alone. Three studies assessing the materials have been examined by the project team in order to compare the materials. These are:

1. LEED, Study of points allocation for PVC in LEED Green Building[25].
2. A study from the University of Bath, UK, summarising data for construction materials in the report "Inventory of Carbon & Energy (ICE)", Version 2.0, 2011.
3. Life cycle analysis of windows, Technical University of Denmark, student project, 2011[26].

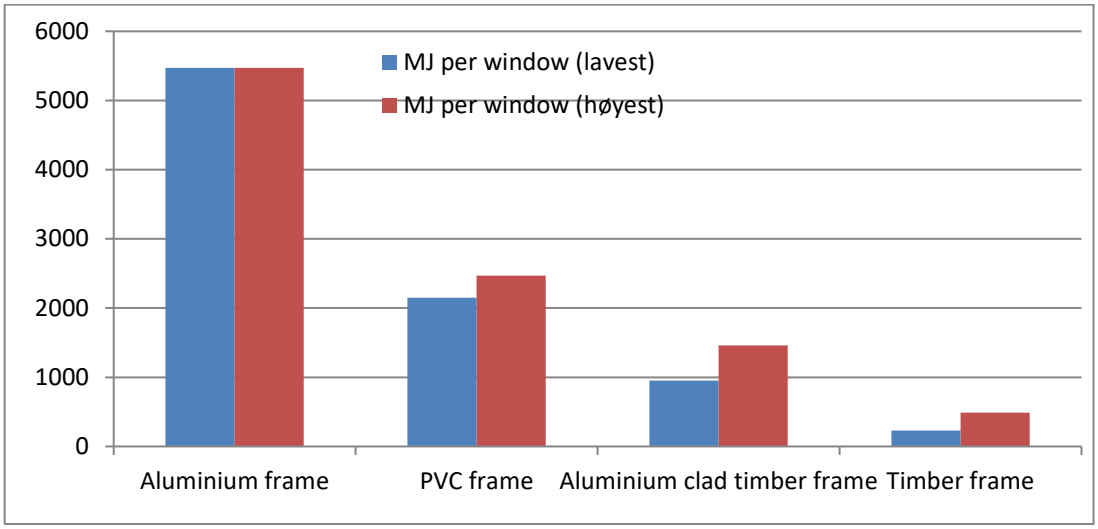
None of the studies assess windows manufactured solely using plastic composite, although the study from the Technical University of Denmark does assess a window made from wood and plastic composite.

The LEED study examines both parts of and the entire life cycle, which has an impact on both health and environmental parameters. It concludes by pointing out that a ban on PVC may result in a shift to worse alternatives, such as aluminium windows.

The University of Bath has examined the energy content associated with manufacturing the materials, compiled embodied energy from cradle to gate and assessed the volumes of the materials in the different windows. The window's usage phase and the waste phase have thus not been taken into account. Material composition in the windows assessed is described as aluminium, PVC, wood/aluminium and wood, ranked in this order with wood being the best material, see Table 4. The figures are taken from the summary report and the project team has not assessed the study itself.

[25] Assessment of the Technical Basis for a PVC-Related Materials Credit for LEED 2007, Sourced from: http://www.usgbc.org/News/PressReleaseDetails.aspx?ID=2957 (visited 10.03.2013).
[26] "Life cycle analysis of windows", Appendix 5. From the course DTU 42372 Life cycle assessment of Products and Systems, Group 11, 1 December 2011, DTU 2011.

Table 4: The table shows the embodied energy of materials used in windows. Figures from the "Inventory of Carbon & Energy" (ICE) Version 2.0, 2011, a database at the University of Bath, UK.

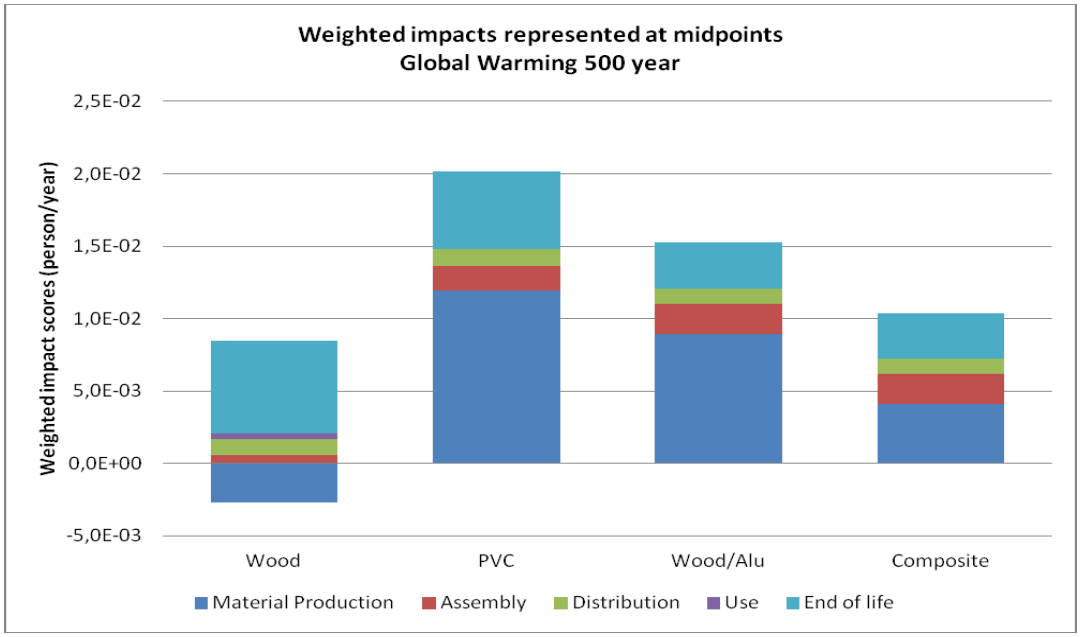


The LCA study from the Technical University of Denmark assessed the environmental impact of wood, wood/aluminium, PVC and wood/plastic composite windows. The wood/aluminium window has aluminium in the load-bearing structure. Wood/plastic composite windows are constructed in the same way as wood/aluminium windows, except that the aluminium content has been replaced by plastic composite. As composite is less airtight than aluminium, a smaller level of composite has been assumed. The study did not include wooden windows where aluminium is used as weatherproofing; this is the type of window that currently holds the Nordic Swan Ecolabel. When comparing windows with the same U-values, one should remember to look at the insulation properties of the different materials, as this is not included in the analysis.

The results expressed as CO_2 equivalents are presented in Table 5, which shows that the three best material combinations, in order of preference, are wood/composite, wood/aluminium and PVC. This study looked at the window's entire life cycle. However, as the windows' U-values are the same, the usage phase could be left out of the materials evaluation. The life cycle phases included in the study are material production, window assembly, packaging, distribution, surface treatment in the usage phase, waste collection and waste management (it was assumed that all window frames were incinerated). The window's service life was set at 40 years with replacement of the glass after 20 years. The study has not made cradle to gate comparisons but looked at various waste scenarios including 100% wood incineration, 30% recycling of aluminium and PVC, and 30% incineration of plastic composite in a cement oven, where the volume of glass fibre replaces the corresponding volume of sand. The materials ranking did not change with the inclusion of different waste scenarios.

The LCA study is based on figures for a plastic composite of polyamide and glass fibre. Plastic composite windows available on the market are made from glass fibre-reinforced unsaturated polyester or polyurethane, which have a higher energy content than polyamide according to the "Inventory of Carbon & Energy (ICE)" Version 2.0, 2011, University of Bath, UK.

Table 5: The wood/aluminium window has aluminium in the load-bearing structure. Note that the composite window is constructed in the same way as the wood/aluminium window except that the aluminium has been replaced by a somewhat smaller volume of composite. The windows have been assumed to contain the same volume of wood.



What life cycle phases should be included in a materials comparison?
The most accurate material evaluation is achieved by looking solely at manufacturing (from cradle to gate). The new standard for the creation of PCRs (product category rules) for construction materials in Europe (EN150804) also calls for cradle to gate data, but information about other parts of the life cycle could also be included. The PCRs form the basis for environmental product declarations (EPDs). If the usage phase and the subsequent waste phase are included for products with a long service life, the assumptions take on a high level of uncertainty.

The Nordic Swan Ecolabel is life cycle-based and takes into account environmental impact in all phases. However, that does not mean that the impact of all phases needs to be summarised, especially not when uncertainty is high and steerability low in the individual phases. What is unique about the Nordic Swan Ecolabel is that it is not only relevance and potential that is assessed, but also steerability.

A minimum requirement for insulation properties is imposed on Nordic Swan Ecolabelled windows, i.e. the energy consumption in the usage phase should be low regardless of the material used in the casements and frames. This means that a requirement is imposed on the main environmental impact arising from the usage phase. The function requirement for wooden components that are exposed to the elements helps reduce the need for maintenance on wood windows in the usage phase. It is difficult to assess the waste scenarios for construction products with a long service life such as windows. We need to reduce our CO_2 emissions in order to tackle the major climate challenges we are currently facing. This means that a high climate impact from production of the window cannot be compensated through the Nordic Ecolabelling criteria in the form of reduced impact in the future. In order to be able to assess materials for Nordic Swan Ecolabelled windows, Nordic Ecolabelling thus wishes to emphasise the environmental conditions during production of the materials, while also ensuring the materials' weatherproofing, in order to extend the service life and reduce maintenance.

One obstacle to comparison is the fact that windows may contain a wide variety of material combinations, including:

- Wood windows with or without aluminium weatherproofing manufactured with or without PUR insulation.
- Aluminium windows may be insulated using a wooden core, glass fibre-reinforced PA or other materials.
- PVC windows may have a wooden core or foam PVC as insulation and steel can be used to stiffen up the casement and frame.
- Plastic composite may consist of various plastic materials, for example 80% glass fibre and 20% PUR.
- Plastic composites may contain various insulation materials and steel for stiffening the casement and frame.

It is therefore impossible to make exact comparisons and we do not know whether the studies referenced reflect the windows available on the Nordic market. Table 6 shows the energy values for manufacturing the materials per kilo of material. As the table shows, wood has the lowest values and primary aluminium and plastic resin, e.g. unsaturated polyester and PUR, the highest.

Table 6: Embodied energy values for various materials.

Material	Embodied energy, MJ/kg
Sawn broadleaf	10.4
Sawn conifer	7.4
Aluminium 50% recycled	108.6
Aluminium primary	224
PVC	77.2
glass fibre	25.6
Plastic resin	200
Plastic composite (65% glass fibre and 35% plastic resin)	86.6
Polyurethane insulation (rigid foam)	101.5
Steel (general – average recycled content)	25.3
Stainless steel	56.7

Source: Inventory of Carbon & Energy (ICE) Version 2.0, 2011, a database at the University of Bath, UK. Embodied energy is the energy required in order to produce the material and includes the materials' inherent energy.

There is a gradual development towards the use of more materials and materials other than wood in the Nordic market. Nordic Ecolabelling has already approved the use of aluminium to provide weatherproofing and the environmental impact of such windows is considered a good basis for comparison when assessing windows made from other materials. As in other product groups there is a lack of exact data and the variation is great. Resource efficiency should be assessed. Looking at Table 4 and assuming a linear correlation, about 65% of aluminium and 50% of PVC needs to be recycled in order to bring the energy content down to the same level as wood/aluminium windows.

Insulation materials should be exempt from the recycled proportion requirement as before, since they contribute to a lower energy consumption in the usage phase. In order to ensure a long service life for the windows, it should also be permitted that the load-

bearing structure may have weatherproofing in different materials without a requirement for a recycled proportion.

In summary, it is clear that recycling is important from an environmental standpoint and for the economy. It reduces the pressure on natural resources and cuts the demand for energy, which leads to lower emissions of greenhouse gases. Nordic Ecolabelling wishes to set a requirement for a certain amount of recycled raw material in order to compensate for the fact that the window being made from a non-renewable material entails higher or much lower energy consumption, see Tables 4 and 5, and to drive the trend towards more material recovery. The opportunities for recovery vary, however, depending on the material. Plastic composite comprises around 35% non-renewable hard plastic such as unsaturated polyester or PUR and cannot therefore be made from recycled raw material. The remaining percentage is glass fibre, which can only be made from virgin glass to achieve the necessary strength.

When it comes to aluminium, there are profiles that are made using a certain amount of recycled aluminium. SAPA Building Systems leads the world in manufacturing extruded profiles for ceilings, facades, windows and so on. They have invested in a re-smelting works in southern Sweden where scrap aluminium is melted into new ingots ready for extruding into profiles. SAPA in Sweden states that the plant in Vetlanda produces around 60,000 tonnes per year, of which around 40,000 is recycled aluminium. The requirement is that the scrap aluminium is pure, i.e. not lacquered.

There are systems in place in Europe for the collection of used rigid PVC from construction waste. Material from the collected PVC waste is recovered for use in new PVC windows, doors and pipes. An ecolabelling requirement could stimulate the growth of these systems and their establishment in more countries.

The consultation document proposed a tightening of the requirement concerning the proportion of recycled raw material, from 30% to 50% by weight, calculated per component, since it takes more energy to manufacture windows and external doors using materials other than wood. Responses to the consultation made it clear that this figure was too high, and so the requirement has returned to 30% recycled material for aluminium and PVC. The requirement level must also be seen in the context of the tougher requirement concerning the U-value for windows made from non-renewable material.

Figure 2: Composite window cross-section. The grey/black external profile is made from composite material and the white profile on the inside is wood. Source: Ecliptica.

To make things simpler, the requirement has not been set at 30% recycled material per component, but as a percentage for the profile material as a whole. Analogous with the requirements in the product group Furniture and Fitments, the percentage of recycled material can be verified by the smelting works certifying that at least 30% recycled aluminium is used on an annual basis. Similar reasoning applies for PVC.

The internal profiles of a composite or aluminium window still tend to be made of wood, see figure 2. Windows made *entirely* from non-renewable material, including the internal parts, cannot carry the Nordic Swan Ecolabel. The exception is PVC windows, where the

casement, frame and glazing bars can be 100% PVC. The reason for this is that there are no material requirements or manufacturing requirements for aluminium or composite that correspond to those in place for PVC (see requirements O6-O8) or for the growing of wood (see requirements O10-O11). The steerability is too low for material and manufacturing requirements. See also the section "Background to the production requirement" under requirement O8.

Figure 3: Wooden window with external aluminium cladding. Source: NorDan

It is common for wooden windows to have an external aluminium cladding over the casement and/or frame to improve weatherproofing and reduce the need for regular maintenance, see figure 3. This type of cladding was exempted from the requirement for recyclable material in version 3 of the criteria, and the exemption continues to apply in the revised criteria. However, the exemption has been reworded to remove the percentage by weight element, since the percentage by weight can be manipulated, for example, by making the glass component heavier.

External cladding in a metal other than aluminium, such as zinc or copper, is not permitted.

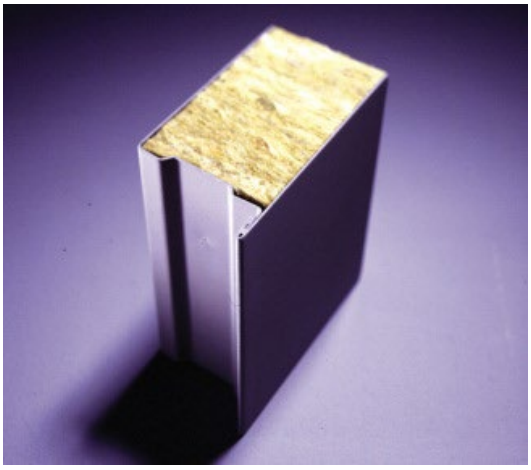


Figure 4: Cross-section of a steel door with a door leaf of 54 mm. The outer layer of thin steel plate encloses mineral wool insulation. Source: Daloc.

Steel for external doors

It has been desirable to include more materials in the ecolabelling. The revision saw an assessment of composite material for windows and steel for external doors. Like most metals, steel has the positive benefit that it can be recycled an unlimited number of times without losing its properties. This is, however, on condition that the cycle is kept free from impurities that would otherwise gradually build up in the steel. Producing a tonne of steel product starting from iron ore requires around 23 GJ of energy, while it only takes 7 GJ using scrap, representing a reduction of 70%.

Of all the steel production in the world, 60-65% derives from virgin raw material, while 35-40% is made from scrap metal. The production chain, from scrap to finished product is simpler and shorter, which means lower manufacturing costs – an important driver of the cycle. The different types of scrap take very different lengths of time to recycle.

Steel production primarily relies on two processes, one ore-based via a blast furnace and the other scrap-based. In the ore-based process, the ore is reduced to iron with the help of carbon. The carbon content in the iron is then lowered to make steel, and in that step of the process around 20% of scrap is added. In the scrap-based process, scrap steel is smelted with the addition of any alloy metals to make new steel. Low alloy steel is thus almost 100% recycled raw material, while a higher alloy steel may have up to around 20% alloys as a primary raw material. It depends entirely on what grade of scrap is available.

The choice of which process to use depends partly on which material (type of steel) is being manufactured. In general terms, steel plate and sheeting are often ore-based, while

bars and construction steel are often scrap-based. Of the world's steel production, around 35-40% employs the scrap-based process.

The amount of recycled raw material in the steel one might purchase thus depends primarily on the process used to manufacture the steel, and this is something the purchaser can rarely control since it is governed by the established process equipment and to a certain extent the parameters that are important for the specific grade of steel. Steel sheeting can, for example, be more sensitive to certain trace elements in the steel that can be difficult to avoid in scrap raw material, which is why ore tends to be used most.

Stainless steel is the most important speciality steel, accounting for around 2% of the total volume of steel in the world. The stainless characteristic is achieved by adding substances such as chromium (Cr) and molybdenum (Mo). Stainless steel is most commonly an alloy with at least 7-18% Cr. Nickel (Ni) is added to make steel more workable, usually at a level of around 8%. As can be seen in Table 6, stainless steel has more than double the embodied energy. The additives are primarily chromium and nickel, and the energy consumption involved in making it means that stainless steel is worse in environmental terms than ordinary steel (carbon steel). Nordic Ecolabelling does not want stainless steel to be used as a material in door leaves.

A steel door has a very long lifetime. If it is scrapped correctly and does not rust, it is in principle inexhaustible. And when the door is replaced, the metal can be 100% recycled. The steel used in door manufacture contains a certain amount of recycled raw material (20-23%). Setting a requirement for the proportion of recyclable material in the steel is relevant, but the steerability is low, since the customer cannot influence or change the situation. The scrap that exists is used, and the reason why we need to continue using ore is that steel production is increasing globally, and steel products have a long lifetime, so it takes a while for them to become scrap. Projections suggest that global steel production will increase up until 2050, and it will not be until 2100 that we may be able to manufacture everything from scrap.

Against this background, a requirement has been introduced for 20% of steel to be from recycled raw material, a figure that is on a par with what is used in steel manufactured using the ore process.

Licensing experience shows that the exception for stabilising plates in exterior doors is also still relevant and an exception has been added for kick boards in this revision. In exterior doors both these components tend to be made from aluminium or steel plate.

Appendix 4 contains a more in-depth description of the most common materials for the product group.

It should be added that the criteria also contain a requirement that it should be possible to easily separate out the various material components in Nordic Swan Ecolabelled windows and external doors in order to facilitate material recovery in the end-of-life phase.

Pre-consumer and post-consumer waste
For metals, the industry is currently unable to steer the processes enough to determine how much is pre-consumer and post-consumer scrap/waste. SAPA's smelting works outside Vetlanda in southern Sweden melts its own internal scrap (i.e. scrap from its own

production of metal profiles), scrap from suppliers and from customers (i.e. manufacturers of ceilings, windows and facade elements). Although it may be considered unsatisfactory, we have to be content with setting a requirement for a proportion of recycled content that covers materials in the pre- and post-consumer phases in line with the definition in ISO 14021. The requirement concerning a proportion of recycled content is to be verified on an annual basis by the supplier of the material.

The plastics industry has developed a European certification system for recycling companies called EuCertPlast. The aim is to create a reliable material flow between plastic recyclers and manufacturers of recycled material.

If the recycler is certified, it has control over its recycling process and can provide certification of quantities and proportions of pre-consumer and post-consumer waste/material. With this certification system and the fact that the purpose behind Nordic Ecolabelling's requirement is to increase demand for recycled PVC from end-of-life building products, the view was that the proportion of recycled PVC should only comprise post-consumer material (see requirement O5).

Fact box: Definition of the content of recycled material in line with ISO 14021

Proportion (expressed as mass) of recycled material in a product or packaging. Only material in the pre- and post-consumer phases is to be considered.

Material in the pre-consumer phase
Material that has been taken from the waste flow during the manufacturing process. The exception is the re-use of material from reworking, regrinding or scrap that is generated in a process and that can be recycled in the same process that generated it.

Material in the post-consumer phase
Material generated by households or trade, industry or institutions in their role as end users of a product that can no longer be used for its intended purpose. This includes the return of materials from the distribution chain.

In the end, the Nordic Ecolabelling Board (NMN) decided to change this and the wording concerning pre-and post-consumer material that was contained in version 3 of the criteria was reintroduced. This means that both pre-and post-consumer material may be used to calculate the proportion of recycled material. However, it is not acceptable to include production waste from the manufacture of window and door profiles, i.e. own production waste.

In the autumn of 2017, Nordic Ecolabelling examined the requirement for profiles and door leaves to contain at least 30% recycled aluminium to ascertain how well it is working. Our requirements define recycled material as post-consumer material, waste material/scrap from the manufacture of windows, external doors and façade components, and other industrial scrap, e.g. from cable production. However, Nordic Ecolabelling does not include production waste from the manufacture of windows and door profiles in the percentage of recycled material.

Through dialogue with a world-leading manufacturer of extruded aluminium/profiles[27], Nordic Ecolabelling has identified the following:

The manufacturer of profiles uses ingots of primary (virgin) aluminium and recycled aluminium. In 2016, 45–50% of the annual volume came from recycled aluminium.

Recycled aluminium consists of scrap from its own manufacturing processes and processing scrap purchased from customers and competitors. Scrap from consumer

[27] Sapa Profiles is now a business area of Hydro and is called Extruded Solutions.

waste is not used. The reason is that aluminium was introduced as a construction material only relatively recently. It also has a long life. The availability of post-consumer aluminium is therefore very low and, at present, is not economically attractive.

Some of the processing scrap that the manufacturer purchases from customers and competitors comes from other profile manufacturers that do not have smelting facilities of their own. According to Nordic Ecolabelling's definition, this fraction could also probably be discounted. That would only leave the scrap purchased from manufacturers of windows, doors, entrance ways and façade components. Sapa estimates this fraction to be significantly lower than 45%, but it does not have exact figures for this.

The manufacturer does not have a system for separating its own processing scrap (scrap from its own production of profiles) from the annual volume.

Extruded material (aluminium) cannot be recycled within its own process. This means that extrusion scrap goes into the re-smelting process and is not returned to its own process. The conclusion is that this material from the profile manufacturer's own extrusion process and the material it purchases from competitors that do not have smelting facilities of their own is material from the pre-consumer phase as defined in ISO 14021.

The investigation resulted in the following adjustment to the requirement on 15 March 2018:

- The percentage of recycled aluminium is increased from 30% to 40% on an annual basis since the text adjustment is of great importance to the amount of recycled aluminium. Since there is no equivalent correlation for PVC and steel, these percentage rates have not been changed.
- An adjustment to the definition of what qualifies as recycled material. After the adjustment, we can align ourselves fully with the definition of recycled pre-consumer material as stated in ISO 14021. But to ensure greater clarity and harmonisation, we have also added "Nordic Ecolabelling defines...".

O6 Non-recycled plastic material

Lead, cadmium, halogenated paraffin, organic tin compounds, bisphenol A, phthalates and halogenated flame retardants may not be actively added to plastic materials.

This requirement does not apply to plastic details with a weight of ≤ 50 grams per unit.

The requirement applies to additives to the actual plastic material and does not include chemical products such as sealants and so on. Plastic based on one of the above-mentioned substances as a monomer is not covered by the requirement.

✉ Declaration from the plastics manufacturer that plastic parts fulfil this requirement. Appendix 2 can be used for documentation purposes.

Background to the requirement on non-recycled plastic material

The requirement applies to all virgin/newly produced plastic material in Nordic Swan Ecolabelled windows and exterior doors. Recycled plastic must fulfil requirement O7. If one of the listed chemical substances/groups of chemical substances is a monomer in the plastic manufacture – bisphenol is a monomer in the manufacture of polycarbonate, for example – it is not covered by this requirement.

A report from 2013[28] on additives in plastic materials by the Norwegian Environment Agency states that bisphenol A may be added in the production of PVC.

Bisphenol A, often abbreviated BPA, is used to manufacture certain plastics and is common in many everyday objects. Studies have shown that BPA may act as an endocrine disruptor even at low doses.

BPA is classified as follows (codes pursuant to the new CLP labelling system and the old system KIFS 2005:7): Risk of serious damage to eyes (H318, R41); respiratory irritation (H335, R37); allergic skin reaction (H317, R43); harmful to aquatic organisms (R52). The substance is also believed to be toxic for reproduction (H361f, R62). BPA is a biological substance that is readily biodegradable in fresh water and soil. (Source: ECHA) The use of BPA is in some cases prohibited or restricted, above all in materials/packaging that might come into contact with foodstuffs.

The other listed substances or groups of chemical substances are also persistent in nature, highly toxic to aquatic organisms, or have other clear health risks. Lead and cadmium have long been known as environmental toxins.

O7 Recycled plastic

Recycled plastic must not contain lead or cadmium in levels exceeding 100 ppm for each substance.

This requirement does not apply to plastic details with a weight of ≤ 50 grams per unit.

Test method described in Appendix 1.

✉ Test results or equivalent demonstrating fulfilment of the requirement.

Background to the requirement on recycled plastic material

Window profiles containing a proportion of post-consumer recycled PVC are currently being manufactured in the UK and in Germany[29]. According to a PVC manufacturer that we have been in contact with[30], the recycled material is used for the core with new PVC surrounding it. The PVC manufacturer points out that it is difficult to achieve less than 1000 ppm lead in recycled PVC[31], meaning that it is not possible to achieve a 50% proportion of post-consumer recycled material as long as requirements stating that levels of lead and cadmium in recycled PVC may not exceed 100 ppm are in place.

Rules governing cadmium in plastic were tightened in the EU in 2011. The new decision to ban cadmium in all types of plastic was introduced in Annex XVII of the REACH regulation. At the same time, it was decided that for the majority of rigid PVC building products that contain recycled PVC, cadmium levels up to 0.1% by weight (1000 ppm) would be permitted. In the interest of customer information, building products made from recycled PVC are to be labelled with a special logo.

Recycled PVC may currently contain lead, cadmium and other undesirable substances, which means that products made from recycled PVC cannot guarantee levels that are acceptable in terms of health and environment. The principle of high and equivalent

[28] Norwegian Climate and Pollution Agency (now Norwegian Environment Agency), Hazardous substances in plastic materials. Prepared by COWI in cooperation with Danish Technological Institute, TA 3017, 2013
[29] Website of window manufacturer VEKA: http://www.veka-recycling.co.uk/ and YouTube clip on recycling of PVC windows: http://www.youtube.com/watch?v=oLJanVPUenY
[30] Meeting with INEOS 29 November 2012, Ecolabelling Norway
[31] Telephone interview with INEOS, October 2012

requirements concerning content of harmful substances in newly produced and recycled materials is important to Nordic Ecolabelling. Cadmium and lead must be removed from the ecocycle before recycling can be promoted. There must also be no risk that ecolabelled windows and exterior doors may be labelled with the cadmium symbol for recycled PVC. Against this background, and on the basis of the consultation, Nordic Ecolabelling has decided to return to the requirement level in version 3 of the criteria, which states a maximum level of 100 ppm for both lead and cadmium. At the same time, we have removed the list of other undesirable substances in requirement O8. These were introduced in version 3 of the criteria in order to gather information on the levels of these that appear in recycled PVC. Since recycled PVC has so far been unable to meet the content requirement concerning cadmium and lead, no information has been received and the requirement is thus not serving its purpose.

Nordic Ecolabelling has limited knowledge of how the levels of substances in recycled plastic are measured and documented. Since the requirement for a low level of lead and cadmium is important, Nordic Ecolabelling wishes the requirement to be verified by the supplier of the recyclable material for every delivery of such material. If, during the period of validity of the criteria, other methods appear that give the same effect, we are positively disposed towards adjusting the wording of the requirement.

O8 Chlorine production for plastic manufacturing

Mercury and asbestos must not be used to produce chlorine for making virgin plastics.

This requirement does not apply to plastic details with a weight of ≤ 50 grams per unit.

✉ Declaration from the plastic manufacturer regarding the method used to produce chlorine. Appendix 2 can be used.

Background to the production requirement

PVC

The proportion of PVC windows on the Nordic market is increasing and currently accounts for over 12% of the window market in Denmark and Norway. The summary of LCA analyses for PVC and competing materials presented by the EU Commission in 2004 concludes that for PVC, the production of intermediaries contributes significantly to the environmental impact.

There are three electrolysis processes used to derive chlorine from salt: the mercury method, the diaphragm method and the membrane process. In Europe, the membrane process accounts for about 46% of chlorine production, the diaphragm method for 14% and the mercury method for 34%[32]. In the diaphragm method, asbestos is sometimes used in the electrolysis cell[33]. According to the industry organisation the Swedish Plastics and Chemicals Federation, European chlorine producers have pledged to phase out the mercury process by 2020. The membrane process or asbestos-free diaphragm method is the Best Available Technique (BAT) for new electrolysis cells in the draft BREF document for chlorine production from 2011.

The project team at Nordic Ecolabelling has reviewed the BAT documents for the production of PVC and chlorine gas and been in contact with the industry. The project team's dialogue with the industry has not yet resulted in any further production requirements that could cause the PVC materials' environmental performance to differ.

[32] Swedish Plastics and Chemicals Federation:
http://www.plastkemiforetagen.se/sektorgrupper/pvcforum/om_pvc/Pages/HurtillverkasPVC.aspx (05.02.12)
[33] Joint Research Centre, BAT Reference Document for the Production of Chlor-alkali, draft 1, Dec 2011. Available at:
http://eippcb.jrc.ec.europa.eu/reference/

It is therefore suggested that the requirements for the production of chlorine gas remain in place. There is thus still relevance, potential and steerability for imposing requirements on the production of chlorine gas without mercury and asbestos.

In summary, the requirement that the manufacture of virgin PVC must be performed without use of the mercury method and diaphragm method and without asbestos was also contained in version 3 of the criteria. The requirement remains unchanged in the revision. However, the exemption has changed to apply to plastic parts that weigh 50 grams or less.

Aluminium
According to a literature study on construction and construction materials by Ostfold Research in 2011, the collection of data from specific aluminium production processes is often made difficult due to the fact that the industry has signed an agreement stating that only average data for the industry as a whole may be published. This means that analyses of aluminium as a construction material are largely based on industry averages. Consequently, it is not possible to identify potential for improvement. Contacts with the aluminium industry also showed that it is very difficult to ensure traceability in the chain, from extraction to finished product. After the extraction of bauxite and production of aluminium, the aluminium is "swapped" on the market, making traceability difficult. The steerability of imposing requirements for the extraction of bauxite is therefore low. Experience from application processing shows that it is possible to achieve traceability from the aluminium profile back to the electrolysis cell. However, traceability is sometimes complicated and not commercially viable. Based on contacts with the industry, it appears to be difficult to establish specific, quantitative requirements for the electrolysis cell. Consequently, the overall RPS for imposing ecolabelling requirements for aluminium production is low despite a high relevance.

Plastic composite
According to one manufacturer of composite windows34, recycled glass is currently not used to produce glass fibre as the purity of the glass is important when it comes to producing the fibre. The glass fibre industry as a whole publishes information about the energy consumed at production and it can be difficult to find a realistic requirement level. As already mentioned, no BAT values have been proposed for the energy consumed when producing glass fibre.

A meeting with a window profile manufacturer found that it is difficult to find polymer resin manufacturers, and steerability is therefore low.

The project group does not see any steerability in imposing requirements on the manufacturing process for plastic composite materials. Please see Appendix 4 for further information on the manufacturing process.

Background to the marking requirement

Version 3 of the criteria contained a requirement for the marking of plastic parts. The purpose was to facilitate correct sorting of end-of-life plastic materials, thus enabling materials recycling. There have been indications that marking is of no importance to

[34] Notes from the meeting with Fiberline Composites AS at DS, 11 January 2013.

waste separation and thus of no importance to recycling. At the same time, manufacturers state that they do mark their plastic components and that there is no problem with marking or imposing marking requirements for plastic components.

Following the consultation, Nordic Ecolabelling chose to delete the requirement in its entirety.

O9 Filler gas

Filler gas used for insulation must not contribute to the greenhouse effect; i.e. the GWP (Global Warming Potential) must be nil over a period of 100 years.

Krypton and xenon must not be used as filler gases due to the high energy consumption at production. The ban on krypton is subject to a transition period of 24 months, starting from the date when these criteria come into force, see the date on the front of the criteria document.

Noble gases have GWP=0.

✉ Details of filler gases used for insulation, and confirmation for gases other than noble gases that they do not contribute to the greenhouse effect.

Background to the filler gas requirement

A mixture of gases is used to lessen energy losses through the windowpane of modern windows. The most common mixture is argon (90% by volume) and air (10% by volume), but krypton and possibly xenon are also used. The noble gases are found naturally in low concentrations in the air and are produced through air distillation followed by further separation processes. The production of these gases results in the production of oxygen and nitrogen. Considerably more energy is required for the production of krypton, which means that the window's environmental impact increases when this gas is used.

Table 7: Energy consumption, production of argon and krypton

	% by volume in air	Energy consumption (GJ/t)
Argon	0.9	6.06[35]
Krypton	0.000108	10.3

Source: Miljøvurdering af vinduer, By og Byg Dokumentation 046, The Danish Building Research Institute, 2003

The 2003 report "Miljøvurdering af vinduer" (Environmental Assessment of Windows) compares environmental indicators for double-glazed windows with argon, triple-glazed windows with argon and a triple-glazed window with krypton. It shows that climate impact, air pollution and waste from energy production are all significantly higher when krypton is used as the filler gas.

A research-based report[36] produced by window manufacturer NorDan examined the possibility of using xenon as the filler gas. Even though xenon has better insulating properties, its embodied energy[37] is far too high. The energy saving made possible by the use of xenon is far smaller than the amount of energy required in order to produce the filler gas. It is estimated that it takes just over 75 GJ more energy to make xenon than to make argon. Krypton requires almost 10 GJ more than argon. On the basis of this,

[35] The energy consumption may vary depending on how it is allocated to by-products. Another manufacturer gives a figure of 0.69 GJ/t, which makes the difference between argon and krypton even greater.
[36] Academic Research, NorDan AS, 2008.
[37] Embodied energy is the total amount of energy bound in the product, from raw material extraction, through all the different manufacturing stages to the finished product, including energy used for transport.

Nordic Ecolabelling does not permit the use of krypton or xenon as a filler gas in Nordic Swan Ecolabelled windows or exterior doors.

Following the consultation, a 2-year transition period was introduced for the ban on krypton, to give manufacturers a reasonable chance of finding alternatives that meet the Nordic Ecolabelling criteria.

Argon does not contribute to the greenhouse effect, nor does any other noble gas. The reasons for this are purely physical. For molecules such as N2, O2 and monatomic molecules such as argon gas, there is no change in the dipole moment when they vibrate and they are virtually unaffected by infrared radiation. Put simply, there is no argon gas atom bond capable of absorbing IR, nor can it twist or bend as this requires three atoms bound to one another within the molecule. Requirement O11 has thus been changed to state that filler gas must not have a contribution to the greenhouse effect, expressed in GWP100, in excess of 0. However, this change has little or no practical impact.

O10 Origin

A) Origin and traceability of wood raw material

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

- Demonstrate traceability for all wood and fibre raw materials. State the name (in Latin and in a Nordic language), volume and geographic origin (country/state and region/province) of the types of wood used.
- A written procedure for sustainable wood and fibre raw material supply.

Wood and fibre 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.

Wood chips, wood shavings, wood waste, untreated demolition timber and recovered fibre from other industrial operations that are used in fibreboard or insulation material are included, but only need to fulfil the requirement for a written procedure.

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 3a can be used.

✉ The manufacturer of windows/exterior doors must have a written procedure for their sustainable wood and wood fibre raw material supply. The procedure shall include up-to-date lists of all suppliers of wood and fibre raw material.

B) Prohibited and restricted tree species

Nordic Ecolabelling's list of prohibited and restricted tree species* consist of virgin tree species listed on:

a) CITES (Appendices I, II and III)

b) IUCN red list, categorized as CR, EN and VU

c) Rainforest Foundation Norway´s tree list

d) Siberian larch (originated in forests outside the EU)

Tree species listed on a) CITES (Appendices I, II and III) **are not permitted** to be used.

Tree species listed on either b), c) or d) may be used if it meets all of the following requirements:

- the tree species does not originate from an area/region where it is IUCN red listed, categorized as CR, EN or VU.
- the tree species does not originate from Intact Forest Landscape (IFL), defined in 2002, http://www.intactforests.org/world.map.html.
- the tree species shall originate from FSC or PEFC certified forest/plantation and shall be covered by a valid FSC/PEFC chain of custody certificates documented/controlled as FSC or PEFC 100% through the FSC transfer method or PEFC physical separation method. Tree species grown in plantation shall in addition originate from FSC or PEFC certified forest/plantation, established before 1994.

* The list of prohibited and restricted tree species is located on the website: http://www.nordic-ecolabel.org/certification/paper-pulp-printing/pulp--paper-producers/forestry-requirements-2020/

☒ Declaration from the applicant/manufacturer/supplier that tree species listed on a-d) are not used. Appendix 3c may be used.

<u>If species from the lists b), c) or d) is used:</u>

☒ Declaration from the applicant/manufacturer/supplier that tree species listed on a) CITES I, II and III are not used.

☒ The applicant/manufacturer/supplier are required to present a valid FSC/PEFC Chain of Custody certificate that covers the specific tree species and demonstrate that the tree is controlled as FSC or PEFC 100% through the FSC transfer method or PEFC physical separation method.

☒ The applicant/manufacturer/supplier are required to document full traceability back to the forest/certified forest unit thereby demonstrating that:

- the tree does not originate from an area/region where it is IUCN red listed, categorized as CR, EN or VU
- the tree species does not originate from Intact Forest Landscape (IFL), defined in 2002 http://www.intactforests.org/world.webmap.html
- For plantations the applicant/manufacturer/supplier are required to document that the tree species does not originate from FSC or PEFC certified plantations established after 1994.

O11 Certified forestry

A) Wood raw material 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 pursuant to a forestry standard and certification system that meet the criteria stated in Appendix 4.

The requirement applies to solid wood, veneer and plywood. The requirement does not apply to fibreboard and wood fibre insulation.

The requirement does not apply to components/parts making up less than 10% by weight of the finished product.

Nordic Ecolabelling may request the submission of further documentation to enable it to assess whether the requirements of 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.

☒ The amount of timber derived from certified forests must be stated and the basis for calculations must be shown. Appendix 3b can be used.

☒ Copy of relevant forestry certificates that meet the guidelines for forestry certification and organic cultivation described in Appendix 4.

B) Wood raw material

The applicant/manufacturer must state the name (species name) of the wood raw material used in the Nordic Ecolabelled window and exterior door.

Chain of Custody certification

The applicant or the supplier of wood raw material must be Chain of Custody certified by the FSC/PEFC schemes.

Manufacturer/supplier of Nordic Ecolabelled window/exterior door using only recycled material are exempted from the requirement to Chain of Custody certification. Definition of recycled material, see glossary/below.

Certified wood raw material

A minimum of 70% by weight of all raw material (virgin/recycled material) used in the Nordic Ecolabelled window/exterior door, must origin from forestry certified under the FSC or PEFC schemes or be recycled material.

The remaining proportion of wood raw material must be covered by the FSC/PEFC control schemes regarding FSC controlled wood/PEFC controlled sources or be recycled material*.

** Recycled material defined according to ISO 14021 in the following two categories:*

Pre-consumer material: Material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

Post-consumer material: Material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose. This includes returns of material from the distribution chain.

Nordic Ecolabelling consider products from primary wood processing industries (sawdust, wood chips, bark, etc.) or residues from forestry (bark, branches, roots, etc.) as recycled material.

☒ Name (species name) on the wood raw material used in the Nordic Ecolabelled window/exterior door.

☒ Applicant/manufacture must present a valid FSC/PEFC Chain of Custody certificate covering all wood raw material used in the Nordic Ecolabelled window/exterior door. (Exempted from this requirement is applicant/manufacturer using only recycled material.

☒ Documentation showing that the quantity of certified wood raw material or recycled material is met by the applicant's/manufacturer's Chain of Custody account.

Background

Requirements O10 and O11 consist of two sets of requirements in the following way:

- Requirements marked A) are the forestry requirements that were introduced in the criteria for windows and exterior doors in conjunction with the establishment of criteria document version 4.0 on 19 March 2014.
- Requirements marked B) are the new forestry requirements that were established by the Nordic Ecolabelling Board in November 2015.

Licence applicants can choose to fulfil and verify either requirements marked A or requirements marked B. It is not possible to mix between the two sets of requirements

Background to the wood requirement 10 A) and 11 B)

Version 3 of the criteria contained a requirement stating that the wood raw material must not originate from forest environments meriting protection due to their high biological and/or social value. This requirement remains relevant as windows and doors made using wood raw material from tropical regions continue to be sold 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.

This wood requirement has been reformulated to correspond to Nordic Ecolabelling's formulation of its equivalent. The traceability requirement was included in the previous version of the criteria but has now been clarified.

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 Ecolabelling's requirements with regard to wood raw material origin and traceability. However, it does not completely replace the Nordic Ecolabelling's requirements, even though it can help to document the origin of the wood raw material. The Nordic Ecolabelling'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.

Windows do not normally contain fibreboard. Instead, wood components tend to be made from solid wood. Exterior doors, on the other hand, are constructed more like a sandwich composing many different materials including solid wood, fibreboard, insulation, metal plates, etc. It is not unusual for the wooden front of an exterior door to be made from veneer, chipboard, MDF or water resistant HDF. Nordic Ecolabelling requires wood and wood fibre components in exterior doors also to be derived from legal sources. The requirement has therefore been reformulated to make it clear that it also applies to fibreboard.

Version 3 of the criteria also contained a requirement calling for at least 70% of solid wood to be sourced from certified sustainable forests. The requirement applies to solid wood, e.g. in the frame and casement, as well as to exterior door veneer material, etc. 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. Fibreboard is, however, not subject to the requirement for a proportion (70%) of certified timber. In addition, a minimal limit has been introduced to allow an exemption for certified timber components making up less than 10% by weight. The purpose of this is to ensure that the threshold of an exterior door, for example, does not have to meet the requirement for certified timber. All wood raw material is, however, subject to the requirement concerning origin and traceability (O10).

In summary, the wood requirements and related appendices have been changed somewhat since the consultation. These changes are briefly presented below:

- The requirements do not entail a requirement for full traceability (physical).
- A Forest Management certificate does not need to be provided.
- The requirements are to relate to procedures not systems for traceability.
- The Swedish desire that a claim should be required on invoices is not being introduced into the criteria at this time.

Background to the new wood requirement O10 B)

A number of tree species are restricted or not permitted for use in Nordic Ecolabelled floor coverings. The requirement applies only to virgin forest tree species and not tree species defined as recycled material according to ISO 14021.

The list of restricted tree species is based on the wood species that are relevant to Nordic Ecolabelling's criteria, i.e. tree species that have the potential to be included in Nordic Ecolabelled products. Listed tree species are indicated by the scientific name and the most common trade names. The scientific name/trade name is not always adequate, as there may be more than one scientific name/trade names for the listed tree species than the list indicates.

Criteria for tree species found in the list are wood originating from:

d) Tree species listed on CITES Appendices I, II and III.
e) IUCN red list, categorized as critically endangered (CR), endangered (EN) and vulnerable (VU).
f) Regnskogsfondet[38] (Rainforest Foundation Norway) tree list
g) Siberian larch (originated in forests outside the EU)

CITES[39] is an international convention for the control of trade (across borders) of wild fauna and flora. CITES includes around 5600 animal species and around 28.000 plant species wherein a part is relevant timber tree species (mainly tropical species). The tree species is, dependent on how threatened they are, listed in Appendix I, II or III. Species listed in Appendix I, are highly endangered and trade with these species is totally banned. For the remaining tree species, special permits for import and export is required (Appendices II and III). CITES is regulated by EU legislation (Council Regulation (EC)

[38] https://www.regnskog.no/no/hva-du-kan-gjore/unnga-tropisk-tommer/tropiske-treslag (visited January 2020)
[39] https://www.cites.org/ (visited January 2020)

No 338/97) and trees with valid CITES permits are considered to be legally harvested under EUTR (EU Timber Regulation). Nordic Swan Ecolabel's ban on the use of tree species listed in CITES (Appendix I, II or III) goes beyond the EU legislation. CITES regulates trade in endangered species, and there are also challenges with corruption in the trade in wild animals and plants[40]. Therefore, Nordic Ecolabelling does not want to approve species on any of the appendices.

IUCN Red Lists[41] are the world's most comprehensive inventory of the global conservation status of the planet's biological species, including trees. IUCN Red List has established clear criteria to assess the risk of extinction among thousands of species and subspecies according to the origin of the tree species. These criteria cover all countries and all species in the world. Nordic Swan Ecolabelling is aware that the IUCN's red list system only focuses on the extinction risk of species, and therefore is not designed for an overall assessment of whether a tree species can be provided with sustainable origin. However, the list is continually being updated and thereby is an important tool to estimate a specific tree species' conservation status on a global scale. Nordic Swan Ecolabel wishes to prohibit tree species listed as endangered (categories CR, EN and VU).

Regnskogfondet[42] (Rainforest Foundation Norway) is an NGO in Norway that works to protect the world's remaining rainforests. Currently, Regnskogsfondet does not see any credible certification schemes working in the tropics, and therefore recommends full stop of buying tropical timber. Regnskogsfondet has developed a list of tropical tree species based on tree species found on the Norwegian market. This list works as a guide to comply with Norwegian guidelines regarding non-use of tropical wood in public construction. We consider this a pragmatic approach for handling tropical tree species on the Nordic market.

In addition, Siberian larch (originated in forests outside the EU) is on the tree list. Siberian larch is a coveted tree species in the construction industry due to its high quality. The tree species is widespread in the Eurasian northern boreal climate zone, and particularly the species *Larix sibirica, Larix gmelinii, Larix cajanderi* and *Larix sukaczewii* are widespread in the large areas of intact forest landscapes (IFL) in Russia. Siberian larch is to be seen as an indicator species for boreal IFL-areas which are important to keep intact.

Exemption from the tree list

Nordic Swan Ecolabelling is aware that tree species originating from b), c) or d) can originate from legal and sustainable forestry. Therefore, it is possible to use tree species listed on b), c) or d) if the applicant/manufacturer/supplier can demonstrate compliance with a number of strict requirements regarding certification and traceability.

Many of the tree species on the list are grown in countries which still have large areas of IFLs. These are important to protect due to biodiversity and climate. Many of these countries also have a high risk of corruption and the national legislation related to environment, human rights and ownership to land are weak and/or not controlled by the

[40] Addressing corruption in CITES documentation processes Willow Outhwaite, Research and Analysis Senior Programme Officer, TRAFFIC, 2020: https://www.traffic.org/site/assets/files/12675/topic-brief-addressing-corruption-in-cites-documentation-processes.pdf
[41] http://www.iucnredlist.org/ (visited January 2020)
[42] https://www.regnskog.no/no/hva-du-kan-gjore/unnga-tropisk-tommer/tropiske-treslag (visited January 2020)

authorities. There are different views on whether certification is good enough to meet the challenges of forest management in land with a high risk of corruption and illegal logging. For instance, relevant challenges related to this have been published by Danwatch in a number of articles in 2018 [43],[44] and by redd-monitor.org in 2019[45]. Greenpeace International has ended its memberships in FSC on the grounds that the certification body is no longer meeting its aims of protecting forests and human rights[46]. Other environmental organisations like WWF support certification as an important tool for sustainable forestry in these countries. However, due to the uncertainty whether FSC and PEFC certification systems are good enough in protecting important areas of biodiversity and ethical aspects like human rights and land ownership in areas with a high risk of corruption, Nordic Ecolabelling have a precautionary approach and wants further documentation about the tree species and its origin.

In order to document full traceability of the tree species, the applicant/manufacturer/supplier must present a valid FSC/PEFC Chain of Custody certificate that covers the specific tree species and demonstrate that the tree is controlled as FSC or PEFC 100%, through the FSC transfer method or PEFC physical separation method. This means that Nordic Swan Ecolabelling does not accept the FSC percentage or credit control system as well as PEFC percentage system. Full traceability of the tree species back to the forest/certified forest unit, enables the applicant/manufacturer/supplier to document that the tree species does not come from an area/region where it is IUCN red listed, categorized as CR, EN or VU. Full traceability also makes it possible to document that the tree species does not come from Intact Forest Landscape (IFL), defined by Intactforest.org in 2002[47]. Intact Forest has been monitoring IFL-areas since 2000 and has developed an online up to date mapping tool that shows the extent of IFL back to 2002. The monitoring results shows that the world's IFL are being degraded in an alarming speed, and that is the reason for Nordic Swan Ecolabelling referring back to 2002.

Plantation: Nordic Swan Ecolabelling believe, that responsibly run forest plantations can play a role in preserving natural IFLs by reducing the pressure to harvest the world's remaining natural forests. In order to secure that plantation has not replaced native ecosystems (forest/grasslands) within the last 25 years, tree species has to come from FSC or PEFC certified plantations that were established before 1994. 1994 is in line with FSCs international forest management standard (version 5.2), whereas PEFC is working with 2010.

The list of restricted tree species is located on http://www.nordic-ecolabel.org/certification/paper-pulp-printing/pulp--paper-producers/forestry-requirements-2020/.

Background to the new wood requirement O11 B)

Name of the wood raw material. Nordic Ecolabelling sets requirements to gain information about which tree species are used in Nordic Ecolabelled products. The

[43] https://danwatch.dk/undersoegelse/dokumentfalsk-og-millionboeder-danske-byggemarkeder-saelger-trae-forbundet-til-ulovlig-hugst-i-amazonas/
[44] https://danwatch.dk/undersoegelse/baeredygtighedsmaerke-er-ingen-garanti-for-baeredygtigt-trae/
[45] https://redd-monitor.org/2019/08/29/evicted-for-carbon-credits-new-oakland-institute-report-confirms-forced-evictions-for-green-resources-plantations-in-uganda/
[46] https://www.greenpeace.org/international/press-release/15589/greenpeace-international-to-not-renew-fsc-membership/
[47] http://www.intactforests.org/world.webmap.html, visited January 2020

requirement makes it possible to control the Chain of Custody certificates in the supply chain (check whether the stated tree species is covered by the Chain of Custody certificate) as well as provide information for future forest requirements. If recycled material is used in the Nordic Ecolabelled flooring, and particularly in the form of recirculated fiber, it is not always possible to specify the name (species name) of all wood raw materials used. In this case, the requirement for documentation of recycled material is to be met.

FSC, PEFC and EUTR. Forest Stewardship Council (FSC) and Programme for the endorsement of Forest Certification schemes (PEFC) cover together 98% of the world total certified sustainable managed forest area and are predominant in the global market for certified sustainable wood. Both schemes cover Forest Management certification of forests and subsequent Chain of Custody (CoC) certification, which documents the traceability of timber and timber products from certified forests. Both systems are considered common among forest owners, forest industries, manufacturers and distributors of wood products, and public authorities as reliable systems for sustainable forestry.

FSC updated traceability standard from 2015 and PEFCs traceability standard from 2013 fully meets the requirements of EU Timber Regulation (995/2010/EC) prohibiting the marketing and sale of illegal timber in the EU. This applies to imported wood, as well as wood harvested in the EU. Nordic Ecolabelling recognizes both the FSC and PEFC as schemes that provide sufficient guarantees for legal and sustainable forestry.

Traceability Certification. Nordic Ecolabelling requires that the applicant/ manufacturer is Chain of Custody certified by the FSC/PEFCs schemes. The requirement for Chain of Custody certification contributes to traceability in the supply chain within the FSC and PEFCs guidance and control systems for traceability. The company's Chain of Custody certification proves how certified wood is kept separate from not certified wood in the production, administration and warehousing and is checked annually by independent certification bodies. There exist different types of Chain of Custody certifications, which varies according to the minimum content of certified wood and the way this is calculated. Both schemes allow, within specified circumstances and rules, to mix wood from certified forests with recycled material or legal wood from non-certified forests. Therefore, it is not certain that a specific batch of FSC or PEFC certified wood necessarily come from certified forest. In all cases, the remaining share of the wood shall comply with a number of minimum requirements to ensure that it can be considered as "legal timber". Both the FSC and PEFC schemes allow several methods to verify the traceability: Physical separation method, percentage-based method and volume credit method. Nordic Ecolabelling accepts all FSC and PEFCs methods to verify traceability and the share of certified and controlled wood/sources. The applicant/manufacturer must submit a valid FSC/ PEFC Chain of Custody certificate, covering all wood raw material used in the Nordic Ecolabelled flooring as documentation.

Nordic Ecolabelling equates recycled material with virgin wood material from sustainable forestry. Recycled materials not covered by an FSC/PEFCs Chain of Custody certification can also be used in Nordic Ecolabelled products. Suppliers of recycled material are exempted from the requirement regarding FSC/PEFCs Chain of Custody certification.

Recycled material. Definition of recycled material (pre-consumer and post-consumer) is based on ISO 14021.

"Pre-consumer material" is defined as material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

"Post-consumer material" is defined as material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose. This includes returns of material from the distribution chain.

Nordic Ecolabelling consider by-products from the primary wood-using industries (sawdust, wood chips, bark, etc.) or residues from forestry (bark, branches, roots, etc.) as recycled material. Industries, who buy virgin wood (round wood) and primarily converts it into e.g. chips, are not counted as recycled material. Industries that process virgin wood (round wood) are counted as primary wood-using industries.

It should be noted that the EU Timber Regulation, as opposed to Nordic Ecolabelling, do not define by-products from the primary wood-using industries as recycled material. Sawdust, wood chips, bark, etc. or residues from forestry (bark, branches, roots, etc.) is subjected to the EU Timber Regulation, i.e. subject to requirements of traceability and legality.

The applicant/manufacture shall demonstrate that the wood has the status of recycled material according to the above definitions.

Certified wood raw materials. Applicants must document that at least 70% of all wood raw material (virgin/recycled material) used in the Nordic Ecolabelled product/production line comes from forestry certified under the FSC or PEFC schemes or is recycled material. The remaining proportion of wood must meet the requirements of FSC controlled wood or PEFC controlled sources or be recycled. The requirement limit, a minimum of 70% of all wood raw material (virgin or recycled), correspond to the FSC and PEFCs requirement limits for use of the respective labels on products, such as "FSC Mix" and "PEFC certified". FSC and PEFC has together five recognized official existing labels. Further information about the use of labels can be found on FSC and PEFCs websites. The requirement can make it easier for manufacturers of Nordic Ecolabelled products to document the requirement, as they can demand labelled FSC/PEFC products. Recycled material is explicitly highlighted in the requirement as both FSC and PEFCs schemes include certified recycled materials.

Nordic Ecolabelling equates as previously mentioned recycled material with virgin wood material from sustainable forestry. Recycled materials not covered by FSC/PEFC's Chain of Custody certification, can also be used in the Nordic Ecolabelled products. The share (% units) of recycled material must meet the requirement regarding the share of wood raw material certified as FSC or PEFC sustainable forestry.

It is specified in the requirement that certified wood raw material (FSC and PEFC credits) must be accounted/recorded from the manufacturer's Chain of Custody account to the Nordic Ecolabelled product/production line. This ensures that the FSC/PEFC credits on a production levels is accounted/recorded to the Nordic Ecolabelled

production, and not to other FSC/PEFC labelled products. I.e. the amount of certified wood raw material that is "sold" into the Nordic Ecolabelled product/production line subsequently is removed from the manufacturer's Chain of Custody account, ensuring that the certified wood material is not sold twice. This will also stimulate increased demand for certified products.

The applicant/manufacture must demonstrate that the quantity of certified wood raw material or recycled material is met. The certification % shall be documented through the applicant's/manufactures Chain of Custody account and invoice or delivery note (paper or via e-invoicing), which also indicates the company's certification codes from which the wood raw material is purchased from. It must be clear which parts of the packing slip or invoice delivery that is certified (e.g. claim/material category must appear, such as FSC MIX and FSC 100% associated with the product concerned on the invoice or delivery note).

Certification and accreditation. The certification (control and approvement of requirements in the standard, chain of custody and eventual use of label) must be conducted by an independent, competent and accredited third party and follow the relevant international guidelines for the certification: "ISO/IEC 17065:2012 Conformity assessment – Requirements for bodies certifying products, processes and services" or equivalent and accredited by an accreditation body operating in accordance with "ISO 17011:2004 Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies" or equivalent.

The accreditation (i.e. verification and approval of the certification firm is working properly) must be undertaken by a national or international body, systems and procedures are consistent with ISO 17011:2004 Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies or equivalent.

O12 Insulation materials

Thermal insulation materials must not contain halogenated flame retardants or flame retardants containing borax or boric acid.

Expanding insulation materials must not be produced using halogenated organic compounds as blowing agents.

✉ Declaration from the supplier of the insulation material and product specification for the insulation material. Appendix 5 can be used.

Background to the insulation material requirement

Flame retardants[48] [49] [50] [51] [52] [53]

Halogenated flame retardants is the common name for a large group of organic

[48] PUR-skum produkter i et livsløpsperspektiv – en vurdering av arbeidsmiljø og ytre miljø. ISBN no.: 82-7520-446-1. Ostfold Research, BA8 Rådgivende Ingeniører and the National Institute of Technology. Norway, 2002.
[49] Bruken av bromerte flammehemmere I produkter: Materialstrømanalyse. The Climate and Pollution Agency (Clif - formerly STF), TA-1947. Norway, 2003.
[50] Kartlegging av utvalgte nye organiske miljøgifter – bromerte flammehemmere, klorerte parafiner, bisfenol A og triclosan (TA-2006/2004). http://www.sft.no/publikasjoner/overvaking/2096/ta2096.pdf. ISBN 82-577-4488-3. Norwegian Institute for Water Research (NIVA). Norway, 2004.
[51] Hvor brannsikre er stoppete møbler og madrasser? http://nbl.sintef.no/publication/lists/docs/NBL_A06103.pdf. NBL A06103. SINTEF. Norway, 2007.
[52] Konsekvensutredninger av forslag til regulering av visse miljøgifter i forbrukerprodukter. Appendix 4. http://www.sft.no/artikkel____42872.aspx. The Climate and Pollution Agency (Clif) Norway, 2008.
[53] Bromerte flammehemmere I avfallsstrømmen. TA-2380. http://www.sft.no/publikasjoner/2380/ta2380.pdf. The Climate and Pollution Agency (Clif) Norway, 2008.

compounds. The substances vary in terms of structure, but all contain fluoride, chlorine or bromine. When subjected to intense heat, these compounds release halogen radicals which stop the chain reaction in the combustion process, thus having a flame retarding effect. In recent years, brominated flame retardants in particular have been under the spotlight due to their poor biodegradability. They can concentrate in the food chain and have been found in live organisms and human breast milk. Some of these substances have been shown to have a harmful impact on human health and the environment. These substances are not very toxic to humans, but some halogenated flame retardants are acutely toxic to aquatic organisms. Prolonged exposure has been proven to cause liver damage. Certain brominated flame retardants are believed to have a hormonal impact and may cause damage to the nervous system. Against this background, among other things, Nordic Ecolabelling has banned the use of halogenated flame retardants. Cellulose based insulation materials (paper, cellulose fibre) can have borax or boric acid added as flame retardants[54]. Borates (borax and boric acid) may be toxic and corrosive. These substances are included in the REACH Candidate List[55].

Expanding insulation materials
Expanding insulation materials may not have been produced using halogenated organic compounds.

Rigid polyurethane (PUR) foam may be used to insulate windows and doors. PUR foam is produced using gas propellant. Halogenated fluorocarbons such as CFC (chlorofluorocarbon) and HCFC (hydro chlorofluorocarbon) were previously common gas propellants[56]. The use of CFC and HCFC is regulated by the international Montreal Protocol[57]. In accordance with Norwegian regulations and EU rules, the use of the ozone depleting substance HCFC was banned in all foam production as of 1 January 2004. However, most Norwegian insulation foam manufacturers had already changed their production processes to avoid the emission of ozone depleting substances in 2002[58]. Pentane is the main blowing agent used in PUR foam today[59].

Version 3 of the criteria contained the following statement: "mineral insulation material must not be classified as carcinogenic in the EU's Dangerous Substances Directive (97/69/EC)". This statement has been deleted, since mineral insulation material is no longer classified as carcinogenic. The requirement is otherwise unchanged.

O13 Separability

It must be possible to separate the main material types and insulating glass units from each other at the end of the window or exterior door's service life.

✉ Description of how the materials and the glass units can be separated from each other for ease of recycling and/or replacement/repair/refurbishment.

[54] http://www.byggogbevar.no/miljoe-og-enoek/artikler-miljoe-og-enoek/isolasjonsmaterialer-a-aa.aspx (10.04.13)
[55] Link to the candidate list on the ECHA website: http://echa.europa.eu/addressing-chemicals-of-concern/authorisation/substances-of-very-high-concern-identification/candidate-list-of-substances-of-very-high-concern-for-authorisation
[56] Report from the Climate and Pollution Agency (now Clif) Reduksjon i utslippene av HFK, PFK og SF6, SFT report 1754/2001. Can be accessed at: http://www.klif.no/publikasjoner/luft/1754/ta1754.htm
[57] The Montreal Protocol, http://www.miljostatus.no/Tema/Klima/Ozonlaget/Montrealprotokollen/
[58] http://www.klif.no/no/Aktuelt/Nyheter/2003/April/Redusert-bruk-av-ozonreduserende-stoffer/
[59] PUR-skum produkter i et livsløpsperspektiv – en vurdering av arbeidsmiljø og ytre miljø. ISBN no.: 82-7520-446-1. Ostfold Research, BA8 Rådgivende Ingeniører and the National Institute of Technology. Norway, 2002.

Background to the separability requirement

Version 3 of the criteria introduced a separability requirement following recommendations from consultation bodies. The purpose of the requirement is to facilitate the recycling of, above all, non-renewable materials. Another purpose is to facilitate replacement and refurbishment/repair, such as the replacement of a glazing unit during the lifetime of the window. The requirement is judged still to be relevant and reasonable, and it is proposed that it should remain in place, albeit re-worded for greater clarity.

5.6 Chemical requirements

The chemical requirements apply to chemical products, for example unhardened paints, lacquers, glues, putty, fillers and sealants used by the manufacturer of the Nordic Swan Ecolabelled products and their suppliers of parts for Nordic Swan Ecolabelled products.

Please note that the requirement on nanoparticles applies to both chemical products and the glass in windows and doors.

The requirements do not apply to touch-up paint or other patching products used by the manufacturer or their supplier if a small amount of damage occurs to the surface layer during manufacture, storage, transport or installation.

Filler gas and insulation material are not covered by the requirements in this section. They are instead covered by the requirements in the earlier section "Material requirements".

If nothing else is stated, the term constituent substance refers to all substances in the product, including additives in the raw materials (such as preservatives and stabilisers) but does not include impurities from production including primary production.

Impurity refers to residues from production including primary production which may be found in the finished product at concentrations below 100 ppm (0.0100% by weight, 100 mg/kg), but not substances that have been added to a raw material or the product actively and for a particular purpose, irrespective of quantity.

Impurities of over 1.0% 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.

For two component products it is the ingredients in the separate components that shall comply with the requirement. Alternatively; the requirement can be applied to the finished product if it can be documented that; mixing of two component products and application of the mixed solution take place in specific areas and with methods and systems protecting from exposure.

O14 Classification of chemical products

Chemical products used to manufacture Nordic Swan Ecolabelled windows or exterior doors must not be classified pursuant to the table below. The product must be classified in line with current legislation (CLP Regulation (EC) No 1272/2008 or the EU's Dangerous Preparations Directive 1999/45/EC as amended in 2008 or later).

Note that classification under the Dangerous Preparations Directive may only be used until 31 May 2015.

Classification under CLP Regulation 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 Chronic 1-2	H400, H410, H411*	N with R50, R50/53, R51/53
Hazardous to the ozone layer	H420	R59
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 (Repr 1 or Repr 2), Xn with R62, R63, R64, R33 (Repr 3)

** Exception for all impregnation and water-based wood preservation treatment and surface treatment where the classification "Toxic to aquatic organisms' category Chronic 2 H411 and/or N with R51/53" is accepted.*

*** Exception for polyurethane adhesives classified H351 and 373 due to methylene diphenyl diisocyanate (MDI).*

**** Exception for the classification H360D for propiconazole in wood preservatives. If propiconazole is no longer approved for use in wood preservatives in accordance with the Biocides Regulation EU 528/2012, the exemption will no longer apply.*

✉ Safety data sheet pursuant to applicable legislation in the country of application, e.g. Annex II to REACH (regulation 1907/2006/EEC) for all chemical products.

O15 CMR substances

Substances with the following classifications are prohibited from chemical products used in the manufacture of Nordic Swan Ecolabelled windows and exterior doors:

- carcinogenic category 1A/1B (Carc with R45/H350 and/or Carc with R49/H350i)
- mutagenic category 1A/1B (Mut with R46/H340) and/or
- toxic for reproduction category 1A/1B (Rep with R60/H360 and/or Rep with R61/H360)

The total content of substances classified as listed below must not exceed 0.5% by weight in products used to manufacture Nordic Swan Ecolabelled windows or exterior doors:

- carcinogenic category 2 (Carc with R40/H351)
- mutagenic category 2 (Mut with R68/H341) and/or
- toxic for reproduction category 2 (Rep with R62/H361 and/or Rep with R63/H361)

Exceptions are made for levels of dibutyltin (DBT) compounds and dioctyltin compounds (DOT) in the following three product types where the limit values* below are accepted:

- 0.5% in SMP polymers such as MS polymers
- 0.2% in silicon products and PUR polymers containing silanes instead of isocyanates
- 0.03% in PUR polymers with isocyanates

Exceptions are also made for polyurethane adhesives containing methylene diphenyl diisocyanate (MDI) classified Carc 2 H351 and H373 classified STOT - repeated exposure Cat. 2.

Exceptions are also made for adhesive products containing formaldehyde, but the amount of free formaldehyde may not exceed 0.2% by weight (2000 ppm).

Exception for the classification H360D for propiconazole in wood preservatives. If propiconazole is no longer approved for use in wood preservatives in accordance with the Biocides Regulation EU 528/2012, the exemption will no longer apply.

Exceptions are made for titanium dioxide (TiO_2) classified Carc 2 H351 and 1,1,1-Trimethylolpropane (TMP, CAS nr: 77-99-6) classified Rep 2 H361.

If nothing else is stated, the term constituent substance refers to all substances in the product, including additives in the raw materials (such as preservatives and stabilisers) but does not include impurities from production including primary production.

Impurity refers to residues from production including primary production which may be found in the finished product at concentrations below 100 ppm (0.0100% by weight, 100 mg/kg), but not substances that have been added to a raw material or the product actively and for a particular purpose, irrespective of quantity.

Impurities of over 1.0% 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.

For two component products it is the ingredients in the separate components that shall comply with the requirement. Alternatively; the requirement can be applied to the finished product if it can be documented that; mixing of two component products and application of the mixed solution take place in specific areas and with methods and systems protecting from exposure.

**TBT and TPT are prohibited.*

✉ Safety data sheet pursuant to applicable legislation in the country of application, e.g. Annex II to REACH (regulation 1907/2006/EEC) for all chemical products and Appendix 6, duly completed and signed by the chemical's manufacturer.

O16 Other substances excluded from use

The following substances are prohibited from chemical products used in the manufacture of Nordic Swan Ecolabelled windows and exterior doors:

- Substances on the Candidate List*.
- Persistent, bioaccumulative and toxic (PBT) organic substances**.
- Very persistent and very bioaccumulative (vPvB) organic substances**.
- 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/pdf/final_report_2007.pdf (Annex L, page 238 onwards)
- APEO – alkylphenol ethoxylates and alkylphenol derivatives (substances that release alkylphenols on degradation).
- Halogenated organic substances***
- Phthalates, with the exception of sealants

Sealants may not contain the following phthalates:

- Di-2-ethylhexyl phthalate (DEHP, DOP)

- Dibutyl phthalate (DBP/DnBP)
- Butyl benzyl phthalate (BBP)
- Palatinol (711P)
- Diisobutyl phthalate (DIBP)
- Bis(2-methoxyethyl) phthalate (DMEP)
- Diisodecyl phthalate (DIDP)
- Diisononyl phthalate (DINP)****

Ingoing substances are defined as, unless stated otherwise, all substances in the product – including additives (e.g. preservatives or stabilisers) in the raw materials, but not residuals from the production, incl. the production of raw materials.

Residuals from production, incl. production of raw materials are defined as residuals, pollutants and contaminants derived from the production, incl. production of the raw materials, which are present in the final product in amounts less than 100 ppm (0.0100 w/w %, 100 mg/kg), but not substances added to the raw materials or product intentionally and with a purpose – regardless of amount. Residuals in the raw materials above 1.0 % are regarded as ingoing substances. Known substances released from ingoing substances are also regarded as ingoing substances.

Impurities of over 1.0% 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.

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

Excluded are D4 (octamethylcyclotetrasiloxane, CAS No. 556-67-2), D5 (Dekamethylcyclopentasiloxane, CAS No. 541-02-6) and D6 (Dodecamethylcyclohexasiloxane, CAS No. 540-97-6) as residual amount from silicone polymer production ≤ 1,000 ppm each.

** *PBT and vPvB substances are defined in Annex XIII of REACH (Regulation (EC) No 1907/2006). Substances that meet, or substances that form substances that meet, the PBT or vPvB criteria are listed at http://esis.jrc.ec.europa.eu/index.php?PGM=pbt. Substances that are "deferred" or substances "under evaluation" are not considered to have PBT or vPvB properties.*

*** *Halogenated organic paint pigments that meet the EU's requirements concerning colourants in food packaging under point 2.5 of Resolution AP (89) are exempted. Non- bioaccumulative biocides and preservatives according to CLP are excluded from the prohibition. For definition of bioaccumulation, see appendix 6.*

**** *DINP is, however, permitted in polyurethane filler/sealant.*

☒ Appendix 6, duly completed and signed by the chemicals manufacturer.

Background to the chemical requirements

The MECO analysis, see Appendix 2, shows that the main chemical products used to manufacture windows and doors are: paint, lacquer, glue, sealants, fillers and putty. Thus, it is these chemical products that chemicals requirements are relevant for. In order to improve clarity, this is spelled out initially under the criteria heading "Chemical requirements".

To further clarify the matter, it is also stated that special requirements for filler gas and materials are included in the section "Material requirements".

Licence application processing has identified a need to clarify the application of the chemical requirements in connection with subcontracting, e.g. of insulating glass units.

A section stating that suppliers are also covered by the chemical requirements for the chemical products listed has therefore been added to the chemical requirements.

Licence application processing has also identified a need to make products used to repair and improve the manufacture of the Nordic Swan Ecolabelled products exempt from requirements. These products include putty and touch-up paint used in very small

volumes compared to the chemical products used for standard production. We are thus not talking about repairs to old windows or doors, but to minor damage that may occur in connection with production and that is rectified before the product is given "final approval" for warehousing and sale. This section is added to the introduction to the chemicals section.

Isosyanates has gained a new harmonized classification according to the CLP-regulation and the compound is now classified "Suspected of causing cancer H351". Isosyanates can be part of special adhesives for example polyurethane adhesive which contains isocyanates to make the product expand with good sealing properties in a joining.

The Nordic Swan Ecolabel ensures that methods and systems protecting the work environment are used to minimize the risk of exposure. Thus, the requirement on classification of the chemical product (O14) and the requirement on CMR-substances (O15) have been adjusted. In O14 and O15 an exemption is introduced that make it possible to use polyurethane adhesives containing the least harmful isocyanate compound: methylene diphenyl diisocyanate (MDI). It has been found that polyurethane adhesives can also have the classification H373, STOT - repeated exposure Cat. 2. An exemption has therefore been extended with the classification H373 for polyurethane adhesives. In the thirteenth technical adaptation of the CLP Regulation (ATP13), propiconazole (CAS number 60207-90-1) has been changed classification. Propiconazole was previously classified as H302, H317, H400 and H410 and, according to ATP13, has been reclassified to also receive the CMR classification H360D (reproductive toxic category 1B). The reclassification will be binding as of May 1, 2020. Propiconazole is a biocide found in many wood preservatives on the market, including those used in the manufacture of windows. Substitution work is a time-consuming process to find an alternative that meets the desired quality and function; therefore, this time-limited exception is introduced. Propiconazole had a time-limited exemption until 31.10.2021. Contact with the industry has shown that attempts have been made to find substitutes for propiconazole, but this has not been successful. The substance has also received extended approval from the authorities. Through the Commission Implementing Decision (EU) 2021/354, the authorization of propiconazole for use in biocidal products in product type 8 was extended until 31 December 2022. Due to the classification as reproductive in category 1B, propiconazole meets the exclusion criteria in the Biocides Regulation. Therefore, a closer examination must be made to determine whether the conditions of Article 5 (2) of the Biocides Regulation are met so that propiconazole can still be approved. The reason for the extension is that the assessment is extensive and will not be completed within the original deadline. If, after completion of the assessment, the authorities no longer approve the use of the substance in wood preservatives, the exemption do no longer apply, and it cannot be used in Nordic Swan Ecolabelled windows and exterior doors.

Classification of chemical products

The production of windows and exterior doors involves a number of different chemical products such as glues, sealants, impregnation liquids and products for priming and surface treatment. These products may, to varying degrees, contain substances that are classified as harmful to health and/or the environment. The most serious danger to health is posed by highly toxic substances and substances that have long-term effects, such as carcinogenic, mutagenic or reprotoxic substances. Other serious risks are posed by substances that cause allergic reactions. When it comes to environmental risks, the focus is on substances that are both highly toxic and at the same time non-readily degradable or bioaccumulative. Hazard categories and designations pursuant to the CLP

Regulation 127/2008/EC have been added to requirements O14 and O15. The classification "Harmful to health – acute toxicity if swallowed category 4" has been deleted as it is not considered relevant.

Version 3 of the criteria contained an exemption that was relevant for the biocides used in wood preservation/impregnation. This exemption remains, but it has been made clear that it applies to all wood preservation – vacuum impregnation with solvent, supercritical impregnation with carbon dioxide, water-based wood preservation and subsequent surface treatment steps, i.e. painting and/or lacquering.

We have chosen only to spell out the general classifications. This means, in accordance with the classification rules, that all following letters and letter combinations indicating specific risks to health and/or the environment are included. Example for clarification: Toxic for reproduction Rep 1A/1B/2 with H360 includes H360F, H360D, H360f, H360d, H360FD, H360Fd and H360Df.

Handling of chemical products
The requirement for a description of the handling of classified chemical products was deleted in its entirety following the consultation, since we see no great risks from production in the Nordic region or from the rest of the EU.

It is, however, relevant to check compliance with chemical handling through on-site inspections of the licensee from an environmental, safety and working environment standpoint. The case officer at the Nordic Ecolabelling organization concerned always conducts an inspection visit to a new licence applicant. Requirement O28 Laws and regulations has an additional requirement for:

Certification of compliance with safety regulations, working environment legislation, environmental legislation and site-specific conditions/concessions.

Contact information for the relevant regulatory authority.

CMR substances
Hazard classes and designations pursuant to the CLP regulation have been added to requirement O15. No changes have been made to the requirement limits. The exemption concerning content of organotin compounds in sealants is considered to remain relevant. There are no alternatives to the sealants required for these technical applications.

When formaldehyde was reclassified to carcinogenic B1 (H350), no adjustment was made to the requirement in this product group, however in others such as floors, building and facade panels, as well as furniture and furnishings. This is a harmonization of the requirement with other product groups.

On 15 September 2020, Nordic Ecolabelling decided to make an exception for titanium dioxide classified Carc 2 H351 and 1,1,1-trimethylolpropane (TMP). TiO_2 was recently classified in the EU as a carcinogen by inhalation, category 2. The classification is for TiO_2 as a powder. TiO_2 is widely used as a pigment in chemicals for surface treatment and as a pigment in e.g. plastic, and currently there are no good substitutes. TMP is also widely used as a coating for titanium dioxide to increase the spreadability of titanium dioxide particles. There is no exposure risk for the consumer, and as these chemicals are produced and handled in industrial production facilities, exposure risk is also low here.

Other substances excluded from use
Requirement O16, which is a list of undesirable substances, has been reviewed to make sure it is as clear as possible and to avoid differing interpretations. Following the consultation, the requirement has also been harmonised with equivalent requirements in version 2 of the Criteria for Chemical Building Products. Below is a brief outline of the 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 only 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.

Nordic Ecolabel decided, 25 February 2020, to exclude siloxanes D4, D5 and D6 who are present as impurities in silicone products/raw materials. From June 2018, these siloxanes have been given a new classification based on the properties of PBT and vPvB. They have therefore ended up on the candidate list. They have previously not had this classification and the limit value is based on customer contacts. An assessment is that there is a development towards a lower concentration of D4, D5 and D6. Nordic Ecolabelling will monitor this development.

"Persistent, bioaccumulative and toxic (PBT) organic substances" and "Very persistent and very bioaccumulative (vPvB) organic substances" are substances whose inherent properties are not desirable in Nordic Swan Ecolabelled chemical building products. PBT and vPvB are defined in Annex XIII of REACH (Regulation (EC) No 1907/2006). 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[60]. Nordic Ecolabelling bans the use of substances that are 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[61], 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[62],[63],[64]: 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 Swan Ecolabelled windows and exterior doors.

An adjustment was made 10 December 2014. The cause was that the requirement excluded the use of certain important biocides and preservatives in wood preservation which was not the intention. These substances (Propiconazole, Tebuconazole and IPBC among others) must be used to achieve the required resistance to degradation. Thus, an exemption is introduced for non- bioaccumulative biocides and preservatives.

Phthalates. Many phthalates have negative effects on health and the environment. Some phthalates are inscribed on the EU's priority list of substances that should be investigated more closely for endocrine disruption – and some have already been identified as

[60] Miljøstatus i Norge, 2008:
[61] 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.pdf
http://ec.europa.eu/environment/docum/pdf/bkh_main.pdf
[62] Substitution af alkylphenolethoxylater (APE) i maling, træbeskyttelse, lime og fugemasser, Working report from the Danish Environmental Protection Agency, No. 46/2003.
[63] Nonylphenol og nonylphenolethoxylater i spildevand og slam, Miljøprojekt nr. 704/2002.
[64] Feminisation of fish, Environmental Project no. 729, Danish Environmental Protection Agency, 2002.

endocrine disruptors. Phthalates have also received a great deal of coverage in the media and are therefore undesirable in ecolabelled products for many reasons.

Di-2-ethylhexyl phthalate (DEHP[65]), dibutyl phthalate (DBP) and butyl benzyl phthalate (BBP) are classed as toxic and as reproductive toxicants, i.e. they may cause reduced fertility and foetal damage. DBP is also classed as toxic to the environment and as highly toxic to aquatic organisms. The EU has introduced restrictions on these three phthalates and a total ban on them in toys and childcare products.

The phthalates dicyclohexyl phthalate (DCHP), dihexyl phthalate (DHP) and diethyl phthalate (DEP) are found on the EU's priority list of endocrine disruptors.

The phthalates diisobutyl phthalate (DIBP), diisoheptyl phthalate (DIHP), bis(2-methoxyethyl) phthalate, diisopentyl phthalate and n-pentyl-isopentyl phthalate are included on the EU's Candidate List of Substances of Very High Concern.

Some phthalates can be found on the Danish "Listen over Uønskede Stoffer" (List of undesirable substances). These include: di-2-ethylhexyl phthalate (DEHP), dibutyl phthalate (DBP), butyl benzyl phthalate (BBP) and dimethoxyethyl phthalate (DMEP). The Danish list used to also include diisobutyl phthalate (DINP). This has now been removed, since it is not classified as toxic to reproduction, although suspicions remain that it may be an endocrine disruptor.

The basic requirement in version 3 of the criteria involved a ban on phthalates. For sealants, a number of phthalates were listed as being excluded from use, while other phthalates were permitted. Our role as a voluntary ecolabelling system is to go further than the legislation in order to drive the development of environmentally aware products and not to simply limit undesirable phthalates to those included on the Candidate List. The requirement concerning phthalates remains unchanged from version 3 of the criteria.

On the decision of the Nordic Ecolabelling Board, an exemption was introduced for the phthalate DINP in sealants based on polyurethane that are used in the manufacture of Nordic Swan Ecolabelled windows. There is no exemption for other sealants. The background to this is that just before the date of the decision (19 March 2014), Nordic Ecolabelling was made aware (by suppliers to Swedish window manufacturers) that DINP "is widely used in sealants such as polysulphide and polyurethane. To our knowledge still the majority (if not all) of polysulphides and polyurethanes contain DINP as a plasticiser.

The market share of polysulphide is now continuously decreasing all over Europe including Scandinavia. Mercury-free polyurethane is a potential and less toxic alternative to polysulphides."

Contact with manufacturers has confirmed that polyurethane sealants are necessary in the manufacture of the insulating glass units to achieve flexibility, durability and impermeability. It is unlikely that polyurethane sealants are also used in other parts of the window, but it cannot be entirely ruled out. As the manufacturer describes it, polyurethane sealants are a good environmental alternative to polysulphide sealants, and

[65] Di-2-ethylhexyl phthalate is usually abbreviated to DEHP, but the abbreviation DOP is also used.

we judge that it is sufficient to introduce a general exemption for DINP in polyurethane sealants. The requirement already stipulates that the sealant must be mercury free.

The explanatory texts for requirements O14 and O16 have been updated and made clearer in order to comply with Nordic Ecolabelling's internal guidelines.

O17 Nanoparticles

Nanoparticles (from nanomaterial*) must not occur in the chemical products used in the manufacture of Nordic Swan Ecolabelled windows and exterior doors. An exception is made for:

- Pigments**
- Naturally occurring inorganic fillers***
- Synthetic amorphous silica and calcium carbonate ****
- Polymer dispersions
- Aluminium oxide

Nano particles (from nano materials*) may not be actively added to the glass/the window's/door's glass surface*****.

* *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 and calcium carbonate (CaCO3) with or without chemical modification. 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 O14 (Classification of constituent chemical substances) and O16 (Other substances excluded from use).*

***** *It is possible to make exceptions during the lifespan of the criteria, for details please see text in Background document under the corresponding requirement.*

✉ The manufacturer must declare any nanomaterials that occur in the product, see Appendix 7a and 7b.

✉ Declaration in Appendix 7a and 7b, duly completed and signed by the chemical manufacturer and manufacturer of glass respectively.

Background to the nanoparticles requirement

There remains a great deal of uncertainty about how nanoparticles affect human health and the environment[66]. 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 chemical building products follows the European Commission's definition of nanoparticles[67]: "A nanomaterial is a natural, incidental or purposely manufactured material containing particles, in an unbound state or as an

[66] European Council, Recommendation 2017 (2013), Provisional version, Nanotechnology: balancing benefits and risks to public health and the environment. Available at the address: http://assembly.coe.int/ASP/Doc/XrefViewPDF.asp?FileID=19730&Language=EN (21.05.13)
[67] COMMISSION RECOMMENDATION of 18 October 2011 on the definition of nanomaterial (2011/696/EU).

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."

A summary has also been given of Nordic Ecolabelling's assessment of nanomaterials in chemical building products and in windows. Nordic Ecolabelling can be contacted for more detailed information on specific nanoparticles.

It has proven extremely challenging to set requirements concerning the content of nanoparticles. A range of different ingredients go into chemical building products and it is difficult to maintain an overview of all the different constituent components and their size. Many of the traditional ingredients in chemical building products contain particles of nano size and are considered as nanomaterials under the European Commission's recommended definition. There are also examples of traditional ingredients with a fraction of nanoparticles being produced with an even greater level of ultrafine particles than before, and of the particles in many cases also having a surface treatment.

It is possible to differentiate between traditional and new nanomaterials. The traditional nanomaterials are widely used in chemical building products and include carbon black (furnace black, lamp black) and amorphous silica (SiO_2). The new nanomaterials include nano-titanium dioxide, nano-zinc oxide, fullerenes and nanosilver[68]. The new nanomaterials are used to give the products new properties depending on particle size. The particles are increasingly being surface treated to prevent them agglomerating when added to a product. These are the findings in the 2010 report "Nanoteknologiske overflader og nye kvalifikationskrav" (Nanotechnological surfaces and new qualification requirements) by the Danish Technological Institute[69]. According to the report, it is necessary to modify the surface of nanoparticles, in order to stabilise and disperse the particles in water, polymers or some other solution. The stabilisation and dispersal of nanoparticles is achieved using various chemical modifiers (particle coatings), which span a broad spectrum from hydrocarbons and alkoxysilanes to phosphates, sulphonates and quaternary ammonium compounds.

Exposure to nanoparticles

There have been several risk assessments of nanoparticles in paints, lacquers and sealants, including through NANOKEM and NanoHouse. "NANOKEM - Nanopartikler i farve- og lakindustrien. Eksponering og toksiske egenskaber" (Nanoparticles in the paints and varnishes industry. Exposure and toxicity) is a Danish project financed by the Working Environment Research Fund[70]. The timeframe for the project was 2007-2011, but articles were also published through this project in 2013. The main focus of the project was on the release of nanoparticles and their health effects when sanding paints and lacquers. The NanoHouse collaborative project is funded by the European Commission through the Framework Programme 7 "Activities towards the development of appropriate solutions for the use, recycling and/or final treatment of nanotechnology-based products"[71]. The project began in January 2010 and has now been completed (January 2014). This project looked at the release of nanoparticles due to mechanical wear and weathering.

[68] 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.
[69] H. V. Kristensen et al, Nanoteknologiske overflader og nye kvalifikationskrav, Danish Technological Institute, 2010.
[70] Website for the NANOKEM project: http://www.arbejdsmiljoforskning.dk/da/projekter/nanopartikler-i-farve-og-lakindustrien---nanokem (06.01.14).
[71] Website for the NanoHouse project: http://www-nanohouse.cea.fr/scripts/home/publigen/content/templates/show.asp?P=55&L=EN&ITEMID=2 (06.01.14).

Both the NANOKEM and the NanoHouse projects show that wear on paint does not lead to the release of free nanoparticles, with the nanoparticles instead remaining locked into the released paint particles.

Another study of nano-TiO_2 as a coating on windows has shown that the photocatalytic effect is reduced and that TiO_2 is released from the surface into the environment when subjected to ageing tests (water, salt, UV light)[72]. It is, however, not entirely clear whether it is nano-TiO_2 that is released or larger TiO_2 particles. The research also shows that the photocatalytic effect is reduced during ageing, although no reason is given to explain this. A European Commission report from 2012 states that there is an ongoing debate on whether leaching from outdoor paints and/or the waste phase can lead to a significant quantity of nanoparticles.

Pigment
In this context, paint pigments are considered to be pigments produced as a more or less finely ground powder, where the powder particles comprise individual crystals up to aggregates of multiple crystals[73]. In paint it is generally more effective to use pigments with smaller particles than larger ones to achieve the same colour.

Inorganic pigments used in the paint industry that may occur in nano size include carbon black, iron oxides and titanium dioxide[74]. The carbon black used in paint is very finely ground and has a particle size of around 10-30 nm[75]. Iron oxide pigment may entirely comprise particles of nano size, or only a fraction of the particles may be nano.

A discussion with Kronos International[76], a producer of titanium dioxide (TiO_2), established that none of their regular grade TiO_2 counts as a nanomaterial under the EU's definition of nanomaterials (where at least 50% of the particles must be of nano size for it to be deemed a nanomaterial). According to Kronos, around 25% of the particles in their regular grades are less than 100 nm.

Nano-titanium dioxide is not considered a pigment, but a new nanomaterial that is added to give the products new properties, such as a self-cleaning effect in paints. These are not exempted from the requirement and therefore must not be used in Nordic Swan Ecolabelled chemical building products.

There are many organic pigments that may comprise or contain fractions of nano-particles. Examples of such pigments are pigment yellow 1, 13 and 83, pigment orange 5 and 34 and pigment red 3.[77]

Pigments are exempted from the requirements concerning nanoparticles, since they are necessary in chemical building products and no other suitable replacement is available to fulfil their function.

Amorphous silica (SiO_2) and Calcium carbonate (CaCO3)
As mentioned above, synthetic amorphous silica is considered a traditional ingredient in chemical building products. Since amorphous silica is a nanomaterial, under the

[72] J. Olabarrieta et al, Aging of photocatalytic coatings under a water flow: Long run performance and TiO_2 nanoparticles release, Applied Catalysis B: Environmental, Volumes 123–124, 23 July 2012.
[73] Coatings Handbook; Thomas Brock, Michael Groteklaes, Peter Mischke; 2000.
[74] Industrial Organic Pigments; W. Herbst, K. Hunger; Third edition 2004; pp 120-124.
[75] Coatings Handbook; Thomas Brock, Michael Groteklaes, Peter Mischke; 2000; p 128.
[76] Email correspondence with the SHE Director at Kronos International, INC, 12.11.12.
[77] W. Herbst, K. Hunger, Industrial Organic Pigments, Third edition 2004.

European Commission definition, synthetic amorphous silica is exempted from the requirement concerning nanomaterials.

Surface-modified colloidal silica is permitted in chemical building products.

Exceptions for calcium carbonate introduced to harmonize the requirement with other product groups. Calcium carbonate is found, for example, in sealants used in window manufacture.

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[78].

Article 2(7)(b) of the REACH Regulation (1907/2006/EC[79]) states that

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):

7. 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.

Inorganic fillers are exempted from the requirement as long as they are covered by Annex V, point 7 of REACH.

Polymer dispersions are also exempted from the requirement. The European Commission's report[80] to accompany the second Regulatory Review on Nanomaterials from 2012[81] states that solid nanomaterials in the dispersant in a liquid phase (colloid) are to be considered nanomaterials in accordance with the European Commission's

[78] Link to the Danish Environmental Protection Agency hearing: http://hoeringsportalen.dk/Hearing/Details/16910 (visited 20.01.14)
[79] Link to REACH: http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l_396/l_39620061230en00010849.pdf
[80] 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
[81] 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

recommendation. Nanoemulsions are not, however, covered by the definition. Polymers/monomers may occur in different phases and sizes, and the choice has therefore been made to explicitly state that polymers are exempted from the definition in chemical building products.

A requirement for information on the nanomaterials found in products has been introduced in order to gain more knowledge about what nanoparticles occur.

Nanoparticles on the glass in windows and doors
The surface of windows and doors, and glass in particular, can be coated with nano-titanium dioxide (TiO_2). TiO_2 is naturally found in three mineral forms: anatase, rutile and brookite. Anatase and rutile are the most common forms. Nano-TiO_2 in rutile form absorbs UV light and is also used in products to scratch-proof them and provide optical effects (anti-reflection, etc.). Nano-TiO_2 in anatase form is used for its photocatalytic properties. This means that in the presence of light, nano-TiO_2 can catalyse degradation or otherwise react with unwanted chemicals or microorganisms. It can thus be used to give window glass self-cleaning properties in order to save resources such as water, chemicals and labour that would otherwise be used to clean windows. Window glass coated with nano-TiO_2 is currently available on the market.

An extensive review article by the US Environmental Protection Agency (EPA)[82] on how nano-TiO_2 affects human health and the environment indicates that there are significant variations in the test results depending on the concentration, test conditions and the material's physical properties (surface area and mineral form). In other words, there remains significant uncertainty with regard to how nano-TiO_2 affects human health and the environment. The report by the EPA indicates that exposure to nano-TiO_2 may arise from coated surfaces when these are subjected to wear. However, few studies have been carried out on this topic. A study examining the use of nano-TiO_2 as a coating agent for window glass shows that the substance reduces the photocatalytic effect and that TiO_2 is released from the surface when it is subjected to ageing tests (water, salt, UV light)[83]. It is not clear whether the TiO_2 is released in the form of nanoparticles or larger particles.

We currently lack knowledge of how nano-TiO_2 affects human health and the environment and how the environment is exposed to nano-TiO_2 when the substance is used to coat various surfaces. Based on the precautionary principle, Nordic Ecolabelling wishes to adopt a restrictive approach to the use of nano-TiO_2 as a window coating agent but will reassess this in connection with the next revision.

For more background information on nanoparticles and what the requirement covers, see the background document for the product group Chemical Building Products, 2013, and the documentation that informed the chemical building products revision.

Following the consultation, the nano requirements were amended and merged into a single requirement (O17) that comprises two parts. The first point governs the occurrence of nanomaterial in chemical building products. The wording of the requirement and its scope/exemptions have been harmonised with the corresponding requirements in version 2 of the Criteria for Chemical Building Products.

[82] EPA (Environmental Protection Agency), State of the Science Literature Review: Nano Titanium Dioxide Environmental Matters;
[83] J. Olabarrieta et al, Aging of photocatalytic coatings under a water flow: Long run performance and TiO_2 nanoparticles release, Applied Catalysis B: Environmental, Volumes 123–124, 23 July 2012

The second point sets out a ban on the use of nanocoating on glass in Nordic Swan Ecolabelled windows/exterior doors. Nordic Ecolabelling has noted, through its general monitoring of the field and responses to the consultation, that there is intensive development work focusing on the use of nanotechnology on windows. Examples of the function and positive effects of nanotechnology include self-cleaning, noise damping and sun screening, with resulting energy savings. Many of these techniques/applications remain in the development stage and have not been introduced into the regular production of windows. It has therefore not been possible at this point in time, as part of this revision, for Nordic Ecolabelling to assess which of these development projects will make it to market and what their environmental consequences may be.

Nordic Ecolabelling does not wish to inhibit window development and innovation but would like to see that development proceed in a sustainable way. Nordic Ecolabelling is therefore open to making changes/introducing exemptions to the general ban on nanoparticles in glass, if we receive specific documentation that nanotechnology/nanomaterial can contribute to an improved environmental and/or health profile for a Nordic Swan Ecolabelled window.

Nordic Ecolabelling may request further information about the nanoparticles and their function on a case-by-case basis, in order to make a decision on the requested change. A change to/exemption from the general ban on nanoparticles in windows must be decided by the Nordic Ecolabelling Board. In order for such a change to be assessed, the licence applicant must submit the relevant information on the use of nanoparticles in or on the glass – what form of nanoparticles are used and in what quantities, where in or on the glass would they be used and what documented improvements to the function of the window do these nanoparticles bring? The submitted documentation must also include a risk assessment concerning human and environmental exposure to the nanoparticles used.

Aluminium oxide is added to the powder coating as an "anti-lump" agent and as a fluidizing agent to improve the function of the electrostatic powder coating and thereby facilitate application. The aluminium oxide can be nanostructured as it is required for the function that the alumina has a small particle size.

O18 Solvents for impregnation and surface treatment

Pressure impregnation is not permitted.

Emissions of volatile organic compounds (VOCs) from vacuum impregnation may be a maximum of 9 kg/m^3 treated wood.

Emissions from surface treatment may be max 60 mg TOC/Nm^3.

Volatile organic compounds (VOCs) are compounds that at 293.15°K have a vapour pressure of at least 0.01kPa or that have an equivalent volatility under specific conditions of use. Appendix 1 describes the requirements of the test body used for VOC classification.

The requirement must be met regardless of whether the wood preservation treatment is performed by the manufacturer or by a supplier.

Nordic Swan Ecolabelled sustainable wood already meets this requirement as no solvents are used.

✉ Calculation of the solvent balance or measurement of the emissions using the methods described in EU Directive 2010/75/EU.

Background to the wood preservation requirements

Solvents for impregnation and surface treatment

Wood can be damaged by bacteria, fungi, insects or other bugs. These organisms can

cause rot, discolouration or mechanical damage. Impregnation or surface treatment using wood preservation products can help protect against these attacks. Wood treated with wood preservation products is used when it is not possible to protect the wood from damp and guarantee its durability using construction technology. Examples include window and exterior door joinery.

The impregnation methods are pressure impregnation and vacuum impregnation. Pressure impregnation is now often water-based with the use of various salts (copper, chromium, etc.). Pressure impregnation is not allowed for Nordic Swan Ecolabelled windows and exterior doors and is therefore not described further in this document[84].

Vacuum impregnation is only used to impregnate finished construction joinery such as windows, doors and garden furniture. The process is less deep and saturating than pressure impregnating but is still considered adequate for the purpose. Vacuum impregnation is normally performed using organic solvents[85]. The product used often consists of 90% organic solvent, usually turpentine, and 10% active substance/fungicide. The most common fungicides are Propikonazol and/or Tebukonazol, see Table 16 in Appendix 5. Vacuum impregnation using organic solvents results in emissions of volatile organic compounds to air. These VOCs are primarily a mixture of aliphatic (as opposed to aromatic) hydrocarbons and contribute to the formation of low-level ozone, a substance that is harmful to health and the environment. The use of VOCs also involves working environment risks. There are ways of reducing the VOC emissions to air. Mainly, this involves using products with a lower solvent volume. One end-of-pipe measure that could be applied is the treatment of emissions through combustion, adsorption or recycling. The BAT/BREF report for Surface Treatment Using Organic Solvents[86] in the EU indicates that up to a 70% reduction in emissions is possible. This should not be taken to mean that pressure impregnation using turpentine is the BAT for window production. As the title of the report indicates, the BAT report relates to surface treatment using organic solvents in general. Unfortunately, the planned BAT report for Wood and Wood Products Preservation has not been started yet. It is scheduled to begin in 2014.

Version 3 of the criteria allows impregnation using organic solvents provided that the limit value for emissions of volatile organic compounds (VOCs) of max. 11 kg VOC/m^3 is not exceeded. The limit value of maximum 75 mg C/Nm^3 for emissions from surface treatment must also be met. The requirement level equates to the level set out in Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control)[87]. However, the requirement has a broader area of application, since the requirement must be fulfilled by everyone who uses solvent-based technology and not just the larger plants that fall under the scope of the EU Directive, see table below.

[84] It is neither relevant nor necessary to use pressure impregnated wood in windows and exterior doors covered by use class 3 in standard EN 335-1.
[85] Impregnation can also be performed using carbon dioxide as the carrier in a so-called supercritical impregnation process. Hampen Træforarbejdning A/S on Jutland, Denmark, has one of the world's first large-scale plants for impregnating spruce wood using supercritical carbon dioxide, so called Superimpregnation/Superwood. This technique impregnates the wood but produces no VOC emissions, since no organic solvents are used.
[86] BREF 2007; Joint Research Centre, IPTS, The European IPPC Bureau.
[87] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) brings together IPPC Directive (2008/1/EC) and six other directives into a single directive on industrial emissions (to air). It includes certain plants and operations that use organic solvents for wood impregnation, for example.

Table 8: Emission values as set out in the Directive on industrial emissions (2010/75/EU)

Threshold value for solvent consumption (tonnes/year)	Limit value for emissions in exhaust gases (mg C/Nm^3)	Limit value for volatile emissions (applies to new and existing plants) (in % of added solvent)	Total limit values for emissions (kg VOC/m^3 of wood treated)
> 25	100	45	11

One way of avoiding the problem of VOC emissions and the treatment of these altogether is to move to entirely water-based techniques or to use vacuum impregnation with carriers other than organic solvents, for example supercritical carbon dioxide. The water-based 2ØKO system has become very popular in, for example, Denmark where 90-95% of the industry has switched to this technology. 2ØKO involves the wood being treated using a substance containing fungicide (a primer), normally through dipping or rinsing to give a so-called flowcoat. The wood is then surface treated/painted using approved surface treatment products that also contain fungicide. This method is recommended in combination with a high proportion (approx. 90%) of heartwood. When water-based techniques are used the wood preservation agent does not permeate nearly as deeply into the wood as when impregnation techniques are used. The idea is that the use of heartwood compensates as it has a natural resistance to attack and degradation.

Appendix 5 contains a more in-depth description of the techniques.

The fact that the Nordic countries' views on the need for vacuum impregnation using turpentine in order to ensure durability and long window service lives vary was strongly emphasised at the time of the previous revision. The various national quality certification systems impose different requirements for impregnation and surface treatment, as well as for the proportion of heartwood used. The 2011 evaluation again highlighted the differing views of the different Nordic countries when it comes to wood preservation methods.

Table 9: National certification systems for wood preservation and surface treatment

Quality system	**Requirements for wood preservation treatment**	**Requirements for surface treatment**
Dansk Vindues Verifikation (DVV). Technical stipulations for DVV 7, edition rev 3-2012	For sapwood/coniferous trees one of the following three alternatives must be met: Alternative 1: Priming using turpentine (vacuum impregnation) or supercritical CO2 impregnation. At least 6 mm lateral penetration into the sapwood. Alternative 2: Priming using turpentine (vacuum impregnation) or supercritical CO2 impregnation. At least 3 mm lateral penetration into the sapwood. In both cases, the impregnation substance needs to meet the requirements pursuant to risk class 3 in EN 599-1. Alternative 3 (2ØKO): Primer treatment using a product containing fungicide in combination with at least 90% heartwood.	For sapwood/coniferous wood: If priming system 1 or 2 have been used, the surface treatment must meet the requirements of EN 927-1 and the lacquer thickness must be: min. 60 µm (alternative 1) or min. 80 µm (alternative 2) If the 2ØKO priming system has been used, the surface treatment must also meet the requirements of EN 927-1, classification Stable and the lacquer thickness must be at least 80 µm. In addition, there are a range of specific requirements in the appendix to the technical stipulations. For heartwood/hardwood: A priming treatment (transparent or opaque) using a wood preservation product that meets risk class 2 pursuant to EN 599 -1. Followed by surface treatment

Quality system	Requirements for wood preservation treatment	Requirements for surface treatment
		pursuant to the requirements outlined in EN 927-1.
Norsk Dør och Vinduskontrol (NDVK). Rules as of May 2012	NDVK allows the use of 2ØKO provided that 90% heartwood is used from the internal hinged edge to the external edge of the window. NDVK also accepts flowcoat without the use of heartwood, provided that the manufacturer primes using a fungicide and performs a subsequent two-step surface treatment.	Where windows are to be delivered surface treated, all visible surfaces shall be surface treated. No reference to EN standards.
Svensk Fönster & Dörrkontroll (SFDK). Approval rules for wood-based windows, June 2008	No requirement	Where windows are to be delivered surface treated, all visible surfaces shall be surface treated. Standards EN 927-1 and EN 927-2 shall be met. Classification as Semi-stable with a coat thickness of at least 80 µm (dry).
P-labelling of windows made from wood and wood/metal (Sweden). Rules as of February 2010	For surfaces exposed to the elements[88] one of the following three alternatives must be met: Alternative 1: 100% heartwood Alternative 2: Impregnation using wood preservation class B pursuant to NTR. This corresponds to a penetration of 6 mm pursuant to product standard EN 351-1, but with an absorption requirement (kg/m3) pursuant to SP's list of approved wood preservation agents. Alternative 3 - currently a proposal: Impregnation with at least 4 mm (lateral) penetration into the sapwood. All end wood shall be sealed using primer and/or covering paint. Joins at the underside of frames and casements, and glazing bars, shall be sealed by applying sealant to the end wood of the profiles prior to assembly.	All wood shall be surface treated, including end surfaces. At least two coats of covering treatment shall be applied to achieve a min. thickness of 60 µm (dry coat).

As Table 9 shows, there is considerable variation in the views on and use of different impregnation and wood preservation techniques across the Nordic countries. Nordic Ecolabelling continues to accept vacuum impregnation *but* with tighter requirements concerning VOC emissions, so that only those with the best emission treatment technology systems can receive the ecolabel. The arguments for this are:

- Wood preservation and surface treatment without VOC emissions is the most environmentally responsible method for preserving window timber. At the same time, VOC emissions are one environmental factor among many that must be met by Nordic Swan Ecolabelled windows. From a life cycle perspective, the most important issue is the window's energy efficiency. There are currently widely differing views on various impregnation and wood preservation techniques in the Nordic region. The Nordic countries have very different traditions and experiences when it comes to the various techniques. This means

[88] Profiles covered by metal cladding are not considered exposed to the elements.

that if, in this version, Nordic Ecolabelling sets very strict requirements concerning VOC emissions, much of the window industry in the Nordic region, which may have focused on other parameters such as low heat transfer coefficient (U-value), will be excluded from the option of ecolabelling. Nordic Ecolabelling has therefore chosen, in this version of the criteria, to link together the requirements concerning U-value and wood preservation. Wooden windows that use water-based wood preservation (no VOC emissions) have to meet a certain U-value, while wooden windows impregnated with solvent (VOC emissions) have to achieve a better U-value.

- Different views on how the water-based techniques work overtime. Some representatives feel that the potential negative impact on quality is unclear due to shortcomings in the studies performed and a lack of shared, standardised measurement methods. This goes together with the need for a high percentage of heartwood.
- Some manufacturers have encountered difficulties with imposing requirements for a large share of heartwood (difficult, expensive, etc.), while others have had no problems with this.
- Version 3 of the criteria contains limit values that do not correspond to the best technology, meaning that there is scope for lowering the limit values significantly. The result is that only factories that have invested in cleansing of hydrocarbon emissions to air using adsorption or catalytic combustion may be approved for Nordic Swan Ecolabelled windows.

In summary, Nordic Ecolabelling proposes the following limit values:

- Impregnation: A lowering from the current 11 kg/m^3, which was in line with the VOC Directive, to 9 kg/m^3 treated wood.
- The limit value for the subsequent surface treatment (painting) is also lowered. The proposed limit value is 60 mg TOC/Nm^3, which corresponds to a 20% reduction. As we can see, the decrease is not as great as for the impregnation step. At the same time, the most important thing is to lessen emissions from impregnation, as these make up the lion's share of total VOC emissions.
- See also O2 for tightened U-value requirements for windows that use vacuum impregnation with VOC emissions.

The revision makes it clear that the requirement must be met regardless of whether the wood preservation treatment is performed by the manufacturer or whether the wood is procured already treated. This is not entirely clear in today's requirements. It should also be added that in cases where the window manufacturer uses Nordic Swan Ecolabelled sustainable material, these requirements are automatically met and no further documentation is required.

At the Nordic Council of Ministers, the BAT (Best Available Techniques) Group under the Working Group for SCP (Sustainable Consumption and Production) is preparing a report on wood preservation with chemicals to be published late spring 2014. In the drafts for the report the techniques used in window production are not in focus. Though, both VOC-based impregnation and flow-coat technology are mentioned, the BAT

recommendations focus on the production from the wood preserving industry of more voluminous wooden products like garden and construction timber and poles.

5.7 Waste management requirements

O19 Production waste

Window and exterior door manufacturers, as well as manufacturers of insulating glass units, shall separate the waste generated in connection with production. Furthermore, a plan for separating waste must be drawn up, stating waste fractions and describing how the waste is dealt with (e.g. material recovery, incineration or landfill).

Hazardous waste must be treated and dealt with in accordance with the regulations applicable in the country of manufacture.

✉ A waste plan detailing the waste fractions and the recipients of each waste fraction. Declaration of hazardous waste, if applicable, and a statement on how hazardous waste is handled in accordance with the regulations applicable in the country of manufacture.

Background to the waste requirements

Production waste

Enabling waste to be recycled or processed for material recovery or energy recovery relies on good sorting of waste and residual products on site during manufacture. The requirement has been updated and simplified. The purpose of the requirement – to ensure that the manufacturer has a good system for waste management – is met, even though the requirement is now less detailed/micromanaging.

Take-back system for plastic windows and doors

Version 3 of the criteria introduced a requirement for a take-back system for recycling and that licence applicants and their plastic profile suppliers must be members of this system.

The European PVC industry's environmental initiative Vinyl 2010, which is now called VinylPlus, would have established a system for the collection of rigid PVC from windows, and other sources, by December 2007. PVC profile manufacturers would have joined the collection system and financed collection for recycling. Despite the PVC industry's intentions, of the Nordic countries only Denmark has introduced a system for collection of rigid PVC from construction waste through WUPPI AS. The waste is ground up and transported to Germany. Germany has had a take-back system for end-of-life PVC windows and doors for many years, which ensures that the material is recycled and used to manufacture new PVC windows, doors and pipes. Approximately 19,000 tonnes of PVC were collected through the German system, which is called Rewindo, in 2011[89].

There are no take-back systems for PVC windows for material recovery in Sweden, Norway or Finland. The industry's explanation for this is that the windows have a long service life and have not been available on the market for very long.

Nor are there any take-back or recycling systems for composite windows or windows made from other materials.

[89] www.rewindo.de

Considering that the service life of windows and exterior doors is at least 20 years, it is not relevant for Nordic Ecolabelling to impose requirements for a recycling system for end-of-life windows. Newly manufactured windows and exterior doors are produced using today's materials and it is impossible to say how the handling of these products should be managed so far in advance. The main aim of the recycling system requirement was to help increase material recovery. Instead, this is achieved through the requirement relating to the share of renewable raw material in the new window/exterior door. For this reason, the requirement for a recycling system for end-of-life windows has been removed in its entirety.

Packaging
Requirement R24 in version 3 of the criteria states that treated timber and halogenated plastics must not be used as packaging material. The requirement is no longer relevant as these materials are not used in wooden pallets[90] or in packaging plastics such as stretch or shrink wrap. It is therefore suggested that the requirement be removed in its entirety.

5.8 Functional requirements

O20 Durability/longevity of exposed wood parts

To guarantee the durability of the window, the wood needs to be suitably treated. Wood that is exposed to the elements and lacks natural resistance against wear and deterioration must meet one of the options below:

- Impregnated using impregnation that meets penetration class NP3 pursuant to EN 351-1 and 351-2.
- Impregnated with least 4 mm lateral penetration into the sapwood. All end wood shall be sealed using primer and/or covering paint. Joins at the underside of frames and casements, and glazing bars, shall be sealed by applying sealant to the end wood of the profiles prior to assembly.
- Coated with wood preservative in combination with construction using at least 90% heartwood.
- Nordic Swan Ecolabelled wood passes the fungal test under EN 113* and field test under CEN/TS 12037 (ENV 12037) or EN 330**, with subsequent two-stage surface treatment.
- The systems for surface treatment are to be tested according to EN 927 "Coating materials and coating systems for exterior wood". The system must fulfil the limit values "stable end use category" in Table 1 of EN 927-2. The "Exposure condition" defined in Table 2 of EN 927-1 shall be "Medium".

** The wood is to be aged using the relevant method, e.g. EN 73 and EN 84.*

*** Testing is to be conducted in line with standard EN 599.*

Profiles covered with aluminium, other metal, composite or polymer materials are not considered to be exposed to the elements.

✉ Test reports under EN 351-1 and 351-2 for any impregnation.

✉ Test report EN 113 and field test under CEN/TS 12037 or EN 330 for durable wood.

✉ Test report and test certificate under EN 927 for surface treatment systems.

✉ Test report EN 350.

[90] Conversation with companies that manufacture and distribute EUR pallets (Trollhättans Emballage Renovering AB and Åsljungapallen AB)

✉ For Nordic Ecolabelled wood, enter license number.

Background to the durability requirement

Wood can be damaged by bacteria, fungi, insects or other bugs. These organisms can cause rot, discolouration or mechanical damage. Treatment with wood preservation products provides protection against such damage and is used when it is not possible to protect the wood from damp and guarantee its durability using construction technology. Examples include window and exterior door joinery.

The Nordic countries have applied an official standard for the classification of impregnated wood since 1976 (the NTR standard). The standard assigns wood to one of four wood preservation classes, M, A, AB and B. The Nordic Wood Preservation Council (NTR) industry standards are the Nordic implementation of the European wood preservation standards EN 351-1 and EN 351-2.

Wood impregnated according to class AB is intended for use in exposed structures above ground, i.e. risk class 3 pursuant to EN 335, such as fences, barge boards, etc. Wood impregnated according to class B is only intended to be used for external joinery such as windows and doors. The other two classes are not described in further detail in this document, as they are intended for more challenging environments than these windows are subjected to.

The requirements are virtually identical to the previous version of the criteria (version 3). The purpose of the requirement is to ensure satisfactory durability of parts exposed to the elements over time. Version 3 of the criteria contained the requirement a) that impregnated wood material needed to meet the penetration requirements pursuant to the product standard EN 351 (Table 1) and the requirement c) tailored for water-based wood preservation combined with heartwood. The class designation in the current standard has changed since the 2007 version, from P5 to NP3.

The technology group for wood preservation at SP Technical Research Institute of Sweden presented a proposal for reworked wood requirements in 2010. This proposal approves impregnation down to 4 mm penetration into the sapwood, see Table 9. Nordic Ecolabelling feels that the extension is reasonable, and quality assured and proposes that this be added to the requirement relating to the durability of parts exposed to the elements.

As an added proposal, the tests used in the requirements for Nordic Swan Ecolabelled durable wood (for "wood for use above soil") may also apply in documenting that wood meets the requirements concerning "Durability/longevity of exposed wood parts" in the revised Criteria for the Nordic Ecolabelling of Windows and Exterior Doors. In the consultation on the revised Criteria for Windows and Exterior Doors, it was proposed that Nordic Swan Ecolabelled durable wood could be used. The proposal above is an expansion of this proposal and means that if wood meets the test requirements for durable wood, it also meets the test requirements for durability in the window criteria.

Note that the durability requirement in the current Criteria for Windows and Exterior Doors does not set a percentage for heartwood, as is done by Dansk Vindues Verifikation (DVV), which has requirements concerning a 2ØKO priming system with 90% heartwood. This means that the manufacturer can choose to use quite a low proportion of heartwood and still be approved as durable in the Nordic Ecolabelling criteria without the performance of the wood preservation being tested. Note too that

NDVK permits water-based surface treatment systems, if the surface treatment is added after two-step priming. This differs from 2ØKO, which permits one coat of primer and one topcoat.

It is therefore proposed that if a water-based surface treatment system is used, it must either be used in combination with 90% heartwood (in line with DVV) or it must fulfil the tests in the criteria for durable wood. This represents a toughening of the requirement for manufacturers that use surface treatment systems in conjunction with less than 90% heartwood. They must now conduct tests to show that the system is effective. It does, however, allow manufacturers that do not use heartwood to fulfil the requirement. They are free to use their systems, as long as they can document durability through testing.

The requirements are now designed such that they meet various criteria: NTR, P-labelling, DVV and Nordic Ecolabelling.

It should be noted that wood structures that are protected by metal (e.g. aluminium clad wooden windows) or plastic composite/polymer materials are not considered to be exposed to the elements.

Thanks to its natural content of preservatives, 100% heartwood has a natural resistance to rot.

The surface treatment requirements remain unchanged, but the envelope text is clarified. Test report and test certificate under relevant standards in the family of EN 927 - standards shall be submitted for the surface treatment system.

The requirement has been harmonized with the criteria for Durable wood.

O21 Technical requirement

Nordic Swan Ecolabelled windows and exterior doors must meet one of the established, relevant standards in the Nordic region, such as: SFD (Sweden), NCDK (Norway), DVV (Denmark), the FI quality mark (Finland) or P-labelling.

The measurement and calculation methods shall be in line with the stipulations of product standard EN 14351-1.

✉ Specification of which standard(s) the window or exterior door meets, plus valid certificate.

Background to the technical requirement

As of 1 July 2013, all construction products covered by a harmonised standard or European Technical Assessment (ETA) must have a performance declaration and be CE marked in order to be sold in the EU countries plus Norway, Switzerland, Iceland, Turkey and Lichtenstein. This is regulated by the EU Construction Products Regulation (305/2011/EU), abbreviated CPR. The purpose of the CPR is to facilitate trade between the member states. If all EU manufacturers use the same methods to assess and describe the key product properties and also have an organised manufacturing control system, the product can be sold in all countries without the need for further testing or labelling.

The Annex to the EU Construction Products Regulation contains a steered template for performance declaration. It should be completed by the manufacturer, after which the product may be CE marked. A correctly completed performance declaration means, among other things, that the company must have a reliable system for production control

to make sure that products display the performance stated when manufactured in series. The EU Construction Products Regulation obligates the manufacturer to operate a production control system. For some product properties (see harmonised standard) it is necessary to contract a third-party capable of checking that the company's own system of production control works, and in some cases to verify product performance.

There is a harmonised product standard for windows and exterior doors: EN 14351-1:2006+A1:2010 - Windows and doors - Product standard, performance characteristics - Part 1: Windows and external pedestrian doorsets without resistance to fire and/or smoke leakage characteristics. This means that in order to be sold within the EU, windows and exterior doors must come with a completed performance declaration and be CE marked by 1 July 2013 at the latest. No independent third-party checks on the manufacturer's production control systems are required for windows and exterior doors.

It is the construction regulations of the individual EU member states that determine what parameters should be performance declared. Consequently, the information provided for a window or exterior door may vary from country to country.

Windows are also defined as chemical products pursuant to the EU's chemicals regulation, REACH. This means that the manufacturer must also declare the window's content of Substances of Very High Concern that are included on the Candidate List in REACH.

The aim of the EU-wide CE marking scheme for construction products was that all national certification schemes would be phased out and rendered obsolete. This has not happened. European standard labelling does not automatically mean that the product in question can withstand the Nordic climate or that it complies with Nordic environmental regulations. The national door and window certification systems in Denmark, Sweden and Norway are based on European standards for calculating and testing a product's properties but the product requirements are specially adapted to the Nordic climate. The national certification systems (SFDK, P-labelling, DVV and NDVK) will probably co-exist with the CE marking but may change so that they do not relate to the same characteristics as the latter, rather complementing it by looking at other properties or through production controls.

In summary, Nordic Ecolabelling proposes that the requirement for national certifications be retained in order to ensure that good functionality and quality is maintained. The added value of taking into account specific Nordic conditions that affect windows and exterior doors in this region is important. At the same time, we wish to achieve a balance that does not place an unnecessary burden on the manufacturers. Following the consultation, the requirement was reformulated such that any one quality system/quality label from the Nordic market is sufficient.

O22 Guarantee

The window manufacturer must provide a 10-year guarantee covering function, insulating glass unit and wood rot. The guarantee must encompass all functional requirements in the applicable/relevant standards.

The exterior door manufacturer must provide a 10-year guarantee for dimensional stability and a 2-year guarantee for function.

☒ Guarantee certificate supplied with the window/exterior door or information on the manufacturer's website.

Background to guarantee requirement

Where maintenance is conducted regularly and following the window manufacturer's recommendations, the consumer is to be given a 10-year guarantee on the window. The corresponding guarantee for exterior doors is 10 years for dimensional stability and 2 years for function. The guarantee period is judged to be reasonable, since the products are a major financial investment that should last for a long time and that have a major impact on the building's energy performance.

The guarantee requirement remains unchanged compared to version 3 of the criteria. Although the guarantee ceases to apply if the manufacturer becomes bankrupt, we believe the requirement to be at an appropriate level. The guarantee periods are deemed realistic and reasonable, both for the consumer and the manufacturer. The purpose of this requirement was never to be far ahead of the industry in general in this regard. The guarantee applies provided that maintenance has been performed regularly and in accordance with the window manufacturer's recommendations.

O23 Customer information

Manufacturers of Nordic Swan Ecolabelled products shall submit:

- Information on the window's g-value and U-value or the exterior door's U-value in line with O2.
- Information on how to select U- and g-values based on the window's positioning in order to achieve good heating economy and a good indoor climate.
- Information on various sun screening solutions and the importance of such, either as part of the licence applicant's own product portfolio or through an agreement with partners.

✉ Information about the above on website or in brochure.

O24 Installation information

The following shall be attached to each window or exterior door delivery, or alternatively a reference to information available on a website:

- Instructions on handling the window/exterior door during transportation, reception and storage at the building site.
- Instructions on how the window/exterior door shall be installed into a wall, adjusted and protected during the construction period. General physical parameters for fitting must be specified. Instructions on how the window/exterior door should best be installed from an energy point of view, in order to prevent heat loss as a result of poor installation. In addition, the fitting instructions must assist installation without the risk of the window/door, or the wall into which it is placed, suffering damage resulting from the effects of moisture from convection, diffusion or external factors such as rain or snow.
- Instructions describing the recommended maintenance for the window/exterior door. Care instructions must contain details on how often the finish should be checked and maintained/re-applied, and which surface treatment is recommended.
- Information on how the window or exterior door should be handled at end-of-life.

✉ Written recommendations included with the delivery of the window/exterior door to the customer, or reference to the website where such information is available.

Background to the information requirements

Even if a window or exterior door has a low U-value, heat can leak out from the building if a poor job is done on the installation. This is why there is a requirement concerning

installation information. To enable a long service life for windows and exterior doors, which is also an important environmental factor, there is a requirement concerning information about recommended maintenance. To ensure correct handling of waste, there is a requirement concerning information on how the product is to be handled at the end of its life.

These requirements have worked relatively well in connection with licence application processing. The point that required manufacturers to inform customers that a window with a low U-value increases the risk of condensation on the outside in humid conditions when the radiant efficiency between the window and surroundings is great has been removed. The reason for this is the weak or non-existent link to environment and energy and the low steerability. Following the consultation, the requirement for information stating that the window is not recommended for installation in buildings that need to be cooled was also deleted. The reason for this is that there are many other factors that have a much greater impact on the solar heat gain and the building's potential cooling needs.

The requirement has also been split into one that relates to installation and one that relates to customer information. To the latter, a requirement has been added relating to how licensees inform their customers of how the U- and g-values should be chosen based on the positioning of the window. In addition, the licensee must now inform the customer of the importance of sun screening solutions in order to avoid an increased need for cooling. These two requests were raised at an industry seminar held in autumn 2012.

5.9 Quality and regulatory requirements

Requirements O25 to O33 in version 3 of the criteria are general requirements that are always included in Nordic Ecolabelling's product criteria. The purpose of these requirements is to ensure compliance with environmental legislation and fundamental requirements for quality management. Furthermore, there is a requirement that regulates how the Nordic Swan Ecolabelled product may be marketed. There are no proposed changes to these requirements, except that regulatory compliance should be certified and the relevant supervisory authorities listed.

The Board of Directors decided on 17 November 2014 to remove O33 Marketing from the criteria document.

Nordic Ecolabelling's Criteria Group decided on 9 October 2017 to remove O32 Take-back system from the criteria document.

6 Changes compared to previous version

Appendix 1 to this report contains a summary of all requirements and the changes made.

7 Next revision

The next revision of the product group Windows and Exterior Doors will include consideration of the following areas:

- Impregnation and wood preservation methods, taking account of any new BAT/BREF report
- A review of exterior door U-values with a view to further tightening the requirement.
- Relevant environmental and energy requirements relating to the production phase for windows and doors made of metal and composite.
- Resource efficiency throughout the entire life cycle of the product.
- Relevant environmental requirements concerning insulation material in windows and doors.
- Smart windows, i.e. windows that have been modified for various positive characteristics, such as adjustable transparency.
- A tightening of the requirement concerning separability to ensure the steerability of functioning material recovery.

Appendix 1 Overview of changes to criteria compared with previous version

Previous criteria (version 3.4)	Revised criteria (version 4.0)	Comment
R1	O1	Unchanged.
R2	--	Merged with O1. Clarified with percentage weight to be stated for the reference size of the window.
R3	O2	The requirement model entails three levels of requirements for highest permitted U-value. For facade windows with wood as the main material in the frame and casement and where water-based wood preservation techniques or other techniques are used with no VOC emissions, it is proposed that the maximum Uw-value should be 0.91 W/m^{2}K. If, however, vacuum impregnation with solvent and thus VOC emissions is used, the maximum Uw-value will be 0.81 W/m^{2}K. For windows made in materials other than mainly wood (non-renewable materials), there is a requirement that the Uw-value is a maximum of 0.71 W/m^{2}K. For window doors and roof windows (skylights) see the criteria. The U value relates to the entire window or exterior door. Testing, calculations and areas pursuant to the harmonised product standard EN 14351-1.
R4	O3	The requirement relating to the window glass' solar energy transmittance, g_g, has been reformulated but the requirement level remains unchanged at 48% or more. Requirement stating that the window's g value must be 34% or higher added. The requirement relating to daylight transmittance remains unchanged. The word "national" in accredited national institute is removed (valid through out of the criteria). Testing, calculations of daylight transmittance according to the harmonised product standard EN 14351-1.
R5	O4	The requirement for window and exterior door air permeability remains unchanged. A requirement stating that the door must first be tested for differential climate impact according to standard EN 1121 has been added. A requirement stating that air permeability is to be tested for a door of normal size. A requirement stating that differential climate impact also can be tested for climates C and D is added.
R6	O5	The recycled share requirement is set to 30% for frames, casements and door leaves in aluminium and PVC and 20" for frames, casements and door leaves in steel. For plastic composite materials the requirement of recycled share is removed.
R7	O6	Bisphenol A has been added to the list of additives which may not be added to new plastic materials. A lower limit of 50 g is added.
R8	O7	The limit value for max. lead and cadmium content is unchanged to 1,00 ppm. The other monitored substances are removed.
R9	O8	Unchanged. Clarified that it is only valid for the manufacturing of virgin plastics.
R10	---	The requirements have been removed entirely.
R11	O9	The use of filler gases xenon and krypton are prohibited. For krypton a transition period of 24 months is introduced. Filler gases must not contribute to the greenhouse gas effect (GWP 100= 0). This is irrelevant for noble gases.

Previous criteria (version 3.4)	Revised criteria (version 4.0)	Comment
R12	O10	The requirement is essentially unchanged but has been reformulated for clarification.
R13	O11	The scope of the requirement has been expanded to include fibreboard, veneer and plywood. Exceptions exist for wood chip, wood shavings, waste wood, untreated demolition wood and recycled fibre from other industrial activities used in fibreboard.
R14	O12	The requirement is practically unchanged.
R15	O13	Unchanged
R16	O14	Hazard classes and designations pursuant to the CLP regulation have been added to the requirement. The requirement is otherwise unchanged.
R17	---	The requirements have been removed entirely.
R18	O15	Hazard classes and designations pursuant to the CLP regulation have been added to the requirement. The requirement is otherwise unchanged.
R19	O16	The requirement is harmonized with corresponding requirement in the criteria for ecolabelled chemical products.
R20	O17	The requirement is harmonized with corresponding requirement in the criteria for ecolabelled chemical products.
R21	O18	The limit values for VOC emissions have been tightened. For impregnation, they are lowered from max. 11 to max. 9 kg/m^3. For surface treatment they are lowered from max. 75 to max. 60 mg TOC/Nm^3.
R22	O19	The requirement has been simplified to be less micromanaging while still achieving its purpose.
R23 & R24	--	The requirements have been removed entirely.
R25	O20	A statement indicating that parts that are exposed to the elements have sufficient wood protection with a depth of penetration of 4 mm into the sapwood has been added. Relevant tests for Nordic Swan Ecolabelled Durable Wood has been added.
R26	O21	The requirement has been simplified. One of the standards on the Nordic market must be fulfilled.
R27	O22	Unchanged
R28	O23 & O24	The requirement has been divided into Customer information and Installation information. The point relating to U value and condensation has been removed. Requirements added as follows: Information on how to select U and g values based on the positioning of the window. Information on various sun screening solutions and the importance of such. The requirement on information stating that the window is not recommended for installation in buildings that need to be cooled is removed.
R29-R37	O25-O33	The quality and authority requirements are essentially unchanged. The Board of Directors decided on 17 November 2014 to remove the marketing requirement (in this document O33) in all Nordic Ecolabelling criteria document.

Appendix 2 MECO analysis

The results from the MECO analysis performed is available in a Nordic language and may be obtained from sara.bergman@svanen.se

A summary of the results is included in the main body of this report, chapter 4.

Appendix 3 Voluntary ecolabelling of windows

1.1 Introduction

While the EU has been working to develop a shared energy labelling system for windows, Denmark, Sweden and Finland developed their own systems some years ago. Norway does not have an energy labelling system for windows but is displaying a great deal of interest in the Swedish model. The European product standard now uses the dimensions 1,230 x 1,480 mm which is then converted into square metres. Both the Danish and the Swedish energy labelling systems use these dimensions. According to the website, Finland uses other measurements.

The U value calculated based on the entire window, i.e. glass, jamb and casement is called the U_W value.

Solar energy transmittance is expressed in the same way. The window's g value (g_W) is always lower than the g value for the glass pane (g_g) as no heat permeates the jamb and sash.

1.2 Description of the Nordic systems

Denmark

In recent years, Denmark has introduced the energy balance concept (E) through its construction regulations. E_W expresses the window's energy balance during the heating season sunlight entry minus heat loss. A positive E value mans that more heat is added than is lost, i.e. that the window contributes positively to the building's heating requirements.

The E_{ref} value indicates the entire system's energy balance during the heating season. Here, the window is fitted into a context; a so-called reference building. E_{ref} is calculated for a reference building with medium-level insulation and a certain window orientation (41% south-facing, 33% east/west-facing and 26% north-facing).

$E_{ref} = 196.4 \times g_W - 90.36 \times U_W$. This formula applies to facade windows. There is a different formula for roof windows.

- the factor 196.4 is the sunlight entry into the house with standardised window positioning.
- the factor 90.36 is the number of degree hours during the heating season.

The Danish energy labelling scheme rates the windows on a scale of A-F. In addition, information about the U value, g values and daylight transmittance is stated for all energy rated windows. Danish construction legislation (BR10) demands class C windows, or better, be used when replacing windows in existing buildings. This is expected to be changed to class B, or better, in 2015.

Table 10: The Danish energy labelling scheme rates windows based on an energy balance calculation.

Class	Energy balance E_{ref} (kWh/m^2)
A	$0 \leq E_{ref}$
B	$-17 \leq E_{ref} < 0$
C	$-33 \leq E_{ref} < -17$
D	$-55 \leq E_{ref} < -33$
E	$-60 \leq E_{ref} < -55$
F	$E_{ref} < -60$

Sweden

The Swedish energy labelling scheme rates windows based solely on the U_W value, i.e. based on the entire window's heat loss. Windows are given an energy rating of A-G based on their U value. A is the top energy rating. Even though the Swedish energy labelling is based only on the U value, g values and daylight transmission are stated alongside the classification for reference.

Table 11: The Swedish energy classification system for windows

Class	U_w (W/m^{2}K)
A	0.9 or lower
B	1.0
C	1.1
D	1.2
E	1.3
F	1.4
G	1.5

The system for energy classification has been revised. One change has been the review of the requirement levels. In the future (unclear when exactly) class A will correspond to windows with a U value of 0.8 or lower.

Norway

The Norwegian industry has not developed an energy labelling/classification scheme for windows like the rest of the Nordic countries. There is, however, a product labelling for windows called 'Enova Anbefaler'. It is not clear what is required in order for windows to be awarded this label. It appears as though tripe-glazed windows may be labelled. Possibly, the U value must be 1.0 W/m^{2}K or lower.

Finland

The Finnish energy labelling system for windows is based on annual energy consumption, E_a, which is a function of the window's U value, g value and air permeability (L) according to;

$$\mathbf{E_a = 140 \times U_W - 160 \times g_W + 50 \times L}$$

The air permeability (L) represents the air permeability of the window structure (glass, frames and sashes) and is measured in m^3/m^{2}h. For example, an E_a value of 100 means

that each square metre of window surface consumes 100 kWh of energy annually. This means that the lower the E the better insulation the window provides.

Table 12: The Finnish energy labelling system which rates windows from A++ to G

Class	Annual energy loss per square metre E_a (kWh/m^2year)
A++	E < 45
A+	E < 65
A	E < 85
B	E < 105
C	E < 125
D	E < 145
E	E < 165
F	E < 185
G	E ≥ 185

It should be noted that the Finnish rating system uses a different surface area than that stipulated in the European product standard, which means that it is not possible to directly compare the U and g values. The energy rating label itself states, aside from rating and E value, the U value, g value and air permeability.

Appendix 4 In-depth materials description

This appendix is available in a Nordic language and may be obtained from sara.bergman@svanen.se

A summary of the materials can be found in the main part of this report, chapter 5.3

Appendix 5 Description of techniques used to protect and treat wood

Introduction

Wood can be damaged by bacteria, fungi, insects or other bugs. These organisms can cause rot, discolouration or mechanical damage. Impregnation or surface treatment using wood protection products can help protect against these attacks. Impregnated wood is used when it is not possible to protect the wood from damp and guarantee its durability using construction technology. Examples include window and exterior door carpentry.

Durability/wood protection effect

The Nordic countries have applied an official standard for the classification of impregnated wood since 1976 (the NTR standard). The standard designates wood one of four wood protection classes: M, A, AB or B. The Nordic Wood Preservation Council (NTR) industry standards are Nordic application documents for the European wood protection standards EN 351-1 and EN 351-2.

Wood impregnated according to class AB is intended for use in exposed structures above ground, i.e. risk class 3 pursuant to EN 335, such as fences, barge boards, etc. Wood impregnated according to class B is only intended to be used for external carpentry such as windows and doors. The other two classes are not described in further detail in this document as they are intended for more challenging environments than these windows are subjected to.

Biocides

Traditional wood protection treatment involves the use of biocides (fungicides). In order for a biocide to be released on the European market, the active substance must have been approved for the EU and included in the positive list in the Biocide Directive (98/8/EC), appendix 1. Those who sell biocides are then responsible for ensuring that the products have been approved by the relevant body for the country in question. In Sweden it's the Chemicals Agency that is responsible for product approval in accordance with the Biocide Directive. In Denmark the equivalent is the Environmental Protection Agency, etc. In the approval process, this body also takes into account the usage phase and the risk of leaks and a diffuse spread of biocides. The risk of diffuse spread is also minimised by painting/lacquering the wood profiles which creates a protective, encapsulating shell. The biocides used in connection with wood protection treatment are fungicides and contain one or several of the active substances listed in table 13.

Table 13: Common active substances in wood protection agents.

Active substance	Classification	Risk phrase	Chemical designation
Propikonazol	R22	Harmful if swallowed	
	R43	May cause sensitisation by skin contact	
	R50/53	Very toxic to aquatic organisms; may cause long term adverse effects to the aquatic environment	
Tebukonazol	R22	Harmful if swallowed	
	R63	Possible risk of foetal damage	
	R51/53	Toxic to aquatic organisms; may cause long term adverse effects to the aquatic environment	

Active substance	Classification	Risk phrase	Chemical designation
IPBC	R50	Very toxic to aquatic organisms	3-iodo-2-propynyl butyl carbamate
	R50/53	Highly toxic to aquatic organisms; may cause long term damage to the aquatic environment	

The most common sources of environmental pollution are the addition of chemicals, storage of chemicals, spillages during the impregnation process, accidents, spillages from drip locations and leaching from storage locations. This applies to both types of impregnation. It is therefore important that these processes take place under controlled circumstances. The Danish Technological Institute has designed and tested an outdoor method together with the Technical Research Institute of Sweden, the Norwegian Institute of Wood Technology, Dyrup A/S, Bayer AG, Troy Corporation and Jansen Pharmaceutica. Here the focus is on products containing Tebuconazol and Propiconazol, two of the products that have replaced older heavy metal-containing products. The test showed that a larger volume of biocide leached was greater for horizontal panels (decking) than for vertical panels (facade) and that all impregnation methods resulted in some degree of leaching. Surface treatment resulted in more than twice as much leaching as the other three impregnation methods (vacuum, pressure and supercritical). This indicates that leaching is very much a surface phenomenon. Leaching was on the same level for the other three methods. The volume of biocide leached from chemical wood protection naturally depends on whether or not the wood undergoes subsequent surface treatment[91].

Processes

Impregnation

The impregnation methods are pressure impregnation and vacuum impregnation. Pressure impregnation is now often water-based with the use of various salts (copper, chromium, etc.). Pressure impregnation is not allowed for Nordic Swan Ecolabelled windows and exterior doors and is therefore not described further in this document[92]. Vacuum impregnation is only used to impregnate finished construction carpentry such as windows, doors and garden furniture. The process is less deep and saturating than pressure impregnating but is still considered adequate for the purpose.

Vacuum impregnation is normally performed using organic solvents. The product used often consists of 90% organic solvent, usually turpentine, and 10% active substance/ fungicide. The most common products are Propikonazol and/or Tebukonazol, see table 13.

The company Osmose Timber Technologies covers 95% of the Nordic vacuum impregnation market. According to the safety data sheet, their biocide product, Protim P-Vac 11, contains 1.6% by weight of the active substance Propikonazol. Protim P-Vac 11 is classed as R43, R65, R66 and R51/53. As there are exceptions for classification R51/53 in vacuum impregnation (see R16 in version 3 of the criteria) there is nothing to stop the product being used.

The Nordic Wood Preservation Council (NTR) imposes requirements relating to the wood's absorption of the active substance of the various wood protection agents. For

[91] Udvaskning af biocider fra imprægneret træ - Viden om Træ 3/2004
[92] It is neither relevant nor neccesary to use pressure impregnated wood in windows and exterior doors covered by use class 3 in standard EN 335-1.

Protim P-Vac 11 the (min.) requirement is 0.41 kg/m^3 impregnated wood for class B. In practice, about 11 kg of fluid is applied to each square metre of wood. The impregnation takes place in a vacuum and 6 mm of the sapwood is impregnated to at least 0.41 kg/m^3 and all excess is removed either directly to the air or via catalytic combustion in order to efficiently reduce VOC. Process optimisation has resulted in a reduction from about 16-20 kg/m^3 of product to the current 11 kg per cubic metre of material produced. The driving force here has been a wish to reduce drying times[93].

Another approved wood protection product is Gori 605, manufactured by Teknos. It contains Propikonazol, Tebukonazol and IPBC, all at 0.33 weight per cent. Gori 605's risk classification does not contradict the Nordic Ecolabelling's current requirements. The total content of substances classed as R63 must not exceed 0.5 weight per cent in order to meet the Nordic Ecolabelling's present requirement R18, and Tebukonazol does not in this product.

Vacuum impregnation using organic solvents results in emissions of volatile organic compounds. These so called VOCs are primarily a mixture of aliphatic (as opposed to aromatic) hydrocarbons and contribute to the formation of low level ozone, a substance that is harmful to health and the environment. The use of VOCs also involves working environment risks. There are ways of reducing the VOC emissions to the air. Mainly, this involves using products with a lower solvent volume. One end-of-pipe measure that could be applied is the treatment of emissions through combustion, adsorption or recycling. A BAT/BREF report for Surface Treatment Using Organic Solvents[94] within the EU indicates that emissions could be reduced by 70%. This should not be taken to mean that pressure impregnation using turpentine is the BAT for window production. As the title of the report indicates, the BAT report relates to surface treatment using organic solvents in general. Unfortunately, the planned BAT report for Wood and Wood Products Preservation has not been started yet.

Impregnation can also be performed using carbon dioxide as the bearer in a so called supercritical impregnation process. Hampen Træforarbejdning A/S on Jutland, Denmark, has one of the world's first large-scale plants for impregnating spruce wood using super critical carbon dioxide, so called Super impregnation/Superwood[95]. One advantage of the supercritical phase is that some of the carbon dioxide's properties are retained while new properties are added. For example, it behaves like a solvent while penetrating the wood like a gas. The impregnation substance Gori SC200 is applied to the wood. The impregnation takes place in a closed process where carbon dioxide acts as the bearer that helps the wood protecting agent penetrate the wood using high pressure (supercritical level). At the end of the process, the carbon dioxide and wood protectant are pumped back and reused, apart from a small volume left inside the material.

The active components of Gori SC200 are:

- Propikonazol (8-9 % in product)
- Tebukonazol (8-9% in product)
- IPBC (3-5% in product)

[93] Conversation with Lars Nyborg, technical manager at Osmose Timber Technologies.
[94] BREF 2007; Joint Research Centre, IPTS, The European IPPC Bureau.
[95]For further information, please see www.superwood.dk

Impregnation using the biocide Gori SC200 is on average 0.12 kg/m^3 wood in the Jutland plant. This should be seen as an indication of the amount of biocide remaining in the finished product. This type of impregnation penetrates the entire material and not just, as in the case of vacuum impregnation, a small part. Superwood is approved for use class 3 pursuant to standard EN 335-1 (wood above ground that is often moistened to 20%). As Superwood is currently only able to impregnate spruce wood, reference cannot be made to NTR's use classes as these apply to pine wood. Apparently the residual volumes of 0.12 and 0.14 (for Protim P-Vac using vacuum impregnation) are relatively comparable. The active substances are also relatively similar. When it comes to biocide use there is no risk of a burden shift between the techniques.

It became clear from conversations with Anders Kjellow at Superwood Denmark that they sell impregnated spruce wood to window manufacturers. However, the Superwood treated wood is not used for all-wood windows but as a core in plastic windows. The wooden core needs to be protection treated due to the risk of moisture permeating the wood through screw holes, etc.

Fact box. Heartwood and sapwood

Heartwood is the innermost part of the tree and is surrounded by sapwood. The sapwood transports water from the root to the needles. The heartwood, however, consists of inactive cells that act as protection and nutrient stores. A cross section of the log clearly shows the line between sapwood and heartwood as a difference in colour (see the image below).

Anders Kjellow states that their product development is currently focused on developing processes that will allow them to super impregnate pine for use in windows, with satisfactory results. In summary, there are good chances of Superwood being used to produce standard pine wood windows in the future. However, this is currently not commercially viable and will not be required in this revision.

Flowcoat and subsequent surface treatment (the 2ØKO concept)
Water-based wood protection techniques have also been developed as an alternative to traditional vacuum impregnation. These are often used together with varying volumes of heartwood. Dipping means that the wood is dipped into a vat containing wood protection product without changing the pressure or temperature. Flowcoat is an application technique whereby the wood is rinse painted/sprayed. One advantage of these techniques is that they are performed in a continuous flow and not in batches.

2ØKO is a two-step surface wood protection technique. First the wood is treated (primed) by being dipping into a vat of fungicidal solution, or given a so called flowcoat. The surface is then treated/painted with a product also containing fungicide and approved surface treatment products. The Association of Danish Window Manufacturers has a list of all certified surface treatment systems on its website.[96]. The Association of Danish Window Manufacturers recommends that 2ØKO be used only in combination with a high share, at least 90%, of heartwood.

[96] www.vinduesindustrien.dk

The method is very common in Denmark and has been for about ten years. Between 90% and 95% of the Danish windows industry use water-based wood protection and surface treatment[97]. The 2ØKO system has almost succeeded in phasing out vacuum impregnation in Denmark. The number of such plants in Denmark has fallen from 60-70 to about seven. It should be noted that even though 2ØKO is normally taken to mean a water-based system, there are also approved solvent based 2ØKO systems on the market!

All water-based techniques are characterised by a far shallower level of penetration than impregnation. The idea is that the use of heartwood[98] compensates as it has a natural resistance to effect and degradation.

Water-based flowcoat technology has been used by the licensee Svenska Fönster in Sweden for almost ten years. Becker Acroma (now a part of the Sherwin-Williams Group) is the supplier and the name of the biocide used is AA1939 Laqvin Seal. The active substance is IPBC (see table 16). Svenska Fönster uses wood with about 50% heartwood on average.

What do the national quality labelling systems say?
Vacuum impregnation does not require heartwood as the wood protecting agent penetrates 5-8 mm into the wood with the help of the solvent and the pressure applied. Both vacuum impregnation, the solvent turpentine and supercritical impregnation using carbon dioxide can be used on sapwood.

2ØKO treatment involves a penetration of about 1.5 mm and in order to ensure durability, a certain share, normally 90%, heartwood is required in the window.

Denmark switched to the water-based 2ØKO systems years ago and these are believed to meet the EN 152 anti-mould requirements. The 2ØKO system is one of three treatment systems approved for doors and windows under the Danish certification system Danish Window Certification (DVC). The other two systems are impregnation using turpentine or supercritical carbon dioxide with various penetration classes (6 mm and 3 mm) for sapwood. According to the technical stipulations, 2ØKO shall be used with 90% heartwood. Compliance with this is monitored through regular on-site inspections.

The Norwegian labelling system NDVK recently accepted 2ØKO as a treatment method provided that 90% heartwood is used from the internal fold edge to the exterior edge of the window. According to NVDK[99], they also accept flowcoat without the use of heartwood, provided that the manufacturer primes using a fungicide and performs a subsequent two-step surface treatment.

The Swedish window quality labelling scheme the P label approves the following three alternatives:

The Swedish manufacturers using a water-based wood protection and surface treatment technique are maintaining a dialogue[100] with the Technical Research Institute of Sweden (SP) with a view to introducing this as an approved treatment method. Discussions are

[97] Conversation with Director Johny Jensen at Vindues Industrien (the Danish Windows Industry).
[98] The Nordic countries apply the same definition of heartwood, conversation with Hans Brolin, P labelling of windows, SP.
[99] Conversation with Ivar Hansen at NDVK.
[100] Conversation with Kent Wahlén at SP Fönster (Swedish licencee)

also being held with the Nordic Wood Preservation Council (Nordic Wood Preservation Council) on how to define wood protection classes treated using water-based systems. Representatives for P labelling[101] are not overly positive to water-based systems for the following reasons:

- The negative impact on quality is unclear due to a lack of studies.
- It has yet to be established how to measure and present results in a standardised manner. Should a certain volume on the surface be shown, as in Denmark, or should the volume in the wood be shown in the same way as for impregnation?
- It is naive to think that a high share of heartwood can compensate for permeation. The wood available today is not heartwood as it was in the 1700s.

Alternative treatment methods without the use of fungicides (modified wood)
Modified wood may be heat treated wood, acetylated or furfurylated wood. All these methods are environmentally adapted alternatives to pressure impregnation as they do not contain biocides. The three methods mentioned above are included in the Nordic Swan Ecolabelling of Durable wood-alternative to conventionally impregnated wood.

Modified wood is still a new material in this context. Tests etc. show that modified wood is well suited to window production. However, there are a number of reasons why it is not a commercially viable option yet:

- Modified wood is far more expensive than normal window wood. Heat treated wood is about twice the price.
- The process is not standardised, meaning that it is not steerable nor possible to show how variations affect product quality.
- Environmentally adapted water-based treatment options work really well, so why try something new?
- The best results with heat treated wood were achieved with beech while the windows industry in the Nordic region uses almost exclusively pine.
- Acetylation and furfurylation increases the risk of the window's metal parts becoming corroded.

In summary, modified wood is not yet an alternative to vacuum impregnated, dipped or flowcoat treated window wood.

[101] Conversation with Jöran Jerner, expert on wood protection treatment and P labelling of windows, SP.